

Cultivating Disaster:

The Effect of Cannabis Cultivation on the Environment of Calaveras County

A Report from
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We also want to acknowledge the important work by those in the public sector here in Calaveras County but also our friends and colleagues work in the government of the United States and the State of California. The work of the Sheriffs Office of Calaveras County is particularly noteworthy along with many county offices and notably the County Office of Code Compliance.

Finally, it is important to thank those in journalism who have engaged in fine news reporting to uncover the truth of the ecological damage being caused by marijuana cultivation. We also want to thank United States Congressman Tom McClintock and his office in their efforts to bring this ecological nightmare to federal authorities.

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Table of Contents

| | |
|---|---------|
| Preface | Page 7 |
| Introduction | Page 9 |
| Putting Environmental Contamination of Water in Perspective | Page 11 |
| Cannabis Cultivation in Calaveras County | Page 13 |
| The Green Rush in Calavaras County | Page 16 |
| Identified Problems | Page 18 |
| US Department of Interior Analysis | Page 24 |
| Summary and Recommendations | Page 27 |
| Final Thoughts | Page 29 |
| Bibliography | Page 31 |
| • The Environmental Impacts of Marijuana in California | Page 33 |
| • Scientific American: Burgeoning Marijuana Market Prompts Concerns about Crop's Environmental Impact | Page 34 |
| • Science Daily: Marijuana's hidden price: Environmental impact | Page 36 |
| • The High Environmental Cost of Illicit Marijuana Cultivation | Page 37 |
| • High Time for Conservation: Adding the Environment to the Debate on Marijuana Liberalization | Page 40 |
| • Study Shows Marijuana is Sucking the Eel River Dry | Page 43 |
| • Legally Grown Pot Still Has a Toxic Pesticide Problem | Page 45 |
| • Pleasure, Panacea, Poison? The little-known health effects of marijuana | Page 49 |
| • Illegal Pot Farms Are Poisoning California's Forests | Page 53 |



Preface

Calaveras County is truly a remarkable place. Recently our county was ranked as one the top 14 places to live in the United States, ranking ahead of counties like Napa. When walking through our foothills, there is a marvelous serenity of silence as one listens to the wind blow through the tall trees. That silence is marvelous but there is a growing threat to that beauty and peace of the county. There is, what could be called, a ***Silent Poison*** creeping into our environment that is significantly and negatively impacting our wonderful area for generations.

Over the past four years, Calaveras County has experienced a dramatic increase in the cultivation of cannabis or marijuana. The Calaveras County Board of Supervisors approved an ordinance that would permit temporary legal production of marijuana. This was a huge mistake in ever allowing any cultivation of the drug without adequate understanding of the impact of the industry on the county's environment, health, and public welfare.

Most local news coverage here has been focused on the serious law enforcement/public safety problems caused particularly by irresponsible growers. However, there is increasing evidence that cannabis production in our county and other counties around the nation is having an appalling impact on the environment. The use of dangerous chemicals has had serious effect on the watersheds throughout the west. An important example is the Eel River in Northern California where a large portion of the river has been polluted and poisoned. A crisis in water quality has been created there.

We now have a ***Silent Poison*** in our foothills that is polluting our water quality and it will take years if not decades to clean up. The purpose of this paper, ***Cultivating Disaster***, is to assess the damage to the environment caused by marijuana production. This report includes in-depth analysis by scientists, government regulators, and respected news organizations.

We appreciate the assistance of The Communications Institute (TCI) in the creation of ***Cultivating Disaster***. TCI has conducted many studies and public policy educational programs for more than a decade working with major academic institutions such as The RAND Corporation, University of Southern California, University of Arizona, the US National Energy Laboratories, and many others. TCI programs have included topics such as energy, health, land use policy, and immigration and has the knowledge and ability to tackle this important subject.

It is ironic that our community, site of much of the Gold Rush, is now experiencing a new invasion of treasure seekers whose new "gold" is "pot.". This is the ***Green Rush*** as opposed to the ***Gold Rush***. This report reviews this important comparison.

Cultivating Disaster assesses the problem but also provides some specific recommendations to meet the challenges caused by production of cannabis in our county. The environmental challenges and complications are huge but too many policy makers and the public itself have no understanding of the ecological time bomb now in our foothills caused by the production of a substance even the United States Government finds is a dangerous drug.

We hope this study will promote intelligent public debate and steps by all levels of government to deal with this problem.

Sincerely,

Dennis Mills
Member of the Board of Supervisors
County of Calaveras
San Andreas, California



Algae in pond



Unabated water run-off



Size of grow sites



Proximity to neighbors



Watershed not protected



No remediation after eradication



Vegetation destruction



More algae in ponds

Introduction

Over the past several years, news organizations have given massive coverage to the movement to legalize the sale of marijuana or cannabis in United States, The Washington Post, among many media touted the “economic benefit” of the growing and selling the drug but ignore the real cost to communities and society. The Post noted: *“Setting up marijuana nurseries and dispensaries would be the first step for the states that voted in favor of medical marijuana. These would not only create jobs but also set the ball rolling for economic activity in the pot industry in these areas.”* The Post totally missed the real story. This study reviews one of those costs ignored by too many in the media for far too long, the impact of cultivation on the environment.

Another research study estimated that at least 81,000 additional direct, indirect and induced jobs in California as a result of legalized marijuana production and sales. It also projected an increase in total labor income by at least \$3.5 billion. Various studies contend California will benefit with large amounts of revenue, taxes and jobs but the big unanswered question is **“At what cost?”**

In 1849 California experienced huge economic and population growth with the Gold Rush. This study will discuss the impact, positive and negative in the following pages. Clearly now, nearly 170 years later, our state is beginning to understand the environmental impact of what could be called the “Green Rush.” However, we are discovering while it is a race for the green of money, it is having a detrimental impact on the “green” of the environment in California today.

Silent Poison- In 1962 Environmentalist Rachel Carson authored the book *Silent Spring*, that focused on the ecological degradation of the environment caused by the misuse of chemicals. It is important to note that the proper use of chemicals in agriculture, industry, and in our homes, is very beneficial. It is the misuse of the chemicals that is important to understand. It is the Silent Poison emanating from marijuana cultivation that is the purpose of this report.

We have entitled this report ***Cultivating Disaster*** in order to bring needed attention to the quiet seeping of dangerous chemicals into our creeks, streams and rivers and eventually our homes here in Calaveras County caused by this cultivation. Now is the time to take action.

Impact of Cannabis Cultivation - The growth of cannabis cultivation in Calaveras County has been significant with incredible ramifications on the public’s health and safety. There has been much written and discussed on the impact on public safety but relatively insignificant attention to the environmental impact as our rivers and streams are being silently poisoned. Few media have covered the environmental impact of the growing of marijuana and the use of high potency fertilizers and toxic chemicals to produce it.

The Scientific American published an important article earlier this year on the impact of marijuana cultivation on the environment. The article noted that without an effort to cope with the negative impact on the environment, the chemicals and water required for cannabis cultivation will have a terrible impact on the environment. The article featured U.C. Berkeley ecologist Mary Power who warns, *“summer plantations could transform local rivers from cool and “salmon-sustaining” to systems full of toxic cyanobacteria. Over eons of evolution native salmon species have adapted to “deluge or drought” conditions, she says. But the double whammy of climate change and water extraction could prove to be a game-changer.”*

Eel River – The Eel River is major California River stretching 196 miles in northwestern California. Its environmental quality has been seriously compromised. The attached Bibliography includes articles documenting the pollution of the Eel River in northern California by chemicals used in cannabis cultivation.

The Yale University School of Forestry and Environmental Studies paper, noted earlier, points out the pollution caused by the heavy use of nitrates and other chemicals in cannabis growing. The paper declares:



Mary Power, a biologist at the University of California, Berkeley, has studied the situation firsthand in the Eel River watershed in Mendocino County. In an interview with Yale Environment 360, Power describes how marijuana growers in that region now siphon off scarce water resources, poison wildlife, erode fragile soils, and overload waters with nutrients.

Chemicals and Marijuana

There are two key health and environmental impacts of marijuana production:

1. **Impact on the Environment** – Land and water is being polluted by the often illegal and over use of chemicals notably ***nitrates***. This is of direct concern to Calaveras County. We do not want to permit further contamination of our county by cannabis cultivation.
2. **Agriculture Chemicals and the Pot Consumer** – Another little considered impact of chemicals in production, is their impact on the product that pot users ultimately consume. There is no required testing of cannabis, sold to the public, by Federal Agencies such as the Food and Drug Administration. The public's health is not protected.

The Huffington Post recently noted:

*Many of the chemicals applied to pot plants are intended only for lawns and other non-edibles. Medical cannabis samples collected in Los Angeles have been **found to contain pesticide residues at levels 1600 times the legal digestible amount**.*

Because the product is generally inhaled rather than eaten, any toxins it carries have an even more direct route into the lungs and blood stream. Raber noted the situation is all the more concerning for patients smoking medical cannabis, whose health problems could make them more vulnerable to the risks pesticide exposure brings — especially if they suffer from a liver disease.

While this paper focuses on the first impact – **the environment**, we believe that policy makers should also be looking more carefully at the impact chemicals in marijuana production have on the long-term health of the consumer.

We hope that this paper ***Cultivating Disaster*** will bring to the attention of policy makers, the public and the media the necessity of ending the environmental destruction caused by cannabis/marijuana cultivation on the health and welfare of the people of Calaveras County but also the region and the nation.

Putting Environmental Contamination of Water in Perspective

According to the United States Environmental Agency (EPA), the Clean Water Act is the central federal law dealing with the pollution of our streams and rivers. The EPA notes: The Federal Water Pollution Control Act of 1948 was the first major U.S. law to address water pollution. Growing public awareness and concern for controlling water pollution led to sweeping amendments in 1972. As amended in 1972, the law became commonly known as the Clean Water Act (CWA). At that time the vast majority of rivers in our country were suffering from various levels of contamination.

Notably the Potomac River that flows through the nation's capitol was a brown mess full of old tires, dead animals, and other disgusting debris. It was a mess. Today, any visitor to Washington will see the huge change in the Potomac. The focus on Clean Water by Congress and President Nixon then was vital to restoring our nations rivers and streams.



The Clean Water Act included these important elements to protecting our nations water:

- Established the basic structure for regulating pollutant discharges into the waters of the United States.
- Gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry.
- Maintained existing requirements to set water quality standards for all contaminants in surface waters.
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.
- Funded the construction of sewage treatment plants under the construction grants program.
- Recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Application to Cannabis Cultivation - In the consideration of impacts created by cannabis cultivation, it is clear that there has been little application of these federal laws in the permitting or operating marijuana cultivation here or probably other areas of California and the nation.

The State Water Board's website notes that in November 2016, California voters voted in favor of Proposition 64, which permits non-medical use of cannabis for adults over the age of 21. The Water Board said the passage of this new legislation regarding cannabis use, distribution, manufacturing, cultivation and transportation brings with it new regulatory requirements.

Supposedly Cannabis cultivators are now required to obtain a state and local cultivation license and must meet all state and local environmental regulations including the Water Code, Basin Plan, and Clean Water Act. This law clearly has not been enforced. Even the state notes "*Cannabis cultivation can cause significant environmental damage, including discharges of polluted wastes to surface water and groundwater, erosion and sedimentation, and illegal diversions of surface water. The environmental provisions of MCRSA and Prop 64 are more important now than ever to limit environmental degradation associated with cannabis cultivation as the new legislation will bring existing cultivators into a regulatory framework and new cultivators will join the growing market.*"

Our research reveals that the state and federal regulations presented on the State Water Board Website have been ignored by policy makers and most growers.

Impact of Water Pollution – There are many examples of the negative impact of water contamination.

- **Hinckley Incident** - The Hinckley incident in southern California is example of a drinking water contamination *Disaster*. This prompted in a communitywide class action law suit as presented in the movie, in 2000, *Erin Brockovich*. It started between the year 1952 and 1956 when many people had reported falling ill—while some even died from the exposure! After drinking the water, residents showed extremely high risk for breast, lung, brain and gastrointestinal cancer, kidney and ovarian tumors, miscarriage and Hodgkin's disease. This was years after the contamination was first noted.
- **North Carolina Incident-** In May 2015, people who live near Coal Ash Pond in North Carolina were advised not to drink their water as it contains high level of toxic heavy metals. As reported, 152 out of 163 water wells were tested for ground water contamination. Sadly, the wells did not pass the state standards for groundwater. Traces of lead, vanadium and hexavalent chromium were found in the drinking water in the area resulting in health impacts on the public.

In each of these cases or other environmental disasters like the nuclear pollution of Rocky Flats near Denver or the Hanford Nuclear Reservation on the Columbia River, policy makers and the public were not aware of the contamination until years or even decades after the pollution occurred. The goal of environmental laws analysis is to reduce or eliminate the negative impact of man's activity in the environment.

Agriculture and controls - It appears the laws that all farmers in our state must follow, have been discarded by too many marijuana growers and particularly those growing the plant illegally. Agriculture in California follows strict requirements in the application of chemicals and fertilizers, the label is the law. Products used must be labeled as approved for use on the agricultural product being grown with application rates, methods, time of day, wind speed, containment, and in the case of chemicals OSHA compliant safety equipment used and blood testing of workers. Air and water monitoring both upstream and downstream are often required to insure there is no migration to neighboring property via air or into adjacent streams. In some cases, neighbors must be notified.

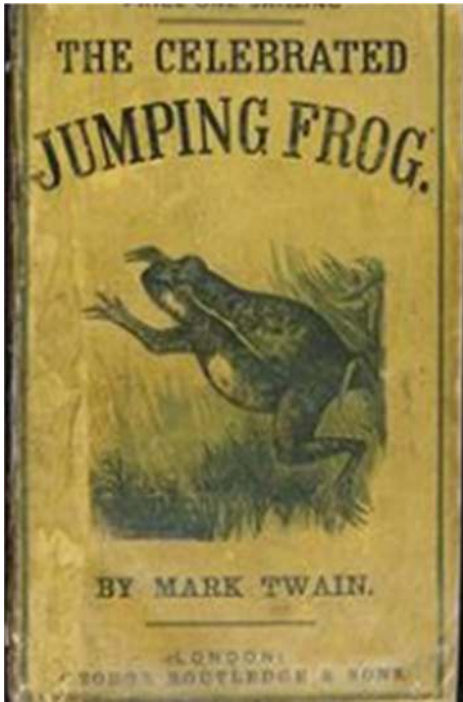
This discussion is about the lack of controls in the use of chemicals and fertilizers on marijuana in Calaveras County and other counties throughout the foothills and nation. The result is unknown levels of environmental damage left behind. Chemical fertilizers are often salty, contributing to additional environmental loading in watersheds. Fertilizers with high nitrates are of particular concern as nitrate loading contributes to cyanobacteria which kills fish and animals. Nitrates from water treatment plants and agricultural dischargers are closely monitored by the state due to the proven environmental damage high nitrate levels can do to the ecological food chain.

Marijuana growing does not fall into any level of agricultural controls for use of chemicals or fertilizers within the state currently. Logging of what combinations of chemicals are used in a specific grow is optional at this time.

Summary - It is clear that the imposition of commercial or even private cultivation of marijuana damages water quality, the environment, fisheries, and the public's health as shown by the Eel River disaster. It is also clear policy makers need to address this reality as they make decisions and insure current federal and state law is abided.

State and federal water agencies need to work particularly with rural counties like Calaveras in addressing the distressing impact of marijuana cultivation on the local environment. Unlike the previous examples, we know **now** that our region has big problems! We do not have to wait decades to discover them.

Cannabis Cultivation in Calaveras County



Calaveras County has long been known for its rich history dating back to Mark Twain and his story, "*The Celebrated Jumping Frog of Calaveras County*". Our county has been known also for its marvelous Giant Sequoia trees, wonderful vistas, rolling hills, great wines, and whitewater rafting. However, perhaps its most important attribute is the clean abundant water provided to millions of California and contributing to the agricultural engine of the state.

Gold prospecting played a huge role in Calaveras County's history which began in late 1848 with a camp founded by Henry and George Angel. According to researchers, the brothers first arrived in California as soldiers, serving under Colonel Frémont during the Mexican War. Following the war's end, the brothers found themselves in Monterey where they heard of the fabulous finds in the gold fields. They joined the Carson-Robinson party of prospectors and set out for the mines. The company parted ways upon reaching what later became known as Angels Creek and that little miners' town eventually became known as Angels Camp. Calaveras County was the home of the Mother Lode which is the large quartz deposit filled with Gold.

Today, Calaveras County is the home of a growing wine industry, and other agricultural products like olive oil. It has become a huge year-round recreational center and is home to 45,000 people. Increasingly many Californians have moved to the country as a prime location to retire and even continue work in a variety of industries. It is also home to thousands who work in the public and private sectors in the Central Valley.

The Green Rush and the County - Today the county has a relatively new industry, purported by owners to provide a great potential benefit to the county; the cultivation of Marijuana. In reality the drug Marijuana has been grown in some form within Calaveras County since before the gold rush. Over the past decades, locals would find hidden out of the way spots to grow a few plants "out back" or under the trees in some remote location of which they knew only a few people were aware. There was no intention to make money growing "pot" or even to grow the most potent new forms, it was for their personal use and they quietly went about their business with little attention paid to their activity.

Marijuana Cultivation Today - All of this was changed in 2010. California voters considered a proposal to legalize the sale and cultivation of marijuana with Proposition 19 (also known as the Regulate, Control & Tax Cannabis Act) on the November 2, 2010 statewide ballot. It was defeated, with 53.5% of California voters voting "No" and 46.5% voting "Yes." In California, the possession or use of marijuana for recreational purposes was illegal going into the election in November 2016. The passage of Proposition 215 in 1996 legalized medical marijuana. Although the Department of Justice under President Obama did not prosecute most individuals and businesses following state and local marijuana laws, both medical and recreational marijuana were still illegal under federal law in 2016.

Voters passed Proposition 64 on November 8, 2016 to permit adults aged 21 years or older to possess and use marijuana for recreational purposes. The new law created two new taxes, one levied on cultivation and the other on retail price. The new law empowered Counties and municipalities to restrict where marijuana businesses could be located as land use decisions. Local governments were also allowed to completely ban the sale of marijuana from their jurisdictions. Moreover, local jurisdictions were allowed by the measure to "reasonably regulate" the personal growth, possession, and use of marijuana plants allowed by Prop. 64.

The debate over marijuana production in Calaveras County became critical in 2010 as the county began to change as noted by Joel Metzger of the Calaveras Enterprise in an article on Proposition 19. *“There was an air of anonymity and little in-depth analysis.”* Metzger noted *“In Calaveras, I doubt anybody growing legally is making \$500,000 a year, unless they are under the radar.”* The growing was done quietly, secretly, with as little attention paid to the activity as possible.

Despite the fact that marijuana cultivation was illegal in Calaveras County the 2015 Butte Fire, the fourteenth most destructive fire in the history of California, created a perfect opportunity for marijuana growers. The resulting lack of vegetation left marijuana growers little cover to hide their activities as it torched 110 square miles of critical watersheds which supplies the rest of the state with clean water. However, there was much open land for these illegal businesses to exploit.

After the fire, a large portion of the properties in the burn scar changed hands and the green rush was on. Growers were aware of the unique climate of Calaveras County and took advantage of the opportunity to purchase or lease any property available in hopes of cashing in on the political instability of the county.

“Some people say Calaveras County has the best climate for growing marijuana, second only to the South American Andes” according to Guy McCarthy, reporter for Sonoma Union Democrat.



People from all over the United States and foreign countries arrived in the county to purchase or lease property for the sole purpose of making quick money. In some cases, when their fortunes turned, they abandoned the property leaving the environmental disaster behind for others to mitigate.

Impact of Gold Rush on the Environment

This was reminiscent of the 1849 Gold rush. The Gold Rush is one of the most significant events that shaped America's history during the first half of the 19th Century. In 1848 the total non-native population of California was 1,000 but in a year, it ballooned to 100,000. About 1,000 people lived in San Francisco in 1848 but the population grew 25-fold to 25,000 in just one year.

More than 750,000 pounds of gold, now valued at \$15.3 billion, was produced during those years. It is interesting to note that the estimate of the value from marijuana sales/production could be \$3 billion in 2018 to \$6.4 billion in 2020. As mentioned earlier in this report, in evaluating the benefit of the Gold Rush, the key question again needs to be asked *“At what cost?”*

Numerous experts have quantified the positive and negative impact of the Gold Rush on California. It is important to note that the product produced by gold rush was a precious mineral and not a mind-altering drug when used recreationally. The University of California Calsphere project has noted:



“The Gold Rush, positive for California in so many ways, had a devastating effect on the state’s environment. Many of these problems were directly related to gold-mining technology. The process of hydraulic mining, which became popular in the 1850s, caused irreparable environmental destruction.

The sediment washed away by hydraulic mining clogged riverbeds and lakes, threatening agriculture throughout the Central Valley. Conflicts over water arose between mining and farming interests. Hydraulic mining essentially came to an end in 1884 with the Sawyer Decision, legislation passed to resolve this conflict.”

The National Geographic published an important analysis on the ecological impact of the Gold Rush:

According to Malcolm J. Rohrbough, a Gold Rush historian and the author of Days of Gold: The California Gold Rush and the American Nation, the countryside of California was torn up as the newly arrived settlers searched for gold. They used high-powered jets of water to wash away hillsides in a practice known as hydraulic mining, and burrowed thousands of mine shafts into the foothills of the Sierra Nevada Mountains.

“Environmentally, the discovery of gold was a disaster,” he says. “People described the California landscape as looking like it had been dug up by giant moles.”

Eventually, the effects of mining began to harm a new industry developing in California’s Central Valley during the mid-1800s. “The major impact it had was on agriculture, because the mining involved digging up the rivers and producing all this silt,” Rohrbough says. “It also involved, in many cases, using mercury in the process of separating the gold out. All of this flowed downstream, and it heavily damaged the rivers as far as agricultural use is concerned.”

Rohrbough says that throughout the 1860s and 1870s, a fierce conflict developed between the mining and agricultural industries. By the mid-1870s, the California government realized that agriculture was more lucrative than mining. They passed a series of laws that restricted the impact of mining on rivers.

“For example, they outlawed hydraulic mining,” the historian notes. “They severely restricted dredging.”

The “Green Rush”: Calaveras County

As with the Gold Rush, the Green Rush is creating huge and even more onerous environmental dangers because high potency fertilizers and chemicals today are much different than those available 170 years ago.

With only 184 permits issued and estimates of between 1200 to 1500 illegal grows operating in the County, the number of illegal grows coupled with the expansion of permitted grows has overwhelmed local governments ability to enforce even the most basic ordinances. Law enforcement and other agencies have destroyed tens of thousands of plants with little effect on the overall scope of the problem. This eradication by local agencies in removing plants, has left the majority of the environmental damage to the watershed behind. Removing empty containers and trash is only part of the solution. Testing the soils, monitoring the air and streams has yet to be started or understood.

Guy McCarthy of the *Union Democrat* pointed out in an article April of 2017 that there are about 1500 grows in Calaveras County.

Number of Marijuana Grow Sites

The Urgency Ordinance adopted by the previous Calaveras County Board of Supervisors brought 737 commercial growers to admit their illicit activity to the local government. There were an additional 200 personal and caregiver grows that registered as well. The Sheriff in speaking to the Planning Commission on September 28, 2017 noted *“We know there are approximately 600 illegal grows through GIS, the problem with that is that it doesn’t include anything that might be inside a building, it doesn’t include anything that might be under canopy that we can’t see”*.

The Sheriff also told the Planning Commission in the same meeting, *“My personal opinion there are probably 1200 illegal grows”*.

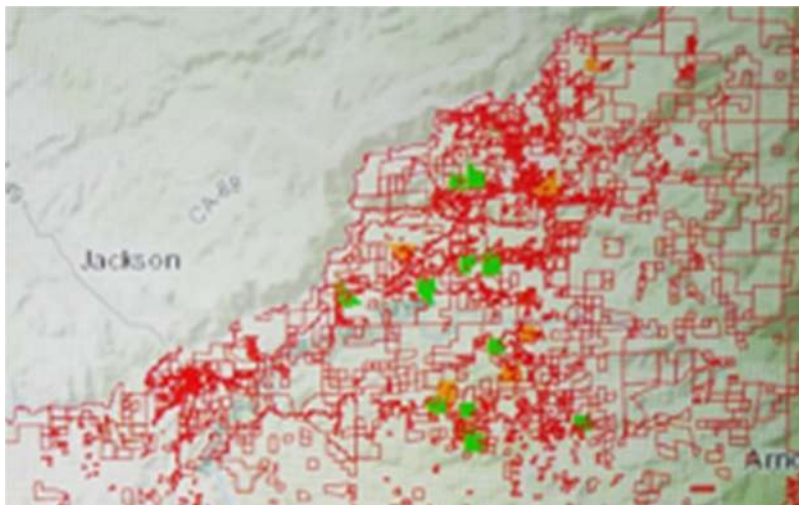


Exhibit #1

Exhibit #1 is Global Information System (GIS) map of Supervisorial District 2 in Calaveras County. Each of the red areas depict potential marijuana cultivation parcels. Each of the green areas are permitted under the temporary urgency ordinance passed by the previous County Board of Supervisors. Orange represents pending action.



Exhibit #2

Exhibit #2 illustrates the problem with the cultivation of marijuana in the foothills and is not unique to Calaveras County. This type of site is called a Tier Three Slope as noted in the State Waterboard Policy. This slope is a problem in the county because Tier Three is a common type of grow location in a county with many steep slopes. Many growers chose to level or terrace sites without grading permits or engineering. These steep slopes create soil erosion and biological degradation of creeks and streams because the chemically treated water and sediments flow directly into rivers and streams. This is a permitted grow site in Calaveras County.

Cost of Clean Up

In the hazardous materials clean-up process post Butte Fire, the county spent an estimated \$200,000 per location to mitigate private properties and deem them safe for re-entry. Most of those costs were recovered from property insurance carriers. Using the Sheriff's estimate of 1,200 illegal grows, the mitigation costs for grow sites could approach \$240 million.

Add to this, if the cleanup estimate of \$200,000 is applied, there would be additional costs for, clean-up of permitted, verified, or validated sites which could add an additional \$147 million, pushing the total costs to almost \$400 million with the numbers currently provided.

However, other respected experts believe the costs will be much higher to clean up and mitigate these sites. Dr. Mourad Gabriel, of the Integral Ecology Research Center is working in conjunction with UC Davis and the US Forest Service to clean-up of sites on federal lands. He estimates costs to be \$1 million to \$3 million per site when OSHA safety protocols, testing, and hazard assessments are properly followed. This would result in costs of \$1.2 billion to clean up the environmental mess in just this county, let alone the rest of the counties damaged by the silt inflows into reservoirs (reducing storage capacity), nitrates and chemicals around the state.

Should the county initiate similar safety protocols as the US Forest Service, the costs quickly jump to nearly \$2 billion in this county alone. These costs do not include litigation with downstream water purveyors for causing harm to their water supplies and nor does it include potential Workman's Comp claims for not following OSHA hazardous material process protocols used by workers on Federal eradication sites, to protect our employees. This does not include costs for prosecution, eradication, or removal of trash! **Again, "at what cost?"**

Identified Problems

Local authorities have documented what has been found on seventeen specific sites with hazardous materials in June 2017. During Operation Terminus in September, 157 state environmental citations were issued on 30 grow sites eradicated. In all, the Calaveras County Sheriff's Office reported 97 California Department of Fish and Wildlife violations, 29 water quality violations, 24 water rights violations and five Cal Fire land conservation infractions were noted at the pot farms.

The following is list of some of the chemicals found on marijuana sites in Calaveras County. These include:

- Carbofuran (banned in the USA)
- Tripicote
- Ammonium sulfate
- Diamond Nector Humic Acids/Phosphates
- Snow Story Ultra Potassium Supplement
- Sonic Bloom with vitamin B1
- Butane
- Romeo Fertilizer
- Unknown Rodent killers
- Mighty Growth Enhancer
- PH Down Phosphoric Aid
- Ammoniacal Nitrogen
- Massive Bloom formulation
- Emerald Goddess
- Liquid Insect Killing Soap
- Bio Root
- Miscellaneous bulk fertilizers

Integral Ecology Research Center Findings - Dr. Mourad Gabriel stated there have been 123 discrete chemicals found in US Forest Service eradications. Each of them is an independent test to determine toxicity and threat levels to humans and the environment. Exhibit #3, on the right, is a list of some of the chemicals identified by Dr. Gabriel as being used illegally on public lands. Dr. Gabriel further stated there is a cross migration between guerilla grows and permitted grows as workers carry their chemicals and knowledge with them to help others.

United States Fish and Wildlife Service - Scott Bauer, of the Fish and Wildlife Service, in an interview on September 20, 2017, noted the significant environmental problems in cannabis sites. They include the following:

- Diesel fuel in streams
- Water diversion
- Clear cutting-deforestation
- Sediment in stream from grading
- Diesel oil leaking into soil
- Steelhead and Coho Salmon impacted
- Golden Eagles seen at our county landfill, where marijuana is buried.

Bauer had other observations:

- Self-regulation won't work
- Too many growers don't want to be regulated
- Too often find growers smoking meth and carrying guns
- In the last four years grows increased by 61%
- It will take 5 years until the damage to fish and wildlife will be understood.

| CARBAMATES | Organophosphates | Pyrethrins | Rodenticides |
|---------------------|-------------------|--------------------|--------------------|
| 3-Hydroxycarbofuran | Diazinon | Allethrin | Zinc Phosphide |
| Aldicarb Sulfone | Dicrotophos | Cyfluthrin | Aluminum Phosphide |
| Bendiocarb | Dimethoate | Cypermethrin | Bromethalin |
| Carbofuran | Dioxathion | Fenvalerate | Cholecalciferol |
| Methiocarb | Disulfoton | Permethrin (trans) | Strychnine |
| Methomyl | EPN | Pyrethrins | Brodifacoum |
| Mexacarbate | Ethion | Phenothrin | Bromadiolone |
| Oxamyl | Ethoprop | Fenpropathrin | Chlorophacinone |
| Propoxur | Famphur | Bifenthrin | Coumaphor |
| | Fenamiphos | Deltamethrin | Difethialone |
| | Fensulfothion | | Diphacinone |
| | Fenthion | | Warfarin |
| | Fonofos | | Difenacoum |
| | Isofenphos | | |
| | Malathion | | |
| | Methamidophos | | |
| | Methidathion | | |
| | Methyl Parathion | | |
| | Mevinphos | | |
| | Monocrotophos | | |
| | Naled | | |
| | Parathion | | |
| | Phorate | | |
| | Phosalone | | |
| | Phosmet | | |
| | Phosphamidon | | |
| | Profenophos | | |
| | Propetamphos | | |
| | Ronnel | | |
| | Terbufos | | |
| | Tetrachlorvinphos | | |
| | Triazophos | | |
| | Acephate | | |
| | Azinphos methyl | | |
| | Carbophenothion | | |
| | Chlorfenvinphos | | |
| | Chlorpyrifos | | |
| | Coumaphos | | |
| | Crotoxyphos | | |
| | Crufomate | | |
| | DDVP | | |
| | DEF | | |
| | Demeton-O | | |
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Exhibit #3 - Chemicals Found on Public Lands

California State Fish and Game – Lieutenant DeWayne Little of the California Fish and Game had important perceptions as well of the current production of marijuana. His observation included:

- Many licensed growers do not abide by the rules
- Identified use of the illegal chemical Carbofuran
- Pesticides used at grows are not approved for human consumption
- The State of California has not authorized any fertilizer or pesticide for application on marijuana.

Little noted that when Carbofuran is found on a site, the following actions should be taken:

- Lock down of site
- Complete assessment of human contamination including workers and animals
- Understand decontamination procedures
- Usually Carbofuran contamination resembles heat stroke and substances may be emitted from every orifice of the human body.
- Carbofuran has been found at multiple locations within Calaveras County.

News Coverage on Local Marijuana Growing

Jason Cowan with the *Union Democrat* reported on an eradication on October 26, 2016 near West Point in Calaveras County:

“Human waste was funneled down the hillside through a hole carved in a manmade bathroom that contaminated a nearby creek whenever wet weather would pass through. Harmful chemicals seeped into the ground from what remained inside pesticide containers carelessly tossed into a pile of garbage when no longer useful. Fallen trees that were chopped down without permission left a scar in the thick brush of the rural landscape. The devastation on the environment was apparent as Calaveras County Sheriff Rick DiBasilio detailed the scene from one of the three illegal marijuana grows busted Tuesday. The marijuana had a street value of about \$6.25 million.”

Jason Cowan further reported on August 10, 2017:

“They squatted near the water, tossing used paper into the creek bed as if it were a toilet. Pesticide containers were left uncapped and tipped on their sides, contents seeping out and saturating the ground. Some slept in tents, shacks, hammocks and other temporary quarters, tossing everyday trash into piles and letting it stand and rot. The environmental trauma was significant, say law enforcement officials.”

Much of the concern came from what would happen when the fluid (chemicals) drains into the earth before the rainy weather season.

“It’s only dangerous in high doses when you’re drinking this stuff,” DiBasilio said. “Running in the ground, it’s a concern when it’s raining and getting into our creeks, lakes and streams.”

Officials seized nearly 29,000 plants, 31 tons of unprocessed marijuana, 1,898 pounds of processed marijuana and 12 opium pods. Also found were 13 firearms, many that had the serial numbers scratched off, one piece of body armor and more than \$57,000 in cash.

California Fish and Wildlife Response to the DEIR

In responding to the Draft Environmental Impact Report on the Calaveras Ordinance Project, Tina Bartlett, Regional Manager for California Fish and Wildlife, stated, “Current cannabis cultivation activities within Calaveras County have led to significant environmental impacts, including habitat degradation, loss and fragmentation burying of streams, diversion of surface waters, and impacts to water quality including sediment, garbage, **pesticides** and petroleum products.”

Documented Examples of Environmental Damage

The following pictures present the challenges facing our law enforcement officers, prosecutors as well as staff from the departments of environmental health and code enforcement, and neighbors in dealing with hundreds of marijuana sites.



Exhibit # 4



Exhibit #5

Illegal grading and terracing in steep terrain – The effects of grading on neighboring creeks and streams with sedimentation is seen in Exhibits # 4 and #5. This grading alters the natural balance of the eco-system.



Exhibit #6

Imported Soils – (Exhibit #6)

County officials have seen the importation specialty soils (soils on steroids specifically designed to grow marijuana) contained in bags by the truck loads and truck loads of soil only, delivered to sites that continue to expand operations in violation of the Urgency Ordinance.

These soils then leach contaminants into the ground as the growers admit they “**flush the plants**” to remove as much chemicals and toxins as possible prior to harvest.



Exhibit #7 – Pictures of Chemical Containers on a site

Fertilizers Impact - It has now become a question of what is the damage to the watersheds of Calaveras County due to the environmental loading of unknown tons of high potency fertilizers and unknown quantities of chemicals that have been used over the past several years. With the massive influx of growers bent on turning profits instead of caring about the environment in their “rented plot” within Calaveras County, they have exhibited absolutely no concern of the impact on the environment, public health, and agriculture and really our county’s future.



Exhibit #8

Water Testing - Independent experts have conducted random sampling of local ponds. The testing reveals that two thirds of the cases found cyanobacteria, proven to be a deadly poison to humans, fish, and animals. The result of nitrate overloading in streams and waterways, cyanobacteria is a form of algae that is used as a marker to indicate severe environmental compromise to streams, as in the case study on the Eel River. There have reported dead dogs near ponds along with other animals.

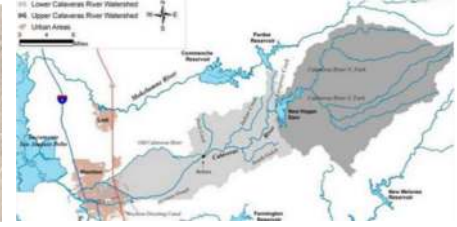
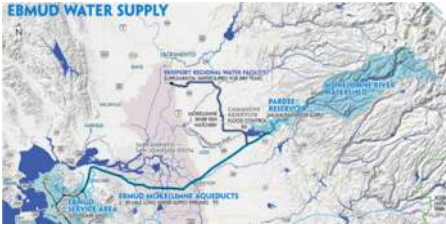


Exhibit #9

Water contamination is seen in Exhibits #8 and #9 from a local grow site. Exhibit #8 shows the damming of a stream to allow for the placement of chemicals and fertilizers directly in the creek or stream for direct use on plants.

Exhibit #9 shows how a spring has been contained with dirt and then chemicals dumped into the water. Algae, created by the nitrates can form cyanobacteria which is deadly poison to humans and animals.

Calaveras Watershed Supplies Large Share of California's Water



Calaveras Watershed Distribution - Since Calaveras County watersheds supply 9% of all water consumed in California, this ecological disaster impacts many more people than just our local county population. Extrapolating on California's population, our county's watershed provides water to as many as 3.5 million Californians plus water for agriculture and business impacting millions more. The above graphics demonstrate how water from Sierra Nevada Mountains and Foothills flows into northern California.

Big Problems with Clean Up

Caroline Peterson representing the California Department of Fish and Wildlife, recently told the Calaveras Fish and Game Commission *"We are aware of the seriousness of your problem but I don't know who is going to help to come in and clean it up"*. The use of the words *"overloaded, understaffed, trying to get up to speed, and evolving process"* are common when speaking with state agencies about the county's environmental problems associated with marijuana cultivation in the county.

Other Problems and Issues

There are many other issues tangential to ecological problems caused by growing "pot" in the open. These include:

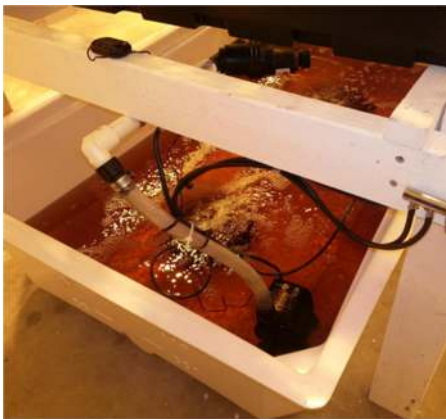


Exhibit #10 – Hydroponic Water found during Calaveras County Raid.

Indoor Growing - Indoor and hydroponic grows present a unique problem yet to be understood. Hydroponic growing is defined as the process of growing plants in sand, gravel, or liquid, with added nutrients but without soil. Proposition 64 will force counties and municipalities to accept indoor growing and the effects the activity will have on infrastructure. The water used contains a specialty mix of chemicals and fertilizers designed for high potency growth. When the water is disposed of into a municipal waste treatment systems or private on-site septic systems not designed to handle the effluent, environmental damage results.

Local Environmental Health agencies have yet to grasp the designs needed or the monitoring required to prevent long term damage on an individual grow site. This could result in polluted drinking water and higher costs to consumers to make it safe. Local water districts have limited knowledge on the potential chemicals and testing is also limited at this time.



Exhibit #11

Well Contamination – Chemicals as pictured in **Exhibit #11**, are leaching into watersheds. Currently private wells must be 75 feet away from septic leech fields and the question becomes, is that a sufficient separation for safety with the aquifer and the neighboring wells that depend on clean water for survival?

Speaking with local sanitary district operators, they universally state their waste treatment systems are not designed to clean up this type of effluent nor are they currently testing for chemicals used in marijuana operations.



Exhibit #12 – Golfer in Angels Camp

Direct Contact with Human Beings –

Research finds that the dangerous chemicals can make direct contact with human beings. Many municipal systems spray their treated water onto local golf courses. Without testing for the 123 discrete chemicals the USFS has found on grow sites, the tainted water could make its way into direct contact with people. People would not be aware of the potential dangers or the level of risk associated with using these recreational facilities not to mention the homes adjacent to golf courses that use this water.



Exhibit #13

Law Enforcement Problems with Marijuana Cultivation –

Another huge problem caused by marijuana cultivation is the threat to public safety caused by too many of those who have invaded areas such as Calaveras County from throughout the nation and foreign countries.

The Sheriff's Office and the California Highway Patrol have spent significant resources on the dealing with "pot growers." Exhibit #13 is from a KCRA News report on a triple homicide in Calaveras County.

United States Department of Interior Analysis

Kim Thorsen, the Deputy Assistant Secretary for Law Enforcement, Security and Emergency Management for the Department of the Interior (DOI) appointed by the Obama Administration, testified to the United States Senate about the significant problems facing law enforcement:

- *According to the Drug Enforcement Administration's (DEA's) Domestic Cannabis Eradication/Suppression/Eradication Program (DECSP), marijuana is the only major drug of abuse grown within the United States' borders, on DOI and our other public land partners are faced with a continued problem of marijuana cultivation on our public lands. Drug Trafficking Organizations (DTOs) are cultivating large amounts of marijuana throughout remote areas of DOI lands wherever they can find or divert a water resource. The vast amount of cultivation takes place in the western region of the United States. However, traditional DTO campsites have been found in several states, particularly in the west, but also in the Appalachia Region in the east.*
- *DOI personnel, both law enforcement and civilian, routinely run across marijuana grow sites, suspicious persons and smugglers across DOI lands. DTOs, particularly in marijuana cultivation sites, often have encampments and are armed. The remoteness of these areas often give the upper hand to the DTOs; particularly in marijuana grow sites where they have been encamped, possibly for several months, and know the lay of the land better than law enforcement. Assaults on visitors and civilian and law enforcement personnel have been documented. Hunters, fisherman, recreational users, researchers and maintenance personnel have reported grow sites, and several times a year report being harassed or threatened by armed individuals.*

The DOI Under Secretary also noted the environmental impact of Cannabis cultivation:

Marijuana cultivation site operators often contaminate and alter watersheds, clear-cut native vegetation, discard garbage and non-biodegradable materials at deserted sites, create wildfire hazards, and divert natural water courses. For example, cultivators often dam streams and redirect the water through plastic gravity-fed irrigation tubing to supply water to individual plants. The high demand for water often strains small streams and damages downstream vegetation that is dependent on consistent water flow. In addition, law enforcement officials are increasingly encountering dumpsites of highly toxic insecticides, chemical repellants, and poisons that are imported from Mexico, purchased by Mexican criminal groups, and transported into the country for use at their marijuana grow sites

These toxic chemicals enter and contaminate ground water, pollute watersheds and can kill fish and other wildlife. Moreover, while preparing land for marijuana cultivation, growers commonly clear the forest understory, which allows nonnative plants to supplant native ones, adversely affecting the ecosystem. They also terrace the land (-especially in mountainous areas) which results in rapid soil erosion. The cost of clean-up and restoration of the land can be extensive, particularly in remote wilderness locations and where cultural sites are impacted.

During "Operation Full Court Press", more than 26 tons of trash, 40 miles of irrigation line, 5,445 pounds of fertilizer, and 260 pounds of pesticides and rodenticides were removed from grow sites.

As with law enforcement, these activities take resource management staff from their regular duties. In addition, the potential for encountering DTOs when conducting routine surveys, weed control, and resource monitoring requires additional coordination and use of law enforcement support.

Public Health and “Pot” Consumption

The reality is that Marijuana is classified by the federal government as a Schedule I controlled substance, which puts it in the same category as heroin and LSD. Every drug consumed by the public has been through expensive research and testing. There is no such testing of marijuana to certify it as safe for use. According to the US Food and Drug Administration:

- The FDA has not approved any product containing or derived from botanical marijuana for any indication. This means that the FDA has not found any such product to be safe or effective for the treatment of any disease or condition. Study of marijuana in clinical trial settings is needed to assess the safety and effectiveness of marijuana for medical use.
- The FDA is also aware that there are potential adverse health effects with use of marijuana in pregnant or lactating women. Further, studies have shown harmful effects on developing brains of children under age 21 from any contact with marijuana.
- It is important to conduct medical research into the safety and effectiveness of marijuana products through adequate and well-controlled clinical trials.

Atlantic Magazine published an in-depth analysis of the impact of marijuana on our forests. The article also dealt with the impact pesticides on the product that the public ultimately consumers:

“Pesticides are showing up on both leaves and buds at trespass grows, Dr. Gabriel says, and they appear at detectable levels when the plant is smoked. If any of this harvest makes its way to a medical dispensary, it could end up in the lungs of people who are already immuno-compromised from AIDS or cancer. There hasn’t been any formal research in California yet, but studies and investigations in Colorado and Oregon have found pesticides on marijuana in legal dispensaries, including in products that were supposedly certified pesticide-free. Last year, the Emerald Cup, a major cannabis competition in Sonoma County that focuses on organic growing, started testing entries for pesticides. **About 25 percent of the concentrates and more than 5 percent of flowers were disqualified.**”

While it is not the purview of local government to test and certify safe drugs or food consumed by the public, there is an obvious concern about the ultimate impact on the consumer of untested marijuana as well as watersheds contaminated by dangerous chemicals.

Other Regulatory Problems

There are many other problems we have identified with current enforcement of law to protect the environment and our natural resources but it is important to focus on how regulations are applied.

The previous board declared in the Urgency Ordinance, 17.95.110 (M) “These trends may be contributing to an unstudied, unregulated, and potentially significant impact on the environment.

Comparison of Environmental Regulations Other Industries vs. Marijuana Growers – All major industries in California are required to complete biological site assessments, cultural resource inventory, and secure waste discharge permits prior to operation. As an example of in equitable treatment of the cannabis growers is seen through an analysis of the State Water Board requirements for Vineyards vs. Cannabis Growers. The Cannabis application is just 5 pages long while just the waste discharge requirements alone for vineyards is 71 pages. These two studies are:

- **Notice of Intent (NOI) for Medicinal Cannabis Cultivation (5 pages)**
- **General Waste Discharge Requirements for Vineyards (71pages)**

Summary and Recommendations

It is not the purpose of this white paper to discuss the pluses and minuses of marijuana consumption. There are many problems associated with the marijuana consumption as pointed out in the Harvard Shorenstien Center paper included in the Bibliography of this white paper. It is the purpose of this paper to analyze the impact of marijuana cultivation on the ecology, public health, and the safety of Calaveras County citizens but also the overall impact of the environmental destruction of the region and the state from environmental loading of unknown quantities of fertilizers and chemicals in our watersheds.

After reviewing the research or top experts from Federal, state and local government, academic experts, and in-depth media coverage, it is clear that the cultivation of marijuana is causing significant damage to the ecology and the region. The purpose of this White Paper is to provide some recommendations that should be undertaken immediately to deal with this problem.

- **Calaveras County Ordinance** – The Calaveras County Board of Supervisors in should pass an ordinance banning the cultivation of marijuana or cannabis in both the open and in-door facilities. The county should address how to monitor and control waste discharge from Proposition 64 growing. The county and agencies such as the Calaveras County Water District are currently not regularly testing for or treating the dangerous chemicals that have been found in the production of the product. Most importantly, there have been no studies to determine the scope and level of damage in the county due to marijuana cultivation. It is clear that the previous Board of Supervisors did a terrible disservice to the citizenry and the ecology of the region by allowing any production without any serious environmental analysis or environmental controls in its production on the local environment. Their interest was on canopy size and stopping the land rush.
- **Calaveras Ecological Task Force (CETF)** – We propose the creation of task force involving all agencies federal, state, regional and local to work together to eradicate illegal growing, clean up the environment, and deal with law enforcement/public safety issues. This is more than about money, it is about manpower and support. There is a desperate need for a coordinated response to deal with problem. It is our hope that the response in this county would be a model for other counties or regions in the nation in coping with the ticking time bomb of an ecological disaster, the contamination of our water supplies and include a declaration of emergency until such time the scope is fully understood.
- **Water Quality Analysis** – We recommend that the United States Environmental Protection Agency undertake a study of the impact of the ecological damage to the water quality in the county and propose steps that should be taken to protect the watersheds and provide a plan for the clean-up. This is critically important not only for the county but for the millions of Californians and agriculture that depends upon clean water emanating from the watersheds of the county. State of California Water Agencies should also be requested by the County with support of State Legislators to take action consistent with US EPA and working with the California Fish and Wildlife.
- **Law Enforcement** – We recommend that the United States Drug Enforcement Administration take action to evaluate grant money and manpower support to eradicate illegal marijuana production and insure the shutting down of cultivation includes their complete mitigation. The county should continue to fund contractors to assist with eradication along with all interagency cooperation available. The ability to eradicate 1200 grow sites based on the current eradication rate will take many years if no other new sites are created. This does not include environmental clean-up or remediation within the watersheds.
- **Prosecution** – We propose that the District Attorney of Calaveras County work with the United States and California Attorney Generals to prosecute those that have broken federal and state laws and county ordinances and seek full prosecution criminally and/or civilly and explore seek funding to pay for the cleanup of the land in the county. There needs to be a true cost recovery with a Nexus study to verify what costs should be implemented across all departments to insure other county services provided are not financially impacted.

Final Thoughts

*“Because of the considerable environmental damage we currently have before us coupled with the unknown costs of eradication, containment and remediation that are heading for the stratosphere, Calaveras County must take appropriate action immediately to stop and reduce any further possibility of contamination – Banning cultivation throughout the County is the only sound measure that will allow the County to take more swift action on the growing of cannabis in our county as we begin to restore our watersheds, our quality of life, and the health and safety of our residents. Our County’s exposure to liability for polluted lands, rivers, streams, ponds, and lakes as well as downstream waters is potentially astronomical. We need to keep in mind under environmental law there are few excuses available in defense of our County’s potential liabilities for inadequate policy as environmental law explicitly states it is **what you knew** or **should have known**”.*

Dennis Mills
Supervisor District Four
Calaveras County

Bibliography

There have been many scholarly, government, and news media on the impact of the use of chemicals for marijuana cultivation. We have included some of the articles that document immense problem these chemicals have on the environment. It is clear that large areas of Calaveras County have been subject to potentially similar severe contamination.

The following document were produced by leading academic research institutions and media.

1. **The Environmental impacts of marijuana in California:** Published by Stanford University Center on Food Security and the Environment
2. **Scientific American: Burgeoning Marijuana Market Prompts Concerns about Crop's Environmental Impact**
3. **Science Daily: Marijuana's hidden price: Environmental impact**
Ithica College and University of California
4. **The High Environmental Cost Of Illicit Marijuana Cultivation**
Published by Yale University School of Forestry and Environmental Studies
Bio Science Magazine
5. **High Time for Conservation: Adding the Environment to the Debate on Marijuana Liberalization**
Published by the Yale University Department of Forestry and Environmental Studies
6. **High Times: Marijuana Growing and the Environment: Excerpts**
Published by Friends of the Eel River
7. **Study shows marijuana is sucking the Eel River dry**
Unregulated water use by marijuana cultivation sites leaves none for fish
Published by the Willits News with California Department of Fish and Wildlife data.
8. **Legally Grown Pot Still Has a Toxic Pesticide Problem: Published by Vice**
9. **Pleasure, panacea, poison? The little-known health effects of marijuana**
Published by the Harvard Kennedy School Shorenstein Center on Media, Politics and Publish Policy

July 8, 2015

The environmental impacts of marijuana in California



In a [new study in the journal BioScience](#), a team of researchers including Stanford professor [Roz Naylor](#) links marijuana cultivation to widespread environmental damage in California and calls for greater regulation of the crop's impact on natural ecosystems.

Recent debates about marijuana legalization have focused on the potential social, health and economic impacts, with little attention paid to environmental issues. The new study, spearheaded by the [California chapter of The Nature Conservancy](#), brings environmental concerns to the forefront of the policy

discussion. Between 60 and 70 percent of the marijuana consumed in the United States comes from California.

Water and wildlife

Marijuana plants require nearly twice as much water as do grapes or tomatoes, and the last five years have brought a 50 to 100 percent increase in the amount of northern California watershed lands used for marijuana production – figures that are causing growing concern among conservationists in the midst of a severe statewide drought.

The majority of California agriculture is subject to heavy water use regulations. Farmers of most irrigated crops help their plants through the dry summer months by filling water tanks in the winter, when streams and springs are full.

By contrast, many marijuana growers draw surface water during the plant's summer growing season, when drought conditions are worst.

"Taking water directly from rivers and streams in the summer not only reduces the water available for agriculture but also threatens wildlife species, especially birds and fish, that depend on these wetland ecosystems for survival," said Naylor.

Illegal marijuana plantations in California are associated with a wide range of other environmental impacts, including pollution, poaching, and pesticides that poison wildlife. Even legal outdoor cultivation can cause deforestation and soil erosion.



Burgeoning Marijuana Market Prompts Concerns about Crop's Environmental Impact

Outdoor cannabis cultivation in northern California has damaged forestlands and their inhabitants. Will legalization of recreational marijuana make things worse or better?

By Melati Kaye on February 2, 2017

A visit to a marijuana farm in Willow Creek, the heart of northern California's so-called Emerald Triangle feels like strolling through an orchard. At 16 feet high and eight feet around, its 99 plants are too overloaded with cannabis buds to stand on their own. Instead each plant has an aluminum cage for support.

Welcome to America's "pot basket." The U.S. Drug Enforcement Administration estimates 60 percent of cannabis consumed nationwide is grown in California. According to the Department of Justice, the bulk of that comes from the three upstate counties of the Emerald Triangle: Mendocino, Humboldt and Trinity. Conditions here are said to be perfect for outdoor marijuana cultivation. But that has proved to be a very mixed blessing for the region, bringing with it a litany of environmental disturbances to local waterways and wildlife. Creek diversions threaten fish habitat and spur toxic algal blooms. Road building and clear-cuts erode soil and cloud streams. Deep within, illegal "guerilla grows" pepper forestlands with banned rodent poisons that are intended to eradicate crop pests but are also fatal to other mammals

On November 8 voters in four states—Massachusetts, Maine, California and Nevada—legalized recreational marijuana. These states join Colorado, Washington, Oregon and Alaska, along with the District of Columbia, where one can already legally buy the drug for recreational use. Will this expanded market mean more environmental damage? Or will legalization pave the way for sounder regulation?

In 1996 California legalized marijuana for medical use, providing the first legal space for pot cultivation since the federal government's blanket ban on the crop some 60 years before. As grow operations in the state flourished, California Department of Fish and Wildlife biologist Scott Bauer analyzed satellite imagery to examine the impact of cultivation on water levels in four Emerald Triangle watersheds. His [study](#), published in *PLoS ONE* in 2015, found that in three of the four watersheds, "water demand for marijuana cultivation exceeds stream flow during the low-flow [summer] periods."

The real problem is not marijuana's overall water consumption, which still falls far short of California staples like walnuts or almonds, explains environmental scientist Van Butsic of the University of California, Berkeley. Rather it is an issue of where and when pot is grown. Analyzing aerial imagery of 4,428 grow sites in 60 Humboldt county watersheds, Butsic found that one in 20 grow sites sat within 100 meters of fish habitat and one in five were located on steep land with a slope of 17 degrees or more. "The problem is that cannabis is being grown in the headwaters, and much of the watering is happening in the summer," Butsic says.

If that arrangement goes on unchecked, U.C. Berkeley ecologist Mary Power warns, summer plantations could transform local rivers from cool and "salmon-sustaining" to systems full of toxic cyanobacteria. Over eons of evolution native salmon species have adapted to "deluge or drought" conditions, she says. But the double whammy of climate change and water extraction could prove to be a game-changer.

Power spelled out the unprecedented stresses in a 2015 conference paper focused on the Eel River that flows through Mendocino and southern Humboldt. She and her team found riverbed-scouring floods in winter, followed by dry, low-flow conditions in summer, led to warm, stagnant, barely connected pools of water. That is bad news for salmon, but ideal for early summer algal blooms. The algae then rot, creating an oxygen-deficient paradise for toxic cyanobacteria, which have been implicated in the poisoning deaths of 11 dogs along the Eel River since 2002.

Dogs are not the only terrestrial creatures endangered by the grow operations. Between 2008 and 2013 Mourad Gabriel, then a doctoral candidate at the University of California, Davis, Veterinary Genetics Lab, carried out a [study](#) of the American fisher, a small carnivorous mammal that is a candidate for the endangered species list. He wanted to suss out the threats to fisher populations in northern California. So he radio-tagged fishers from Trinity County's Hoopa Valley Reservation and public lands near Yosemite National Park to track their movements.

Between 2006 and 2011, 58 of the fishers Gabriel and his team tracked turned up dead. Gabriel studied the necropsies and found that 46 of the animals had been exposed to anticoagulant rodenticides—rat poisons that block liver enzymes, which enable blood clotting. Without the enzyme the exposed mammals bled to death from flesh wounds.

The finding puzzled Gabriel at first, because rat poison is more common in agricultural and urban settings than in remote forests. But then he started visiting the remnants of guerilla grows that had been busted under the guidance of lawmen such as Omar Brown, head of the Narcotics Division at the Trinity County Sheriff's Office. "We have found [anticoagulant rodenticides] carbofuran on grows in the national forest," Brown reports. "These are neurotoxin-laced pesticides that have been banned in the U.S. since 2011. And even for allowed pesticides, we've found instances where trespass grows are using them in illegally large quantities." The poisons hit female fishers particularly hard, because the early, pest-prone phase of marijuana cultivation coincides with the fishers' nesting season, when pregnant females are actively foraging.

Gabriel, now director of the Integral Ecology Research Center based in Humboldt County, says other states may be dealing with rodenticides, water diversions and other problems from guerilla grows, too. "The climate in Colorado, Oregon and Washington is conducive for marijuana cultivation," he observes. But "there just isn't the scientific data to prove whether other states have these problems because there has not been research funding put towards answering these questions."

In California headwater ecosystems could get a reprieve if a greatly expanded legalized pot industry moves to the Central Valley, where production could take place indoors and costs would be less. In pot-growing pioneer states like Colorado or Washington much of the production has moved indoors, where temperatures can be more closely managed. But other factors may hinder that move. "Bud and pest problems are always worse indoors, which biases farmers toward a chemically intensive regime," says Marie Peterson of Downriver Consulting, a Weaverville, Calif.-based firm that helps growers fill out the paperwork for state and county permits as well as assesses water management plans for their plantations. And besides, the Central Valley already suffers from prolonged drought.

Of the eight states that legalized the cultivation of recreational marijuana, only Oregon and California allow outdoor grows. But regulating open-air pot plantations in these states remains challenging, even though legal operations for medical marijuana have been around since 1998 and 1996, respectively. In 2015 California passed the Medical Marijuana Regulation and Safety Act, which calls on the state's departments of Food and Agriculture, Pesticide Regulation, and Fish and Wildlife, along with the state's Water Board—to oversee environmental impacts of the industry. The board came up with a list of requirements for a marijuana plantation water permit, which in turn became a necessary condition for a license to grow medical pot in any of the three Emerald Triangle counties. Counties have until January 2018 to decide whether to create similar stipulations for recreational marijuana growing permits.

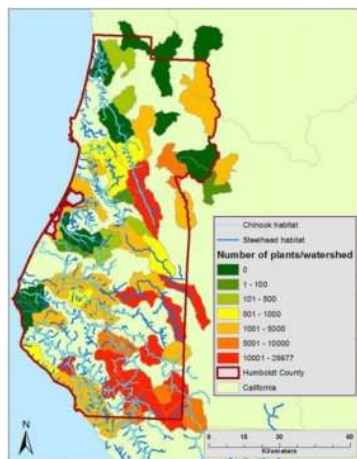
Butsic is optimistic about a more regulated future for the marijuana industry in California. "I think five years from now things will be more sustainable. Permitting shows growers that the state is interested in water use and their crop."

Science Daily: Marijuana's hidden price: Environmental impact

October 19, 2016 *Source:* Ithaca College

Summary:

A new survey of marijuana grow sites in California demonstrates the potential environmental impact of marijuana farming and provides an example of the survey and analysis needed as farming expands.



This chart from Brenner's study shows the number of plants per watershed and location of critical habitat for steelhead trout and Chinook salmon.

Credit: Image courtesy of Ithaca College

"It's just a plant" is a common refrain from those who want to legalize the leaf, but a recent study of cannabis production argues that the environmental impact of marijuana farming must be considered -- especially as more states move toward further legalization this election season.

The study was conducted by Jake Brenner, an assistant professor in the Department of Environmental Studies and Sciences at Ithaca College, and Van Bustic, a specialist at the University of California Cooperative Extension. It was published earlier this year in the journal *Environmental Research Letters*.

The study also highlights the lack of published, peer-reviewed empirical research on all aspects of cannabis agriculture, which is already a multi-billion dollar industry in the United States despite still being listed as a Schedule 1 drug by the federal government.

Location, location

The amount of land and water used for growing cannabis has not traditionally been a concern, especially when compared to other agricultural products grown in California. But where the cannabis is grown has potential ecological consequences.

Brenner and Bustic examined grow sites in three northern California counties and found that their usual placement had potentially negative impacts on two threatened fish species.

That's because the sites are typically placed on remote plots of land in forested areas, many on steep slopes. Access roads need to be created and swaths of land cleared for production, regardless of whether the cannabis is grown outdoors or in a greenhouse; that increases potential for soil erosion and chemical run-off into streams in which the Chinook salmon and steelhead trout live.

The fish are also susceptible to harm from a decrease in water flow as a result of the cannabis agriculture.

"Siting grows in areas with better access to roads, gentler slopes, and ample water resources could significantly reduce threats to the environment," Brenner and Bustic write. "Future cannabis policy should take into consideration the potential for mitigating environmental impacts through land-use planning."

Know before you grow

Brenner and Bustic say their study, which covers the watersheds of northern California's Humboldt County, is an example of the sort of survey and analysis that could be done -- and is necessary -- anywhere cannabis agriculture takes place.

And while California is taking efforts to encourage local governments to create land-use policies for cannabis agriculture, they argue that more research on marijuana farming needs to be done.

"Land-use science on cannabis agriculture lags behind research on other crops, but advances in the field will be crucial for predicting future cannabis expansion and moderating its impacts," they write.

That multi-billion marijuana production industry is only going to grow: This November, voters in Arizona, California, Maine, Massachusetts and Nevada will decide whether to allow their states to legalize and tax recreational marijuana; while voters in Arkansas, Florida, Montana and North Dakota will head to the polls to determine whether their states will allow medicinal uses of marijuana, joining the 25 other states that already do so.

The High Environmental Cost Of Illicit Marijuana Cultivation

Published by Yale University School of Forestry and Environmental Studies

Marijuana growers are ravaging forests in northern California to produce their lucrative crop. In a Yale Environment 360 interview, biologist Mary Power talks about the massive ecological footprint of marijuana growing and why nationwide legalization could help alleviate it.

BY DIANE TOOMEY • JULY 16, 2015

As some U.S. states move to legalize marijuana, one issue has been largely ignored in the policy debates: the serious environmental effects of the marijuana industry. A new paper in the journal Bioscience, co-authored by ecologist Mary Power, details many of those impacts by focusing on marijuana cultivation in California, where most of the marijuana consumed in the U.S. is grown. Much of that cultivation is done in sensitive watersheds where the effects, says Power, can be devastating.



Mary Power

A biologist at the University of California, Berkeley, Power has studied the situation firsthand in the Eel River watershed in Mendocino County, which had recently started to recover after being damaged by decades of logging operations. In an interview with *Yale Environment 360*, Power describes how marijuana growers in that region now siphon off scarce water resources, poison wildlife, erode fragile soils, and overload waters with nutrients. What's needed, she contends, is the legalization of marijuana at the federal level, which would likely drive down marijuana prices nationally.

"As long as there is a market that will pay enough to compensate for the brutally hard work they do to grow this stuff in forested mountains," she says, "then it will keep growing."

Yale Environment 360: You and your co-authors focused on marijuana cultivation in California, where up to 70 percent of marijuana consumed in the U.S. is grown. The paper delineates the many ways the environment is harmed by outdoor marijuana cultivation. Are you talking about both legal and illegal cultivation?

'The eight to ten gallons [of water] a day that marijuana needs per plant is not going to be available to the fish or this river.'

Mary Power: You probably know how intertwined those are. We are starting to use the term "gray market" because the laws are inconsistent between county, state, and federal jurisdictions. So what's legal under some lenses is illegal under others, and that's made enforcement very difficult. That, plus the economic woes of northern counties in California, means that there aren't very many enforcement officers and their mandate isn't crystal clear.

e360: Describe the typical location of a marijuana cultivation site in Northern California.

Power: You have one of the world's most fragile, erosive landscapes, a landscape that is very easy to damage further. The guerilla growers are building poorly engineered, illegal roads, scraping off the forest, and then sometimes putting up hastily dug trenches that are just lined with plastic, high in the landscape so they can gravity-feed the water to their marijuana plants. And those can fail, taking hillsides down into the rivers.

What is very frustrating is that the Eel River was really starting to heal. It's been about 50 years since the most devastating logging was done there. So the river was really deepening, the mature riparian vegetation was starting to reform complex channel habitats. The river was going from being just packed with fine sediments and too wide and too shallow to stay cool enough to support salmon, or sometimes even to allow their passage as they migrate between the river and sea. That was all starting to go in the right direction. The Eel [River] is on this very pointed knife edge of recovering because of better land management. But that's now being derailed and reversed because of the rapacious damage that the marijuana growers are doing all over the watershed.

e360: I was surprised to learn that marijuana is twice as thirsty as wine grapes. Where do growers typically get the water to irrigate this crop?

Power: They suck directly from the river. They also are dewatering the tributaries that start as springs in this landscape, which then don't supply their cold groundwater to the river, so the river dries up and warms up. And the marijuana growers, like the regular populations, are tapping springs. In this geology and landscape, the water sources are usually seeping out of the hillside in places where fractures have allowed the water to surface.



Photo: Jennifer Carah/The Nature Conservancy

Discarded fertilizer containers used in marijuana cultivation litter this forest floor.

e360: And, of course, in a time of extreme drought, siphoning off this water is not helpful.

Power: No. Certainly this year and next, probably any water that is diverted into the eight to ten gallons a day that marijuana needs per plant is not going to be available to the watershed or the fish or this river.

e360: There's a long list of pesticides, rodent poisons, and fertilizers that are used on these growing sites. I've seen a pretty ironic photo of leftover Miracle Grow containers on the forest floor. What's the effect of this chemical mixture on the wildlife and on the ecosystem in general?

Power: They are killing all of the carnivores — hawks, martens, bears, mountain lions, bobcats — that prey on the herbivores that eat the marijuana and the omnivores, like rats. The rodenticide is largely warfarin. It prevents blood from coagulating and, as some articles say, causes the victim to liquefy from the inside.

e360: Taken in totality, it seems like an environmental nightmare.

Power: It is. Here's the other thing: When you're adding fertilizer to the stream, you're adding another ingredient to the witch's brew that during drought is going to convert this cool, flowing system that could support salmon into a warm, disconnected, stagnant series of pools. If you have cool, flowing conditions, algae are good. They're edible things, like diatoms. They actually are the source of the polyunsaturated fatty acids that make fish so healthy. So those are the good guys, but they require cool, flowing water. Many of the problematic species start to thrive when the water is stagnant or very low-flowing, and also when it gets warmer.

Picture a few specks of deep blue-green cyanobacteria. If you add nutrients — which could leak in if the growers are excessive [with fertilizer] — and it's warm anyway, they'll grow. The blue-greens will spread and become a little blanket that smothers the good algae. That can happen, though, even without extra nutrients, if there's not enough water, or if it's hot. Then the good algae die and release their nutrients, and that fuels the cyanobacteria that carpet them. So this little speck turns into a blanket, and can make a blue-green drape over the entire good algal assemblage. And a lot of those blue-green algae are neurotoxic in the Eel.

e360: In 1996, the [California] Compassionate Care Act [which legalized medical marijuana use] went into effect and, concurrently, marijuana cultivation increased drastically.

Power: That was the unintended consequence that happened. I like [American novelist] Wallace Stegner's contrast between people who come to the West to make a living, and others who come to make a killing. So these folks came in to make the killing. And then there are cartels, too, that are starting to organize and make things even worse.

e360: When these sites are discovered, when they're busted, how often do they get cleaned up, and to what extent can they be cleaned up?

Power: That's very difficult. It always lifts your heart to see a very bad grower in your area have his crop carried out. But often, these guys have about three or four grows that are widely dispersed. So losing one, they can still make quite a profit that summer. And the agents, the wardens, are so understaffed that they don't have the person-power to clean up the infrastructure or even remove it. So all the piping and tanks and things remain in place in the headwaters of our [UC Berkeley's] reserve [in Mendocino County]. Fortunately for us, it was on the part that's owned by BLM [the U.S. Bureau of Land Management], so the federal agencies paid to have about 70,000 plants helicoptered out. But they left all the black pipe and some bags of fertilizers. So volunteers, who are doing a lot of the

If it were legal in every single ... place where there's a market, then it probably could be grown in the sunshine.' cleanup, have to slowly backpack this stuff out, or else the bags will split open and the chemicals will get into the streams.

e360: You and your co-authors say that the quasi-legal status of marijuana cultivation impedes the ability to address its environmental harm. What is the effect of that quasi-legal status, vis-À-vis these environmental issues?

Power: I think it just makes it hard. There are good growers who don't want to damage the environment, and who want to make a living and not a killing. So they get all of their plants registered, and they pay \$500 every time the sheriff visits to make sure that the environment's okay. So that's going on, and then there's been some rumors that the feds use the sheriffs' lists of good, law-abiding — at least at the county-level or the state-level — growers. There's been some concern that feds might use those lists to make easy arrests of people that are not going to shoot them. ... Remember, the federal law doesn't permit any growing. Obama clearly stated that he was not going to prioritize enforcement of the federal law, but federal law is still zero plant tolerance.

e360: Would full legalization, legalization at the federal level, make things better from an environmental standpoint?

Power: We think so. There are lots of uncertainties, but if it were legal in every single state, and every single place where there's a market, then it probably could be grown in the sunshine.

e360: You mean that literally, right?

Power: And figuratively, too. The enforcement would be transparent, and the plants would be out in the open. They'd be doing better, because they need sun. They're really an agricultural crop that would do well on agricultural land. And if the price dropped to the point where there was no incentive to do this harmful growing, then obviously the industry would collapse quickly. But if it's just legalized state-by-state-by-state, I've heard the cartels are organized enough to keep pushing the crop east, where there still is a market and it's still illegal. So as long as there is a market that will pay enough to compensate for the brutally hard work they do to grow this stuff in forested mountains, then it will keep growing.

e360: I think there might be some marijuana users who would be appalled to learn that they are supporting an industry with such serious environmental effects.

Power: Everybody thinks that it's kind of a counter-culture, alternative, cool, green thing. And 70 percent is coming from California. It's almost inevitable that they're using weed that has really damaged a drought-stricken river system.

e360: You and your co-authors propose some interesting solutions to the environmental problems caused by legal cultivation, like eco-labeling. Talk a bit about that.

Power: The timber companies some years ago were talking about having a web site stamped on the end of every two-by-four in a lumberyard. You could look at that website and get a video sweep through the watershed from which that timber was extracted. So there's no reason we couldn't have a zebra stripe on bags of marijuana that would let you use your iPhone to then look at a video of the conditions under which it's being grown. The technology would make that relatively simple, unless people falsified it.

e360: What do you and your co-authors hope to accomplish by publishing this paper?

Power: It's just heartbreaking to see the environmental damage that's going on. And there's not much support in the [California] legislature for environmental monitoring or cleanup or enforcement. All of those things are expensive and incredibly important, and yet all of the attention on the legalization issue has been diverted toward the really important medical questions, like what's it going to do if young kids use it too much. Those kinds of issues have been front and center, and the environment has been pretty much overlooked.

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

By Jennifer K. Carah Jeanette K. Howard Sally E. Thompson Anne G. Short Gianotti Scott D. Bauer Stephanie M. Carlson David N. Dralle Mourad W. Gabriel Lisa L. Hulette
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Abstract

The liberalization of marijuana policies, including the 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 by some estimates 60%–70% of the marijuana consumed in the United States is grown, we argue that (a) the environmental harm caused by marijuana cultivation merits a direct policy response, (b) current approaches to governing the environmental effects are inadequate, and (c) 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.

Issue Section:

Marijuana is the subject of heated debates over whether the liberalization of marijuana policies would benefit or harm society (Kilmer et al. 2010, Caulkins et al. 2011). Countries as diverse as Uruguay, Morocco, and the Netherlands—as well as 23 US states—are experimenting with the decriminalization of marijuana, including the states of Colorado, Washington, Oregon, and Alaska, which have legalized recreational sale and possession (AP 2014, Hughes 2014). The policy debate, which has focused on the public-health and criminal outcomes of liberalization, has largely neglected another notable source of societal harm arising from widespread marijuana use: the environmental harm associated with its commercial-scale cultivation. Where this harm has been examined by policy analysts in a legalization and policy context in Washington State (O'Hare et al. 2013), it was assumed that the environmental impacts are largely associated with energy use in indoor cultivation and will shrink in state-legal markets through regulation and other mechanisms. In that case, it was also assumed that environmental considerations are of minor importance in framing marijuana policy (O'Hare et al. 2013).

These assumptions are questionable in warm, arid, or semi-arid regions with extensive outdoor marijuana cultivation, or where state-legal/medical markets and black markets are significantly intertwined. California, where by some estimates 60%–70% of the marijuana consumed in the United States is grown (USDOJ NDIC 2007, Gabriel et al. 2013), serves as a good example of both conditions. California marijuana is primarily outdoor grown, and there is significant mixing between the medical and black markets (Short 2010, Bauer et al. 2015). Although the total area under marijuana cultivation in California is likely low compared with that of traditional Californian crops such as grapes, hay, or tomatoes, the site-specific impacts of marijuana production are significant and problematic. Illegal marijuana production in California is centered in sensitive watersheds with high biodiversity (Bauer et al. 2015), which represent habitat for several rare state- and federally listed species. The Mediterranean climate of much of the state results in the limited availability of surface water within these watersheds during marijuana's growing season. The combination of limited water resources, a water-hungry crop, and illegal cultivation in sensitive ecosystems means that marijuana cultivation can have environmental impacts that are disproportionately large given the area under production.

Like all forms of agriculture, marijuana cultivation has implications for natural resources that should be part of the current and future policy discussion. However, regulation designed to mitigate environmental harm is more difficult to implement for marijuana cultivation than for other agricultural activities because of its unique and evolving legal status. Although many US states are legalizing recreational and medical marijuana possession and use, it remains illegal at the federal level, putting the industry in a semi-legal gray area in these states. This status separates marijuana from fully legal agricultural commodities and greatly complicates regulation of the industry.

Without adopting a position on liberalization of marijuana use and possession policies, we argue here that (a) the environmental harm caused by marijuana cultivation in both the semi-legal and black-market context is significant and merits a direct policy response, (b) current approaches to and funding for governing the environmental effects are inadequate, and (c) 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

The environmental impacts of marijuana cultivation

Marijuana is a water- and nutrient-intensive crop (Cervantes 2006, HGA 2010). Its cultivation is associated with land clearing (figure 1), the diversion of surface water (figures 2 and 3), agrochemical pollution, and the poaching of wildlife in the United States (Gabriel et al. 2013, Thompson et al. 2014, Bauer et al. 2015) and internationally (Armstead 1992, McNeil 1992, Bussman 1996). Where grown indoors, it can require extensive energy inputs with potentially negative effects on climate (Mills 2012, O'Hare et al. 2013). Marijuana cultivation in California is mainly concentrated in remote forested watersheds, on private, public, and Native American tribal lands, and is largely grown outdoors (Gabriel et al. 2012, Milestone et al. 2012, Thompson et al. 2014, Bauer et al. 2015), with environmental impacts often extending far beyond the specific cultivation site (Gabriel et al. 2013, Bauer et al. 2015).

Both semi-legal and black-market marijuana plantations can be harmful to water resources and aquatic life. In the California north coast region, an estimated 22 liters (L) of water or more per plant per day are applied during the June–October outdoor growing season (HGA 2010). Using this water application rate and documented planting densities in greenhouses (900,000 plants per square kilometer [km^2]; Bauer et al. 2015), water application rates would be approximately 3 billion L per km^2 of greenhouse-grown marijuana per growing season. Outdoor planting densities appear to be much lower (Scott Bauer, California Department of Fish and Wildlife, personal communication, October 13, 2014), and if we assume a planting density of 130,000 plants per km^2 , water application rates would be approximately 430 million L per km^2 of outdoor-grown marijuana per growing season. For comparison, wine grapes on the California north coast are estimated to use a mean of 271 million L of water per km^2 of vines per growing season (CDWR 2001, 2002, 2003, 2004, 2005). Marijuana is therefore estimated to be almost two times more “thirsty” than wine grapes, the other major irrigated crop in the region.

Compared with more established forms of agriculture on the north coast, where abundant winter stream flow is sometimes captured and stored locally in ponds or tanks for later summer use, marijuana cultivation is – typically irrigated with summer and fall surface water diversions directly from headwater streams and springs (Gabriel et al. 2013, Bauer et al. 2015). These diversions are localized in smaller, sensitive watersheds that are hotspots of biodiversity—and particularly aquatic biodiversity (Bauer et al. 2015). Although legally constructed water storage can be strategically located within a watershed network to mitigate the cumulative downstream effects of water abstraction (Grantham et al. 2010, Viers et al. 2013), surface water diversions for marijuana cultivation have been documented to significantly reduce or eliminate already low stream flow during California's Mediterranean-type dry summer season, particularly during drought years, and therefore threaten the survival of rare and endangered salmonids, amphibians, and other animals (Gabriel et al. 2013, Bauer et al. 2015).

For example, Bauer and colleagues (2015) found minimum stream flows in four northern Californian watersheds to be so low in the summer months that direct surface-water diversions, based on small pumps operating at standard pumping rates, could dewater streams if more than one pump ran at once. For three of the four watersheds examined, existing demand for water for marijuana cultivation exceeded minimum instream flows in the summer by more than a factor of 2 (Bauer et al. 2015). These estimates can be scaled up to larger watersheds by considering the average summer water yields from larger rivers on a per-area basis. For comparison, the annually averaged water yield from the Eel River during the marijuana-growing season is approximately 50,000,000 L per km^2 per season (figure 4)—ten times lower than the estimated marijuana water requirement of 430,000,000 L per km^2 per season. Marijuana plantations, even if relatively small in area, can have a disproportionately large impact on water resources and flow.

Actual growing season (June–October) discharge volumes (liters per square kilometer [km²] per season) for the Eel River watershed compared with mean growing season discharge volume and estimated marijuana irrigation water need. Note that marijuana water demand (on a per-area basis) exceeds water yield by almost ten times.

Marijuana plantations can also pollute watersheds and poison wildlife. Pesticides, used heavily in black-market cultivation on public lands, make their way into terrestrial food chains, posing significant risks to mammalian and avian predators (Gabriel et al. 2013). For example, Gabriel and colleagues (2012) and Thompson and colleagues (2014) found that more than 80% of deceased Pacific fishers (*Pekania pennanti*) they recovered in northern California and the southern Sierra Nevada were exposed to anticoagulant rodenticides, pesticides used to control wood rats (*Neotoma spp.*) in black market–marijuana cultivation. The likelihood of exposure increased and female survival rates decreased with the presence of marijuana cultivation sites within fisher home ranges (Thompson et al. 2014).

The use of these pesticides is a significant threat to fishers, which are already rare and are candidates for listing under the Federal Endangered Species Act. In addition, where marijuana growers trespass onto public and tribal lands or large industrial timberlands to grow marijuana, they often camp out for many months at a time and poach wildlife for sport and sustenance (Milestone et al. 2012, Gabriel et al. 2013).

Land terracing, road construction, and forest clearing for both semi-legal and black-market marijuana plantations remove native vegetation (Milestone et al. 2012) and increase erosion (USDOJ NDIC 2007, Gabriel et al. 2013, Bauer et al. 2015). Erosion increases fine-sediment loading into streams, damaging spawning and rearing habitat for salmon and trout, such as federally endangered Coho salmon (*Oncorhynchus kisutch*; USDOJ NDIC 2007). Nonbiodegradable trash and human excrement are commonly dumped around black-market marijuana cultivation sites on public and tribal lands (USDOJ NDIC 2007). The heavy use of pesticides, herbicides, fertilizers, and petroleum fuels in both semi-legal and black-market cultivation can also contaminate watersheds (USDOJ NDIC 2007, Gabriel et al. 2013). Environmental clean-up and remediation efforts in the affected watersheds are limited, even after enforcement actions are taken, because of lack of resources and staff in state or federal agencies (Gabriel et al. 2013).

Minimal governance of environmental impacts

Because of the clandestine nature of the business, hard data on California land in marijuana production or production volumes are unavailable (Kilmer et al. 2010). Several older estimates of US marijuana-consumption rates exist, although they span a large range and incorporate significant uncertainty (Kilmer et al. 2010). Numbers range from 1 million kilograms (kg; Abt Associates 2001) to estimates from the Drug Enforcement Administration (DEA) and the United Nations Office on Drugs and Crime (UNODC) of about 4.2 million kg (Drug Availability Steering Committee 2002; UNODC 2005) and almost 10 million kg estimated by an industry insider (Gettman 2007). If we take the midrange DEA–UNODC estimate, assume that the US Department of Justice (USDOJ) estimate that California produces 60% of the marijuana consumed in the United States holds true (USDOJ NDIC 2007), and assume a 6600-per-kg price (Kilmer et al. 2010), then wholesale marijuana sales in California total approximately 16.7 billion 11.2 billion if one assumes a lower price of 4400 per kg). Even considering the uncertainty, these estimates suggest that marijuana is the largest cash crop in California, with the next largest commodity, milk and cream, securing 6.9 billion in wholesale sales (USDA 2012).

However, marijuana cultivation is not subject to effective statewide governance (Short 2010). Cultivation for medical use was decriminalized as part of the Compassionate Use Act in 1996, specifically for ill individuals. Since the passage of that law, both the small- and large-scale cultivation of marijuana for medical purposes and the black market have increased dramatically (USDOJ NDIC 2007), particularly in the last 5 years, where watersheds in northern California have seen increases in area under production ranging from 55% to over 100% (Scott Bauer, California Department of Fish and Wildlife, personal communication, April 8, 2015). The production and sale of medical marijuana in California are currently regulated through a patchwork of county and state rules. However, all cultivation—including cultivation for medical purposes—remains illegal under federal law.

This semi-legal status greatly complicates local authority to regulate the medical market (Mozingo 2013) and sets the industry apart from traditional agriculture. For example, in recent efforts in Mendocino County, the local authority's attempts to regulate medical markets have come into direct conflict with federal authorities, causing local officials to cease regulating the medical market (Mozingo 2013). This conflict also encourages secrecy and invisibility among producers for both the semi-legal medical and black markets, leading to lower levels of voluntary compliance with existing environmental regulation (Short 2010). The minimal regulation of medical markets further compounds the already significant intermixing of the medical and black markets in California (Short 2010). This intermixing creates further challenges for the effective enforcement of environmental laws and requires extensive coordination between natural-resource and law-enforcement agencies (Short 2010). In particular, the threat of violence associated with black market–marijuana cultivation complicates efforts and increases costs by natural-resource agencies to conduct field surveys or carry out enforcement or regulatory activities (Short 2010, Gabriel et al. 2013).

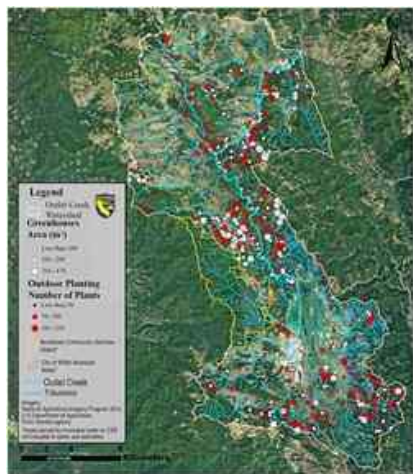
In short, the semi-legal status of the medical market and the significant intermixing of the medical and black markets complicate regulation of the industry. As a result, local marijuana-specific laws and regulations, as well as other existing state and federal environmental laws that apply (e.g., the state Fish and Game Code and Water Code and the federal Clean Water Act and Endangered Species Act) are currently inconsistently and lightly enforced (Short 2010). The lack of a robust legislative mandate to prevent and address the environmental impacts associated with marijuana cultivation adds to this challenge (Short 2010).

A lack of adequate resources also plays a significant role (Short 2010, Gabriel et al. 2013). The small number of state agents currently available to regulate this industry and others—and to enforce environmental laws—is not sufficient to adequately address the large number of marijuana cultivation sites. As an example, the State Water Resources Control Board, the agency tasked with administering water rights in California, is chronically underfunded (Grantham and Viers 2014) and already suffers from lack of staffing capacity and from permitting backlogs in processing water-rights applications for traditional water users (Little Hoover Commission 2010). Without new revenues, adding marijuana cultivators to this permitting queue will only further stretch already-thin resources. (Published by Oxford University Press on behalf of the American Institute of Biological Sciences.

Study shows marijuana is sucking the Eel River dry

Unregulated water use by marijuana cultivation sites leaves none for fish

By Linda Williams, *The Willits News* Saturday, April 4, 2015



Researchers from the California Department of Fish and Wildlife published a study in March on the impacts of marijuana growing on several Eel River segments including the Little Lake Valley's Outlet Creek.

The researchers concluded pot growing has become so prolific in this region it is literally sucking the streams dry. The study found the quantity of unregistered water abuse was many times the registered water use in the areas studied.

Unlike regulated forms of agricultural, livestock, home and municipal diversions, the clandestine nature of Emerald Triangle marijuana cultivation means that growers have been free to drain the Eel River with few controls in place to prevent it.

Water hungry marijuana plants need maximum watering just as California's Mediterranean climate enters its dry period and normal flows in area streams drop naturally.

By regulation, the Brooktrails and Willits water reservoirs, located on tributaries of Outlet Creek, can only store water for human use during the wet season, allowing all dry weather flows to pass through the dams to benefit the fish. For much of the last 10 years it appears these water releases have gone, instead, to support marijuana operations.

“The broad array of impacts from marijuana cultivation on aquatic and terrestrial wildlife in California has only recently been documented by law enforcement, wildlife agencies, and researchers,” according to the study. “These impacts include loss and fragmentation of sensitive habitats via illegal land clearing and logging; grading and burying of streams; delivery of sediment, nutrients, petroleum products, and pesticides into streams; surface water diversions for irrigation resulting in reduced flows and completely dewatered streams; and mortality of terrestrial wildlife by rodenticide ingestion.”

“Given the lack of precipitation during the growing season, marijuana cultivation generally requires a substantial amount of irrigation water. Consequently, Marijuana Cultivation Sites (MCS) are often situated on land with reliable year-round surface water sources to provide for irrigation throughout the hot, dry summer growing season. Diverting springs and headwater streams are some of the most common means for MCSs to acquire irrigation water, though the authors have also documented the use of groundwater wells and importing water by truck.”

Much of the past regulatory efforts have been based on whether the marijuana on a property was legal or illegal, rather than whether the growers followed grading ordinances or had registered their water rights. If a “farm” does not apply for building permits, there is little chance the farm will be forced to comply with the appropriate building and grading standards. If they do not have a registered water right, they cannot be contacted by the state and be asked or ordered to cut back to save the fish during periods of drought.

While this study is much more comprehensive and better documented than prior “studies,” it reached the same conclusion as Willits student Brian Pearn did in his 2008 state award-winning science project. Pearn tried to uncover why Alder Creek, located in the Eel River watershed east of Willits, no longer flowed year ‘round. Pearn documented 21 illegal water diversions that left little water in the creek for fish or wildlife.

TWN looked in 2011 at the South Fork of the Eel River’s historical flow records and concluded that even in abundant water years, South Fork water flows now drop off more abruptly following the last rains than the historical norms and by September are at or below drought levels every year.

As stream flows drop, water temperatures in the rivers and streams climb—making salmonid survival unlikely. Stagnant flows in parts of the Eel River during summer months have become the new norm.

The study says, “diminished streamflow is likely to have lethal or sub-lethal effects on state-and federally-listed salmon and steelhead trout and to cause further decline of sensitive amphibian species.”

The study identified 441 marijuana cultivation sites in the Outlet Creek watershed from aerial photographs combined with field observations. Some sites had outdoor plantings, some greenhouses and many had both. Watershed photos were taken in 2012 by the U.S. Department of Agriculture.

The researchers estimated the marijuana cultivation sites in the Outlet Creek watershed were growing 32,000 marijuana plants and requiring about 191,000 gallons per day of water.

Plantings were nearly evenly split between greenhouse and field plants. The water use was calculated to be about 6 gallons per day per plant using soaker hose and emitter line watering methods. No irrigation losses due to leaking hoses or fittings were included in the calculations.

Any Outlet Creek sites served by the city of Willits or Brooktrails water service were excluded.

The other three Eel River basins studied were Upper Redwood Creek, Salmon Creek, and Redwood Creek South, located in Humboldt County. The study reached similar conclusions for these watersheds.

Upper Redwood Creek was the only basin where marijuana irrigation did not exceed the summer time flows. The Upper Redwood Creek MCS were concentrated in 79 parcels clustered in a small area and only diverted 23 percent of the low water flow in the creek.

“Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds” by Scott Bauer, Jennifer Olson, Adam Cockrill, Michael van Hattem, Linda Miller, Margaret Tauzer and Gordon Leppig may be viewed at <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0120016>

Legally Grown Pot Still Has a Toxic Pesticide Problem

Published by Vice

By Keegan Hamilton and Tess Owen

July 17, 2015 |

Last October, dozens of DEA agents and police officers, some clad in hazmat suits, raided multiple marijuana grow-ops in Denver. The use of the protective clothing in the operation appeared excessive — after all, the agents' targets were indoor pot farms, not meth labs. But the drug cops may have had a legitimate reason to be wary: City inspectors would later catch growers slathering their plants with pesticides.

The DEA doesn't necessarily care if growers use toxic chemicals on their weed — the federal government considers cannabis illegal whether it's organic or not. An agency spokesman told VICE News that agents "wear personal protective equipment and gear as dictated by the circumstances of the particular grow," and referred questions about the raid to federal prosecutors in Denver, who said "no charges have ever been filed based on the use of pesticides" in a marijuana grow.

It appears the raids were unrelated to extensive pesticide use later documented by Denver's Department of Environmental Health (DoEH), which led to thousands of plants being quarantined, the destruction of crops, and an ongoing investigation. According to records obtained by the industry watchdog Cannabis Consumers Coalition and shared with VICE News, Denver health inspectors found plants treated with a variety of chemicals.

Related: California Has Finally Stopped Denying Organ Transplants to Medical Marijuana Users

The boom caused by state-level cannabis legalization — Colorado, Washington, Oregon, Alaska, and Washington, DC, allow recreational use of the drug, while 23 states permit some form of medical marijuana — has prompted farmers to embark on larger-scale grow operations to meet the higher demand. A mature pot plant can be worth as much as \$5,000, and pests can destroy thousands of them in a matter of days. With stakes that high, some growers are doing whatever it takes to protect their investments.

Mitch Shenassa, author of *The Cannabis Aficionado's Handbook*, told VICE News it doesn't take an expert to spot pesticide-tainted pot. "If it turns black and sort of pops, then it probably has pesticides in it," he said. "It's sort of like the difference between drinking antifreeze and nice French wine."

Even in states where growing pot is legal, using commercial pesticides without EPA approval is still prohibited. But the fact that weed remains strictly illegal under federal law has left a gaping loophole: As a federal agency, the EPA can't approve any chemicals for use on an outlawed crop. Even legal growers had no guidelines until recently, and several states are still catching up. With a black market still supplying most of America's recreational pot smokers, the vast majority of marijuana farmers are free to put whatever they want on a product that most consumers plan to inhale into their lungs.

The impact of pesticides on marijuana crops is still relatively unknown. The products that growers use aren't necessarily illegal, and the EPA has approved many of them for use on food crops. But their safety profile covers only ingestion — not inhalation. Jay Feldman, director of Beyond Pesticides, a DC-based nonprofit that monitors pesticide and environmental policy, told VICE News the lack of regulation poses a genuine public health concern.

"When you prescribe marijuana for medical use, especially for patients who have cancer, or immune-deficiency conditions, or seizures, the EPA has extra responsibility to evaluate these chemicals," Feldman said.

In March, Colorado became the first state to issue informal pesticide guidelines for pot farmers, working with the state's Department of Agriculture to "assist growers" in selecting what to use on their weed, suggesting products that have been cleared for use on similar plants, such as tobacco. Washington, Nevada, and Illinois have since followed suit with similar lists.

Sixteen of the legal marijuana states require some form of lab analysis before a cannabis product can hit the shelves. The testing, however, can be unreliable. Industry experts told VICE News that there's no standardized process for lab testing pot, little oversight of what actually happens in the facilities, and an incentive for businesses to mislabel pot in order to help their clients sell to dispensaries.

"Unfortunately, none of the testing labs are accredited in Oregon right now," said Sam Chapman, founder of New Economy Consulting, which specializes in the marijuana industry. "You can take one product to one lab and it will test at 27 percent [THC], and in another lab it will be 12 percent. There's no standard operating procedure or consistency between labs, which almost makes them pointless. You can give me a gram of marijuana and I could write on a piece of paper in crayon that I tested it at 97 percent THC, and technically that would be valid."

Another industry expert pointed out that even the most professionally run labs are not required to test for contaminants other than pesticides — like the pests themselves. At the recent "Weed the People" party celebrating legalization taking effect in Oregon, Patrick Irwin, a representative of the CO2 Company, which specializes in cannabis extractions, showed VICE News a large glass jar of buds from a crop infested with spider mites. It had been submitted to the "growers garden," where 1-gram samples were handed out to the public.

In severe cases, Irwin said the mites can leave spider-like white webbing around the leaves and buds. In this instance, the leaves were pale and dotted with tiny, almost imperceptible, white spots. The bugs sometimes die — often after being sprayed with pesticides — leaving their carcasses and bits of feces on the weed. Savvy dispensary owners would likely spot and refuse to distribute such a product, but legally there's nothing wrong with offering it to the public.

"Your weed could test totally clean for pesticides, but it could be full of rotten bugs because they don't test for that," Irwin said. "It blows my mind."

Jeffrey Raber, who holds a PhD in chemistry and runs a cannabis analytics lab in California called WercShop, conducted a study in 2013 for the *Journal of Toxicology*, which examined how much pesticide residue is transferred to a cannabis consumer through inhalation. In his experiment, Raber used three pesticides available for commercial use on food produce. He found that pesticides are easily transformed into a vapor and inhaled with marijuana smoke.

It's possible that a seemingly innocuous pesticide could transform to a more toxic or volatile substance when heated, but Raber, whose lab was raided by Pasadena police in April, told VICE News that's still uncharted territory from a research perspective. Still, he said it's clear that smoking pesticide-laced pot is unhealthy.

"If you smoke something," he said, "you're basically injecting it directly into your bloodstream."

* * *

According to a report compiled by marijuana industry groups, the market for legal marijuana in the US grew 80 percent last year, bringing in a total of \$2.4 billion. That figure is projected to swell to \$11 billion by 2019 as the so-called green rush continues. Cannabis is going corporate fast, but, as the recent raids in Denver show, there are few ground rules, and some of the big industry players have already run afoul of new pesticide restrictions.

Larisa Bolivar, director of the Cannabis Consumers Coalition, was determined to find out which pesticides the Denver inspectors identified during their raid and whether disciplinary action was taken. Bolivar filed a request under the Colorado Open Records Act for the companies' grow logs, inspection reports, and other documents, which she shared with VICE News.

LivWell, one of Colorado's largest grow operations, also maintains a chain of medical marijuana dispensaries across Colorado, with nine locations in five cities selling what their website describes as "high quality medicine." According to Bolivar's records, the company was treating its plants with Eagle 20, a fungicide that was not among those recently recently approved by the state for use on cannabis plants.

After the raid, the Denver Department of Environmental Health placed a "hold" on contaminated plants. Growers could harvest and maintain their crop, but not sell it for consumer use. LivWell had a total of 60,000 plants temporarily taken off the market, worth up to \$300 million.

Either the Colorado Department of Agriculture or "an independent accredited laboratory" was required to carry out a pesticide analysis to prove that the level of chemical residue on the buds was "insignificant" and safe enough for human consumption.

A LivWell spokeswoman told VICE News that after running their contaminated plants through the lab tests, business "went back to normal." She declined to share the results of the chemical testing with VICE News, and would not comment further on the specifics of the raid.

LivWell's logs appear to show regular applications of Eagle 20, which is used by growers to treat powdery mildew, a white mold that spreads rapidly and can be toxic to humans. Eagle 20 is registered by the EPA for use on stone fruits like peaches, as well as on ornamental roses and lawns — but not on tobacco. It's also classified a carcinogenic "bad actor" by the Pesticide Action Network, which claims it may cause long-term damage to the human reproductive system. LivWell weren't the only ones in Colorado using Eagle 20. Others, such as Organic Greens and Herbal Alternative, advertise themselves as "organic," but their grow logs seemingly tell a different story.

"They were operating unethically across the board," Bolivar told VICE News. An Herbal Alternative employee initially denied using pesticides when contacted by VICE News, then clarified and said that the company no longer uses them. Organic Greens, whose parent company is Natural Remedies, did not respond to repeated requests for comment. Bolivar said other big industry players in Colorado such as MMJ America and The Green Solution were using Avid, a pesticide used commercially to kill mites on Christmas trees and other ornamental plants. Like Eagle 20, the Pesticide

Action Network says Avid can potentially have harmful effects on the human reproductive system. Bolivar noted that MMJ America later invited the Cannabis Consumer Coalition to tour their facilities after the raid as a show of good faith. Documents obtained by Bolivar show that many of the targeted companies were also using Mallet, Akari, and Abamectin, insecticides that, according to the warning labels on the products themselves, can cause respiratory problems, birth defects, and other problems depending on the level of exposure.

John Scott, the Colorado Department of Agriculture director, told VICE News that he is unable to disclose whether disciplinary action will be taken against the growers who used the banned pesticides because an investigation is still underway. Dan Rowland, a spokesman for the city of Denver, told VICE News the most the city can legally do is put a grower's plants on "hold," and that some business owners opted to destroy their plants rather than deal with the hassle. "It is a complex jurisdictional issue and a unique situation," Rowland said. "If our environmental agency was concerned that the chicken a restaurant was using was unsafe, we'd ask that they throw it out. But it's a new industry and a new area with very young science, so we didn't condemn any of their product. If it was a different product, we might have. It's been an educational process."

* * *

There are many growers who go out of their way to avoid using pesticides at all. Several farmers told VICE News they are keenly aware that harsh chemicals could seriously harm medical patients — or recreational users — and instead rely predominantly on preventative measures to nip pest infestations in the bud.

Cristian Koch, the founder and master grower at HiFi Farms in Portland, Oregon, explained the company's technique of strengthening a plant's immune system by introducing carnivorous mites, such as microscopic worms or ladybirds, which prefer to eat other mites rather than cannabis foliage.

"The plants can do half the work for you," he told VICE News. Koch said HiFi also uses imported neem oil from India; a concoction of wheatgrass, rosemary, and thyme; and a compost mixture that cultivates bacteria in the soil to break down the eggs of spider mites and other pests.

Dustin, the head grower at Otis Gardens in Oregon, agreed to show VICE News around a state-of-the-art warehouse grow-op of about 100 large plants on the condition his last name not be used. The crop is entirely organic, and he stressed that prevention is the key to avoiding pesticides entirely. Anybody who sets foot in his grow rooms has to step on a mat with disinfectant, and hand sanitizer dispensers are set up outside each door.

"Everything is grown in a sealed environment," Dustin said. In one grow room, he sprinkled carnivorous mites from a tall white plastic cylinder "like parmesan" onto the potted soil beneath several mammoth, six-foot tall plants. "Most of the research you find published [on pesticides], even if it's safe for food crops, it hasn't been tested on cannabis flowers," he said. "We're very selective about the pest control methods we use."

If pests get past their first lines of defense, Dustin's preferred strategy is to heat up the grow rooms — which are normally kept at a steady, air-conditioned 78 degrees — to about 115 degrees for an hour.

"It kills most pests, and most beneficial insects are resistant to it," he said. "It stresses out the plants, you might lose a day or two of growth, but if it kills off a significant portion of the pests, the plants will thank you for that."

Both HiFi Farms and Otis Gardens are licensed to grow for medical purposes, but even some growers who work illicitly choose to eschew pesticides. A grower based in New York who asked to be identified as Elly has 99 plants, which are grown almost exclusively for a 15-year-old girl with severe cerebral palsy who is fed a mixture of cannabis and coconut oil through a tube every day.

"I just really wouldn't want to use anything else," Elly said of his organic approach. Of course, weed that is grown and sold exclusively on the black market has no restrictions whatsoever. In some cases, such as at outdoor farms in northern California's infamous Emerald Triangle, police have found jugs of pesticides and other evidence that suggests the use of chemicals in these clandestine grows is widespread. With no oversight, these chemicals often seep into local streams and waterways.

Industry advocates hope that as more states legalize weed, the black market will dissipate and the federal government will allow agencies like the EPA to develop guidelines to help prevent the use of harmful pesticides on pot. States that have already legalized the drug are also constantly updating their rules and regulations, trying to create a regulatory framework for what is still a very new industry.

Colorado officials require all marijuana products sold in the state to be properly labeled, listing the pesticides used during production. They also require medical marijuana to be tested in a lab for pesticide residue before hitting the shelves. But even with standardized lab testing, the question of which pesticides are safe to use on marijuana crops remains unanswered.

Asked about pesticide oversight, EPA spokeswoman Cathy Milbourn sent VICE News a letter the agency had previously sent to Mitchell Yergert, head of the plant division at the Colorado Department of Agriculture. Yergert wrote to the EPA earlier this year seeking advice on how to address the issue. In response, the agency suggested that Colorado pursue a "Special Local Needs" (SLN) registration, a status granted when states can prove they have a unique agricultural condition that makes them exempt from federal guidelines. The EPA wants Colorado to identify pesticides approved for crops similar to marijuana, such as tobacco, tea, barley, and sage.

For Scott, the fact the EPA is willing to work with his agency is a good sign. The Colorado Department of Agriculture chief said they are still in the process of compiling a database of pesticide products they believe might be safe for marijuana cultivation.

But ultimately, Feldman, the director of the pesticide and environmental policy monitoring group, said it's unlikely that the EPA will grant Colorado's request for SLN status, since it would entail the federal government treating marijuana like a legal substance. "They're caught in a bind," he said.

Though Denver is way ahead of the curve compared to other states and cities that have legalized weed, Rowland, the Denver spokesman, said the city is still trying to decide what's safe for consumers while balancing the interests of business owners.

"Obviously the easiest thing to do would be to set the limits at zero," he said. "But we're trying to find a middle ground and navigate this emerging agriculture and industry. We determine the tolerances by looking at tolerances that are set on other products, and we take the lowest one and apply it to marijuana."

He added that the city has faced a steep learning curve, but suggested that increased awareness is already leading to progress.

"I didn't know anything about pesticides on marijuana six months ago," Rowland said. "It's in everyone's best interest to keep consumers safe, and it's cool that we're having this conversation."

Pleasure, panacea, poison? The little-known health effects of marijuana



By *David Trilling*

As marijuana use becomes ever more socially and legally acceptable in the developed world, researchers are scrambling to understand how the plant — more potent today than ever before — impacts our health. Marijuana is now legal in 28 U.S. states for medical use and in eight for recreation. But policy has far outpaced science, with almost every clinical study calling for further inquiry and many researchers complaining their work is stymied by federal regulations, which still treat cannabis as an illegal substance.

Judging by the available research, ample evidence exists to say that marijuana can treat pain, nausea and multiple sclerosis. It can harm lungs and the developing adolescent brain. Under certain

circumstances, it can be addictive and increase the likelihood of auto accidents, low birth weight and, in cases of heavy use, schizophrenia.

The open questions about marijuana and its derivatives are far more numerous. How do benefits balance against side effects? How well can these substances treat seizures? How exactly do they affect the brain? How dangerous are the barely regulated chemicals used in processing weed for commercial use, like butane, pesticides and food additives? What other regulatory loopholes could lead to dangerous effects on consumers?

Without more rigorous study, these questions will remain unanswered and new ones will crop up, leaving policymakers and citizens to argue based on piecemeal research and personal convictions instead of adequate empirical data.

What's in it and how it's used 12th century manuscript of medicinal plants from France or England. (British library)

Cannabis has dozens of chemical compounds unique to the plant, known as cannabinoids. The one most famous for the high it gives is tetrahydrocannabinol (THC). But another one, cannabidiol (CBD), is largely non-psychoactive and is often the focus of research on marijuana's medicinal properties: It may lessen the frequency and intensity of seizures and may even improve cognitive function in adults. Medical marijuana is generally higher in CBD. Both THC and CBD are present in the cannabis plant as inactive acids. Heating — whether by smoking, vaporizing, baking, infusion or other methods — transforms them into active compounds.

What we know

A January 2017 report by the National Academies of Sciences, Engineering, and Medicine reviews most of the known research published since 1999 about marijuana and its impacts on health, making for one of the most comprehensive reads available. "The Health Effects of Cannabis and Cannabinoids" draws almost 100 conclusions, arguing that enough evidence exists to declare that marijuana can be used to treat pain, chemotherapy-induced nausea, and multiple sclerosis.

The report finds substantial evidence that marijuana use may: worsen respiratory function and cause bronchitis (when smoked); increase the likelihood of car accidents; and cause heavy users to develop schizophrenia. It also shows that males who both smoke cigarettes and use marijuana are more likely to develop an addiction to weed than either females or those who don't smoke cigarettes. Starting to use marijuana before age 16 also raises the risk of addiction. For expectant mothers, considerable evidence suggests that marijuana can negatively impact birthweight.

The report finds moderate evidence: that marijuana use impairs learning, memory and attention, especially in adolescents; that it may improve cognitive performance among some people with certain psychotic disorders; and that it does not worsen schizophrenia. (There is no evidence it can treat the disorder.)

No known association has been found with lung cancer and there is limited evidence that marijuana use increases the risk of heart attacks.



Why we don't know more

One problem in compiling the report, and in exploring the health effects of marijuana more generally, is a dearth of studies and funding for research because of federal regulations, said the lead author, Marie McCormick, during a March 2017 event at Harvard's T.H. Chan School of Public Health.

For one thing, researchers complain about their limited legal access to real weed, the kind people outside of labs use: "It is often difficult for researchers to gain access to the quantity, quality, and type of cannabis product necessary to address specific research questions on the health effects of cannabis use," the National Academies report declares.

The Drug Enforcement Agency (DEA) classifies marijuana as a Schedule I narcotic. By definition, that means, like heroin, it is highly prone to abuse and has no medical purpose — a rating that *Scientific American* has called "highly controversial and dubious." So researchers cannot simply use what they might buy on a street corner or even at a pot shop in states where it is legal under local laws.

The plant clinical researchers do use comes from a farm at the University of Mississippi that the National Institute on Drug Abuse (NIDA) licenses to grow marijuana for research purposes. But scientists complain that what they receive is far less potent than marijuana consumed by the public and even looks like an entirely different plant. The result, *The Washington Post* declared in 2017, is "akin to investigating the effects of bourbon by giving people Bud Light."

In August 2016, the DEA announced it would loosen control over the cultivation of government marijuana, though it remains unclear when the changes will go into effect.

Other difficulties studying the effects of marijuana relate to metrics. There is no standard definition of what constitutes frequent use, moderate use or low use, noted Staci Gruber of McLean Hospital at the Harvard event. Researchers have yet to look closely at the effects of marijuana use on those who smoke or eat it once or twice a month. Federal health surveys, moreover, do not ask detailed questions of users.

Kids and pot

One question that has loomed large as more places have legalized marijuana use is, "How bad is it for children?"

Two recent studies observe that regular marijuana use is likely much worse for children before age 16 than it is for adults. A 2015 study in *Developmental Cognitive Neuroscience* found that kids who start using marijuana before age 16 may have lower cognitive function than people who start using later: "Given that the brain undergoes significant development during adolescence and emerging adulthood and that the frontal cortex is among the last of the brain regions to mature, it is perhaps not surprising that individuals with earlier exposure to [marijuana] have difficulty with tasks requiring frontal/executive function." A 2014 study in *Psychopharmacology* also found a correlation between smoking marijuana and impulsive behavior, especially among those who begin regular use before they turn 16.

Marijuana bred for high levels of THC often has less CBD. A 2017 study found CBD may act as a safety mechanism, especially among adolescents.

Other research includes studies on addiction, IQ and the links between legalization and usage:

- One 2017 review in *The Lancet* notes that while about 1 in 11 people who use marijuana will develop a dependence, that number almost doubles among people who started as adolescents.
- A 2011 study of twins — where one uses pot and one does not — finds no evidence to associate the drug with a lower IQ, though it calls for more research.
- A 2016 study in *Drug and Alcohol Dependence* analyzes the design of medical marijuana laws and use by adolescents. Looking at 45 states, it finds slightly higher use of marijuana among teenagers in states where medical marijuana is legal (22.7 percent in the previous 30 days) compared to states where it is not (19.8 percent). But after adjusting for demographics and other factors, the authors discover a small decline in adolescent use in those states where medical marijuana is legal.
- Research in Washington and Colorado before and after recreational marijuana was legalized in both states in 2012 found perceptions of its harmfulness fell among youth in Washington but not in Colorado, where medical marijuana had already been well-established. Eighth- and 10th-grade students in Washington increased their usage over the same period; youth marijuana consumption in Colorado did not appear to change, the authors report in *JAMA Pediatrics*.

The Canadian Pediatric Society in 2016 released a position statement recommending that Ottawa — where full recreational legalization is being considered — take a number of steps to keep marijuana out of the hands of anyone younger than 18 and regulate the amount of THC in legal marijuana products.

“Dang, that’s strong!”

It’s not your parents’ grass anymore: The marijuana available today is many times more potent than it was in the days of “Reefer Madness” or Woodstock. In 2015, the American Chemical Society reported that THC content in some marijuana strains had roughly tripled in three decades.

One of the most potent products on the market is butane hash oil, sometimes known as marijuana wax. Used in increasingly popular “vape pens” and in the production of edibles, it is made by passing butane (a liver-damaging, explosive and all-around dangerous hydrocarbon gas) through marijuana buds to make a viscous liquid and then evaporating off some of the butane. It is illegal in many states. Not only is the production process dangerous, but smoking “wax made with butane leaves small molecules that adhere to the lungs and creates a black spot much like miners’ lung,” says a handout from the Department of Health and Human Services.

Medical marijuana

With medical marijuana now available in more than half of U.S. states and a growing number of countries, the plant is being used to treat all sorts of ailments including pain and chemotherapy side-effects such as nausea, loss of appetite, and insomnia (even as doctors complain they lack dosing guidelines). Each of these uses is addressed (and generally endorsed) in the 2017 National Academies report.

A major area of study is the use of medical marijuana in treating epileptic seizures, discussed separately below. Other research has explored its effects on cognitive function, on the use of opiates and on the use of recreational marijuana:

- One 2016 study in *Frontiers in Pharmacology* finds signs that medical marijuana may help improve cognitive function in adults. The researchers suspect this is because some medical marijuana products contain higher amounts of CBD and other cannabinoids than does recreational marijuana, “which may mitigate the adverse effects of THC on cognitive performance.”
- Some scholars see a decline in the use and abuse of opiates by cannabis users, though the National Academies report uncovers no evidence to support or refute this finding.
- Writing in *JAMA Internal Medicine* in 2014, Marcus Bachhuber of the Philadelphia Veterans Affairs Medical Center and his colleagues find “medical cannabis laws are associated with significantly lower state-level opioid overdose mortality rates.” Patients seem to be using marijuana as an opioid substitute; marijuana is far less addictive and dangerous than drugs derived from the opium poppy. A 2016 study by Columbia University researchers confirms those findings and observes that states with medical-marijuana laws have fewer opioid-related car accidents.
- A 2015 study sees an association between medical marijuana and the lower use of addictive opioids as pain medication; it also reports fewer opioid-related deaths. At the same time, the paper finds a correlation between the availability of medical marijuana and higher rates of recreational marijuana use.

A 2017 study in *Drug and Alcohol Dependence* finds no indication that CBD, the “medical” cannabinoid, might be addictive.

Treating epilepsy

A fast-growing body of research suggests that CBD — now sometimes called Charlotte’s Web after a CBD-based medicine that reportedly helped a severely ill child — might alleviate treatment-resistant seizures among epilepsy patients. In 2013 the Food and Drug Administration (FDA) allowed tests of Epidiolex, a CBD oil concentrate developed by GW Pharmaceuticals, which is not yet commercially available.

In 2016, the American Epilepsy Society (AES) called on the federal government to support further research into the use of marijuana to treat the neurological disorder. “Robust scientific evidence for the use of marijuana is limited. The lack of information does not mean that marijuana is ineffective for epilepsy. It merely means that we do not know if marijuana is a safe and effective treatment for epilepsy, which is why it should be studied using the well-founded research methods that all other effective treatments for epilepsy have undergone,” the AES statement says.

It also calls on the DEA to review its classification of marijuana as a Schedule I drug: “AES’s call for rescheduling is not an endorsement of the legalization of marijuana, but is a recognition that the current restrictions on the use of medical marijuana for research continue to stand in the way of scientifically rigorous research into the development of cannabinoid-based treatments.”

A 2016 study of CBD in *Lancet Neurology* finds a 36.5 percent decline in monthly seizures among 162 patients suffering severe, childhood-onset, treatment-resistant epilepsy. The trial was open, meaning patients knew what they were receiving, which is not a preferred way to do medical research; the authors call for randomized controlled trials. Besides the decline in seizures, they find side effects including fatigue, diarrhea, decreased appetite and convulsions.

A number of recent studies — such as this [2017 paper](#) in *Epilepsy Behavior* and this [2014 paper](#) in *Epilepsia* — summarize the research and anecdotal evidence that CBD can help control epileptic seizures. They both call for randomized, controlled research trials that are double-blind — i.e., where neither the patients nor the doctors know who is receiving the drug and who is receiving a placebo.

The National Academies report takes a dimmer view of the available clinical data, noting that it consists “solely of uncontrolled case series, which do not provide high-quality evidence of efficacy.” It acknowledges the need for more research into CBD’s potential effect on neurological disorders such as epilepsy and seizures, but concludes that “there is insufficient evidence to support or refute the conclusion that cannabinoids are an effective treatment for epilepsy.”

Regulations, pesticides, food production

Some of the biggest holes in research concern the production of marijuana and its derivatives, including the use of pesticides and the preparation of edibles. Like other deficits in research they stem in part from the disconnect between federal and state laws on marijuana.

In agriculture, pesticides are usually regulated by federal bodies such as the [Environmental Protection Agency](#) and approved for specific crops after the pesticide manufacturer pays for testing that the EPA deems reliable. But because the EPA is a federal agency, it will not label a chemical safe for marijuana. So regulation is handled by individual states, which often lack the capacity to investigate problematic pesticides. State governments “have never been made to play the detective role in this,” [Andrew Freedman](#), the former director of the Office of Marijuana Coordination for the state of Colorado, tells Journalist’s Resource.

States where marijuana is legal have been known to recall batches believed to have been exposed to unapproved pesticides such as the insecticides [imidacloprid](#) or [pyrethrin](#). (Some states have websites with regulatory information, including [California](#), [Colorado](#) and [Washington](#).) Some researchers, meanwhile, express [concern](#) about lobbying by the chemical industry to weaken pesticide regulations. Very little has been published about the effects of marijuana pesticides on human health.

Another area in need of study is the production of edibles. The FDA has [not approved](#) any product containing CBD as a dietary supplement, but, at the time of writing, has not aggressively enforced federal laws that the FDA interprets to ban marijuana compounds in food.

Marijuana marketing is another topic worthy of greater scrutiny. A [2015 commentary](#) in *The New England Journal of Medicine* sounds the alarm about the popularity of edible snacks containing THC that are “packaged to closely mimic popular candies and other sweets.” Citing the risk of consumption by children, the authors, two researchers at Stanford, call on the federal government and the courts to regulate the sale of edibles.

Other resources

The number of American cannabis users is rising. According to an [August 2016 Gallup Poll](#), 13 percent of Americans say they use the drug, up from 7 percent in 2007. Slightly older data from the [National Survey on Drug Use and Health](#), published by the U.S. Department of Health and Human Services, say over 22 million Americans aged 12 or older have used marijuana in the past month. That is 8.4 percent of the population.

[CannabisWire.com](#), [The Cannabist](#), and [High Times magazine](#) are among the news outlets that cover the growing legal marijuana business. Pot beats and pot critics are increasingly common at traditional newspapers.

For *Scientific American* in 2016, David Downs [wrote](#) a history of the federal government’s “war” on marijuana. Downs, the cannabis editor at the *San Francisco Chronicle*, has also penned a [glossary](#) of marijuana terminology.

Journalist’s Resource has reviewed literature on how [crime and drunk driving tend to fall](#) after marijuana legalization. We also have looked at [potential tax revenue](#) from legal weed.

The National Institute on Drug Abuse regularly updates its [fact sheet](#) on marijuana.

Illegal Pot Farms Are Poisoning California's Forests

Secret growers are taking advantage of the state's remote stretches of public land—and the environmental impact is severe.



JULIAN SMITH MAY 21, 2017

In the gray half-light of dawn, eight figures creep through the dry pine forest near Quincy, California. Seven of them wear camo uniforms bearing the logos of various government agencies: U.S. Forest Service, National Guard, California Fish & Wildlife, Plumas County Sheriff. Most have blackened faces and assault rifles at the ready. An 11-year-old Belgian Malinois named Phebe and her K9 handler lead the way.

Number eight is tall and dressed in black, with a rumpled bush hat and a Springfield Armory 9 millimeter pistol in a hip holster. With a kaffiyeh wrapped under a dark beard, and eyebrows (in his words) “like two caterpillars about to mate,” Dr. Mourad Gabriel could pass as a local interpreter on a Special Forces raid if this were Iraq or Afghanistan. Instead, he’s a wildlife biologist accompanying law-enforcement agents on an illegal marijuana farm bust.

The group traverses’ hillsides, fords streams, tiptoes through thickets of fern and willow, trying not to snap twigs or shake saplings. Radios crackle with whispers. Tiptoeing through rough terrain is slow going: It takes almost four hours to go three miles.

At last the goal is in sight: a dense garden of pot plants on a steep slope above Palmetto Creek. The dog team and two others move in while the rest, including Gabriel, hold tight down by the creek. Growers are often armed, and if there are any around, they could make a break for it. Runners usually head downhill.

Word comes back: Nobody’s home. The whole team can enter safely. It’s time for Gabriel to go to work.



* *

A combination of ideal growing weather and proximity to tens of millions of potential customers has always made northern California a great place to grow dope. California was the first to permit medical marijuana, in 1996, and this past November, residents voted “yes” on Proposition 64, making California the fifth state to legalize recreational pot. Almost two-thirds of the country’s total legal harvest comes from the Golden State. The crop brought in \$2.8 billion in 2015, putting it somewhere between lettuce and grapes, and some estimates project the state’s “green gold rush” could become a \$6.5 billion market by 2020.

Even as California embraces the booming legal marijuana market, though, it is also seeing an explosion in illegal cultivation, much of it on the state’s vast and remote stretches of public land. National forests and even national parks have seen a surge in large-scale illegal “trespass grows,” some with tens of thousands of plants spread across dozens of acres. As much as 80 percent of illegal pot eradicated in California is grown on federal lands, and that’s just the fraction

that authorities find. (Trespass grows occur in other states in the American West, and even in remote areas back east, but at nowhere near the scale of California.)

The surge has overwhelmed land-management and law-enforcement agencies, whose resources are already stretched thin. Here in the Plumas National Forest, for instance, three USFS officers have to cover some 4,600 square kilometers (1,790 square miles). That's why so many different agencies are cooperating on this raid.

As the executive director of the non-profit Integral Ecology Research Center (IERC), Gabriel's usual purview is studying ecosystems and their inhabitants, from big cats to endangered invertebrates. He never expected to find himself packing heat and creeping through the forest, let alone facing other threats to his and his family's safety. But he has taken up the challenge because of illegal pot growing's insidious side effects: The lethal poisons growers use to protect their crops and campsites from pests are annihilating wildlife, polluting pristine public lands, and maybe even turning up in your next bong hit.

Up on the hillside, bright green plants sprout from shallow holes gouged into the slope. Some plants are more than 2.5 meters (eight feet) tall—a sativa strain, known for its energizing highs—while others are shorter, with the darker leaves of mellower indica. A tangled web of plastic irrigation lines feed every hole. It smells like you'd expect a pot garden to smell as it bakes in the sun: herbal and musky and medicinal all at once.

As soon as they arrive, officers begin chopping down the plants with machetes and garden pruners. Gabriel pulls on blue nitrile gloves, plucks a pot leaf and sticks it into a small plastic bag to test for pesticide residue. Then he kneels to examine a Gatorade bottle lying on the ground. Growers often use empty containers like this to store toxic chemicals. In the previous year, every Gatorade bottle Gabriel and his team found at grow sites tested positive for carbofuran, a neurotoxic insecticide that is so nasty it has been banned in the U.S., Canada and the EU. Farmers in Kenya have used it to kill lions. Symptoms of exposure range from nausea and blurred vision to convulsions, spontaneous abortions, and death. "They just leave these sitting around," Gabriel says as he carefully swabs the bottle.

In 2009, Gabriel was studying Pacific fishers (*Pekania pennanti*), cat-sized carnivores that live in old-growth forests in the Rockies and Sierra Nevada. Fishers look cute and cuddly, but they're the only animals that regularly kill and eat porcupines (*Erethizon dorsatum*). Small, isolated populations live in Washington, Oregon, and California. (Just last year, despite the numerous threats fishers face, including logging and wildfires, the U.S. Fish & Wildlife Service decided against granting the animals federal protection under the Endangered Species Act.)

There are fewer than 500 fishers left in the mountains of northern California. So when Gabriel performed a necropsy on one individual in 2009 and found its body cavity filled with blood from some kind of hemorrhagic response, red flags went up. Tests showed the animal was full of an acute rodenticide (AR) so toxic it is not sold legally in the U.S. (Acute or second-generation rodenticides are exceptionally lethal, designed to kill in a single dose.) As more poisoned fishers turned up, Gabriel and other biologists were baffled. Radio collar data showed the animals hadn't gone near farms. Where were the poisons coming from?

Gabriel started reporting his findings at scientific conferences, in part to see if anyone could help figure out what was going on. At one of these, a conservation officer approached him afterward and offered an explanation: illegal marijuana grow sites, where the officer would often see containers of rodenticides and other chemicals.

Suddenly the puzzle made sense. Gabriel and his colleagues tested 58 fisher carcasses they had collected over the previous three years and found that more than 80 percent had rodenticide in their systems. It even showed up in nursing kits, meaning the mothers passed it through their milk. Some animals tested positive for four separate toxic compounds. Since then the numbers have only risen. In 2016, the scientists tested 22 radio-collared fishers that had apparently died of natural causes; every one had some kind of synthetic poison in its system.

Some 50 different toxicants have turned up at grow sites. ("Toxicants" are manmade poisons, while "toxins" are naturally occurring.) Growers use the poisons to keep rodents and other animals from eating the sugar-rich sprouting plants, from gnawing on irrigation tubing, and from invading their campsites in search of food. Acute rodenticides cause neurological damage and internal bleeding. Animals literally drown in their own blood or stumble around until they're eaten themselves, passing the poison up the food chain to predators like owls and fishers.

Growers bait open tuna cans with pesticides, which are often flavored like meat or peanut butter, or string up poisoned hot dogs on fishhooks. People have found bears, foxes, vultures, and deer with chemicals from grow sites in their bodies. One study of barred owls (*Strix varia*) in the Pacific Northwest found that 80 percent of the birds tested positive. And for every animal found, there are probably dozens more in a similar condition.

“It’s a massive problem,” says Craig Thompson, a wildlife ecologist with the U.S. Forest Service. “People don’t tend to grasp the industrial scale of what’s going on. There are thousands of these sites in places the public thinks are pristine, with obscene amounts of chemicals at each one. Each one is a little environmental disaster.” Thompson also studies fishers in the Sierras, and he is one of the few scientists besides Gabriel who studies the problem firsthand. “I can stand at the intersection of two forest roads and generally know of three or four pot gardens within a quarter or half a mile.”

Gabriel and Thompson fear the poisons could spread far beyond each grow site and contaminate the water supply of towns and cities far downstream. The toxicants can leach into the soil and linger for years. Using water monitors, Gabriel has already found organophosphates—nerve agents used to make insecticides and certain types of chemical weapons—several hundred meters downhill from grow sites. “We know it’s happening, we just don’t know the extent, and we don’t know what other chemicals are involved,” he says.

“I think they were out of here already, maybe to resupply,” says Chris Hendrickson, a detective with the Plumas County Sheriff’s Office who coordinated the raid. Hendrickson is soft-spoken, with glasses and a light mustache. He’s sifting through the mess of the growers’ campsite, a dirt platform under a camouflage tarp just beyond the last plot. It contains everything a few people would need to live for months: sleeping bags, cots, a propane stove, bug spray, cartons of eggs and bags of rice, potatoes, and sugar. Many of the food labels are in Spanish; a jar of pickled nopales—prickly pear cactus pads—sits near a pile of dirty clothes and a solar cell phone charger.

Hendrickson estimates he has gone on about 50 raids in his nine years as an investigator. This one is typical, he says: probably two guys tending the plots for anywhere from two-to-four months, with occasional food drops and extra help during planting and harvest.

It takes about an hour for the team to chop down or uproot all 5,257 plants. While wholesale prices for illegal pot have fallen by half over the past decade, even at the current rate of around \$1,500 per pound, at a rough estimate of a pound per plant, that’s almost \$8 million lying in the dirt. Someone’s going to be severely disappointed when they come to check the crop. “These guys will be coming back,” Hendrickson says. “It would be interesting to be a fly on the wall when they see what has happened.”

Pot from illegal sites like this one can end up anywhere. “These guys aren’t growing for the legal recreational market or medical dispensaries—they’re growing to exploit a black market somewhere,” says Mark Higley, a wildlife biologist with the Hoopa Tribe in Humboldt County, whose reservation has seen an explosion in illegal grow sites. While there is no proof that illegal pot ends up in the burgeoning legal market, many familiar with the industry suspect it does.

Law enforcement officials think many trespass grows are set up by Mexican drug cartels, which prefer to ship marijuana from state to state rather than smuggle it over the international border. Growers arrested during raids are often undocumented immigrants in their 20s from Michoacan, experienced in covert agriculture and hard living. They earn around \$150 a day for two-to-four months, much more than they would at a farm or winery.

Captured growers sometimes claim their employers are holding their families’ hostage until the harvest is collected. Whether or not that’s true, they’re motivated to protect the crop. Hendrickson estimates between a quarter and half of raids turn up some kind of weapon, from crossbows to automatic rifles. He has found elevated sniper positions set up near grow sites.

Growers have followed, detained, threatened, pursued, and shot at officers and civilians, including scientists and field techs. One Forest Service biologist who stumbled upon a grow site in Sequoia National Forest was chased for close to an hour by armed growers. When he briefly lost radio contact, his supervisors feared he had been captured or was dead, but he made it out safely. In a single week in the summer of 2016, two K9 dogs were stabbed while apprehending suspects at trespass grows. (Both survived and have returned to work.)

“I’m worried about my family going hiking and running across one of these, or my friends,” Hendrickson says. Gabriel looks up from counting empty bags of fertilizer. “I’ve hiked and snowmobiled through this drainage,” he says. “We’ve done spotted owl surveys here, too. There’s a nest right over there.”

Pesticides have been the biggest recent game-changer for law enforcement, Hendrickson says. The possibility of coming into contact with a neurotoxin sprayed on a plant or hidden in a Coffee-mate jar makes raids even more dangerous, not to mention slower. “We still make sure a garden is safe when we go in, but now it takes a lot longer to assess if there are dangerous chemicals or not. Safety-wise, it’s huge for us.”

Just walking through rows of plants coated with toxic chemicals can be enough to bring on symptoms like lethargy and headaches—let alone spending hours cutting them down in the hot sun under the wash of a helicopter. Gabriel and his employees have started getting monthly blood tests to check for pesticide exposure.

Some chemical threats are more immediate. At one site Gabriel was inspecting an unfamiliar container full of aluminum phosphide, a poisonous powder used to kill rodents and insects. It had gasified and built up pressure in the heat of the sun. When he touched it, it exploded in his face. Luckily he was wearing a hazmat respirator.

“My biggest fear is that some kid will come across one of those bottles,” Thompson says. “Carbofuran is pink, it looks like Pepto, like candy. Can you imagine what a five-year-old would do with that?”

As the last of the plants at Palmetto are cut down, Gabriel totals up his findings: 3.6 kilograms (8 pounds) of bromodialone, a restricted-use neurotoxic rodenticide, and two bottles of malathion, an organophosphate insecticide that’s basically a watered-down version of the nerve agent sarin. Each bottle is enough to make 1,900 liters (500 gallons) when mixed with water. All of it has to be left behind, at least for now, since moving it would require hazmat protocols and more time and money than anyone has at the moment.

Gabriel’s expertise in wildlife toxicology has become a huge asset to law enforcement, both in terms of keeping officers safe and gathering evidence for prosecution, says Forest Service patrol commander Chad Krogstad. “He’s helping us out tremendously, giving us environmental background data and even testifying in some of our cases.” But the work comes at a cost.

* * *

That evening in a tiny pizzeria in nearby Greenville, the stress of the morning’s efforts shows in Gabriel’s face and posture. Usually he’s fizzing with energy, peppering conversations with “Dude!” and going off on endearingly geeky tangents about chemistry or animal behavior like a kid talking Minecraft. Now he’s glancing at the clock, wondering where dinner is. Three simultaneous orders have overwhelmed the kitchen.

“I never thought that studying wildlife diseases would land me in the middle of the drug war,” he says. “But you can’t just stand by and do nothing.” He’s quick to emphasize that his role is strictly that of an objective observer. He’s not advocating or making arrests; he’s a scientist, collecting and analyzing data and reporting his results—even though that entails going on raids and packing heat, and in the end, seeing his efforts help put people in jail.

“I gave up being objective about this a long time ago,” Thompson says. “I think it was the day I looked at a map and saw a grow site maybe 100 yards upstream of a place I’ve taken my kids to play in the water and fish. That makes it a personal issue.”

It’s an unusual position to be in for a scientist trained in dispassionate data collection and objectivity above all, and one that’s often uncomfortable as well as dangerous. Gabriel’s many published papers and presentations on the topic of pot poisons have raised his public profile significantly. In the heart of drug country, that’s not a good kind of notoriety.

Growing marijuana has been a way of life in northern California for decades. Even though more and more is being grown legally, Gabriel’s inadvertent role as “the scientist who helps cops raid pot farms” has—in some eyes—brought unwelcome attention. In Eugene, near where he lives, strangers at the supermarket and gas station have invited him to go fuck himself. Grower websites have posted the latitude and longitude coordinates of his home, and his office has been burglarized. From the pattern of door and room alarms that were triggered, it looked like the intruder headed straight for his desk. “That means someone was probably watching where I sit,” he says.

The worst fallout came one evening in February 2014. Gabriel and his wife Greta Wengart, who was pregnant at the time, called their two dogs in from the backyard. Nyxo, a 100-pound black lab mix, had been barking at something across the fence. He was a gentle giant they had adopted from a local shelter ten years before, after he had been shot at, tossed from a truck, and left for dead. Nyxo seemed sluggish as he went to sleep. In the middle of the night they heard him throwing up.

That’s ... the only way to make sure no one on the entry team stumbles upon anything toxic.

Early the next morning Nyxo started drooling and collapsed. Gabriel rushed him to the vet, but the dog slipped into a coma. That afternoon he had to be put down. Mourad helped with the necropsy—“one of the hardest things I’ve ever had to do.” He found Nyxo had been poisoned with brodifacoum, an anticoagulant rodenticide. A reward of \$20,000 still has not brought in a single lead. Gabriel and Wengart’s daughter was born two weeks later.

Since then Gabriel has surrounded his house with high-def cameras and motion-sensor lights. He has learned to live with one eye over his shoulder, always scanning for suspicious cars or strangers. “I’m not being ignorant,” he says. “I have to be perceptive, for my family’s sake.”

Wengart is also a biologist, and serves as the IERC’s assistant director. She and Gabriel work closely on grow sites and other projects. “I worry about him less than I used to,” she says. “When he’s doing ground entry, that’s the only time I get nervous.” But that’s the only way to get certain kinds of information, by questioning captured growers, and the only way to make sure no one on the entry team stumbles upon anything toxic. The couple started out working together on busts, but now they try to take turns. Not being in the same place at the same time is both safer and more efficient. “It’s definitely a conscious choice,” she says.

“I think we’re all worried a little about Mourad,” says Higley, who often delivers public presentations along with Gabriel. “I wish he would keep a lower profile.” Higley himself has documented dozens of trespass grow sites on the Hoopa reservation, including one last year, the first, with a cache of carbofuran.

In his defense, Gabriel says legal growers have thanked him in person for drawing attention to the issue of illegal pot grows—not just because of the threat they pose to their profits, but also because the environmental and health risks could tarnish the industry’s overall image.

* * *

Early the next morning, Gabriel and five field techs from IERC park along a dirt road in the hills northwest of Quincy. The brushy slopes bristle with blackened tree trunks, remnants of a forest fire years earlier. The team is here to survey a grow site nicknamed Rattlesnake that was busted in 2015. Henderson is along for security, as is a burly National Guardsman from a specialized unit trained in chemical, biological, radiological and nuclear threats. The Guardsman doesn’t want his name used, and later pulls on a balaclava for a group photo. “Mourad’s a badass,” he says. “He’s smarter than all of us, and he’s a goat on the trails.”

Gabriel goes over security protocols as everyone gears up and tests radios. “No wallets, no cell phones, nothing identifiable.” The chance of dropping something that could lead someone unpleasant to your front door, while tiny, just isn’t worth it. “If you run into a grower, remember: Turn your mic on, and the safety code word is ‘hammerhead.’” He shouldered his backpack and checks his pistol. “Everyone have their mace?”

Personal safety has become a primary concern for anyone doing field work on public land in California, Thompson says. “It’s an entirely different paradigm than five or ten years ago. It pervades every aspect of the job.” It’s too dangerous to send anyone out alone, which means having to pay two people to do a job one could do. Law enforcement regularly declares scientific study areas off limits because of safety concerns.

“My techs are going in with guys with M-16s to recover dead animals, and that’s just to do our normal wildlife job,” Thompson says. Techs are taught to identify signs of illegal grow sites, such as trash, new trails, and sneaker prints in places where people generally don’t wear Nikes. They also learn how to appear as nonthreatening as possible in the field: no camo clothing, scientific equipment in full view. “I have to talk about it in job interviews now when I hire people,” Thompson says. “It used to be the risks were bears, snakes, driving mountain roads. Now it’s pot gardens.” It’s enough to scare away applicants, he says.

With all this in mind, Gabriel and Henderson lead the group up the hillside in the open sun. The field techs, two women and three men in their 20s, are clearly inspired by their boss’s enthusiasm. “This is real-world applied biology,” says Alex Reyer, climbing over a crumbling log. “I feel like I’m actually having some sort of impact for the better.”

Topping a bare ridge reveals Mt. Lassen’s snowy peak just above the horizon. On the other side of the ridge, a wide basin spills to the northwest. Somewhere down there, amid the dense wild lilac bushes and blackened 60-meter (200-foot) snags, is the grow site. Gabriel was on the bust, which netted 16,455 plants growing across 300 vertical meters (1,000 feet). One suspect was captured and another escaped by fleeing down the valley, evading two K9 dogs.

Today the team wants to catalog the environmental damage caused by two large campsites, to help plan a cleanup effort. Step one is finding the three plots, but in the past year, the vegetation has grown more than two meters (six feet). It’s so dense that soon none of the team members can see anyone else. Drifting pollen fills mouths with a bitter taste.

It takes half an hour of sweaty bushwhacking to find the first piece of water tubing. Gabriel turns on a satellite tracker to map the plot, pulls on nitrile gloves, and starts digging through a trash pile inside a burned-out stump. He pulls out a propane canister, red Solo cups used to transport seedlings, a filthy pair of underwear. He counts empty bags and containers out loud: “Twenty pounds of 6-4-6 fertilizer, 50 pounds of 0-50-30, one pound of unknown white powdery substance in a Gatorade bottle.”

The irrigation lines lead along what were once rows of thriving plants, now barely visible indentations in the ground. A few still hold dead plants, their buds dry and mildewed. Someone calls in a dead bird on the radio. “Take a swab inside the mouth,” Gabriel replies. “Grab liver or kidneys if you can.”



Samples of marijuana collected from trespass grows are tested at a UC Davis toxicology lab to identify chemicals used in their cultivation. (Morgan Heim / bioGraphic)

It could end up in the lungs of people who are already immuno-compromised from AIDS or cancer.

Suddenly he pulls up short. It’s a single marijuana plant, small but definitely alive. “No way!” Just as quickly, excitement turns to concern. Growers often return and replant a raided site if all the irrigation line is left in place, like here. Could someone be here right now? But the plant has a taproot, which means it wasn’t planted by hand. Somehow it sprouted from a leftover seed, survived a winter buried in snow, and got itself pollinated. “Amazing. I’ve never seen that.” Gabriel shakes his head and takes a leaf sample to test for contaminants.

As it turns out, survival isn’t the only thing exceptional about the plant. Its leaves test positive for carbofuran, most likely from the soil, meaning the chemical persisted much longer than anyone suspected it could. According to official estimates, the chemical should have been gone from the soil within a month. “It’s completely new data nobody would have ever conjured up,” Gabriel says.

Pesticides are showing up on both leaves and buds at trespass grows, Gabriel says, and they appear at detectable levels when the plant is smoked. If any of this harvest makes its way to a medical dispensary, it could end up in the lungs of people who are already immuno-compromised from AIDS or cancer. There hasn’t been any formal research in California yet, but studies and investigations in Colorado and Oregon have found pesticides on marijuana in legal dispensaries, including in products that were supposedly certified pesticide-free. Last year, the Emerald Cup, a major cannabis competition in Sonoma County that focuses on organic growing, started testing entries for pesticides. About a quarter of the concentrates and more than 5 percent of flowers were disqualified.

Higher up the hillside, at the edge of the burn scar, is what looks like a sprawling homeless encampment in the trees. Folding camp chairs, a pile of sneakers, and at least 20 cans of athlete’s foot spray are scattered around a dirt sleeping platform reinforced with logs. Four rolls of unused irrigation pipe as big as truck tires lie near a deep drift of food cans that smells like death. Each roll is a thousand feet long and retails for \$250. “All of this was trucked in on someone’s back,” Gabriel says. “This is not done on a whim. This takes organization and capital.”

Just below the campsite are three natural springs, or at least what’s left of them. When Gabriel was doing owl surveys here ten years ago, the trickling springs fed a thriving wetland of willows and alders. To give the pot plants a reliable, controllable source of water, the growers dug out the springs into pools the size of hot tubs, covered with sticks and tarps to hide them from the air. As a result, the wetland is virtually gone.

In a controlled setting, a marijuana plant uses about six gallons of water per day, which over a 150-day growing season comes out to 3,400 liters (900 gallons) of water per plant. Legal growers have found their once-unrestricted water use under increased scrutiny as the state confronted extreme drought conditions. (Some grows in Humboldt County have literally sucked creeks dry, leaving salmon and steelhead to flop and die in puddles.)

Under a law passed last June, growers now have to secure official water rights to get a growing permit.

Illegal grows, of course, are another story. Gabriel has estimated that trespass grows use 50 percent more water because of less efficient irrigation systems and added stressors like pests, pathogens, and drier weather at higher elevations. Worse, some trespass growers leave their irrigation systems running around the clock throughout the year, even when nothing is growing. Multiply that by hundreds of thousands of plants and you have a serious water problem. One study by the California Department of Fish and Wildlife estimated that trespass marijuana grows used about 300 million gallons of water per square mile, roughly the same as almond orchards.

To put things into perspective, by Gabriel's estimates the 1.1 million illegal pot plants removed in California in 2016 would have used somewhere around 1.3 *billion* gallons of water—as much as 10,000 average California households do in a year. He calculates that this Rattlesnake site alone could have used enough water in a single season to fill seven Olympic pools.

Near one of the springs, an empty jar of ibuprofen lies on the ground. This is where the one grower was caught: Fleeing a K9 dog, he took a bad jump and broke his leg. "I gave him some pills—he appreciated that," Gabriel says. Not all of Gabriel's interactions with growers are so friendly: He once had to help tackle a grower who had thrown off a law enforcement officer twice his size.

To keep growers from returning and replanting the site, it will have to be remediated, returned to something like it was before it was planted. By Gabriel's calculations that would mean removing around 6,000 meters (20,000 feet) of irrigation tubing and hauling out all the trash in 50-gallon bags, probably 40 or 50 in all. The springs will have to be rebuilt to function naturally, an expensive and lengthy process. This site is close enough to a road that all the crap can be hauled out on foot; more remote sites require helicopters.

Remediation requires money and manpower, both of which are scarce to nonexistent—just as they are on the law enforcement end. Out of the roughly 80 grow sites Gabriel and his team have investigated since 2014, they have been able to remediate just 29 so far. "We'd like to get that to a hundred percent, but there's just no money for it," he says. "Right now it's all soft money, grants through our NGO, volunteers helping. I'm on the cusp of putting up a GoFundMe site. Next I'll try selling cookies."

He nudges a grimy digital scale with his boot. "How do you clean up hundreds of sites?" he says, with an edge of bitterness in his voice. "That's a lot of bake sales."

* * *

The biggest trespass grow sites are broken up into dozens of smaller subplots, making it less likely every plot will be busted—and also spreading out the environmental impact. "It used to be a single gaping wound, like a bullet hole," Gabriel says. "Now it's a shotgun."

Last September, the IERC team surveyed two grow complexes in Lassen National Forest. Together they covered 2.6 square kilometers (one square mile), the largest site the team has ever seen. There were 30 camps in all, each with its own cache of rodenticide, and more than 65 kilometers (40 miles) of irrigation tubing that sucked up 269,000 liters (71,000 gallons) of spring water a day.

They also found the carcasses of a bear (*Ursus americanus*) and a gray fox (*Urocyon cinereoargenteus*). Test results are still pending, but they're reasonably sure the fox, at least, is full of poison. Right next to it was the carcass of a turkey vulture (*Cathartes aura*); by all appearances, it took a bite or two and dropped dead. As he was taking samples, Gabriel watched flies land on the fox and die within seconds. "That night was the longest shower I ever took," he says.

Twenty years after giving the thumbs up to medicinal marijuana, Californians voted in November to allow anyone over 21 to buy pot legally. By some estimates, Proposition 64 could double the state marijuana market to \$6.6 billion by 2020. But as long as the plant is still illegal in other states, the demand that fuels trespass grows will continue.

* * *

Gabriel knows he's fighting the good fight. He also knows he can't keep going like this forever. Almost all his working hours are eaten up by "drug stuff" now. The raids, the long field days of surveys and remediation, the endless presentations and interviews: It's rewarding—but draining, too.

He'd like to train other researchers and law enforcement officers to identify and remove chemical threats at grow sites. If enough people learn to do what he does, then he can step aside and become just another researcher again. "But if I stopped right now, it would be gone," he says.

The idea of moving away comes up a lot at dinner, he says. The legal-growing boom is making Humboldt County a crazy place: Real estate is through the roof, and the murder rate just hit an all-time high. Gabriel's mother is from Michoacan, and a lot of what he's seeing in California is starting to sound like the stories he hears from south of the border. "I worry about raising a family here," he says. "You do it for your kid, but you have to be there for your kid."

The legal and illegal marijuana markets are different beasts, with different suppliers and customers, but in the end it's all about growing the same plant. Even as the industry as a whole goes more mainstream, the ever-changing jumble of law and jurisdiction between different states and the federal government will encourage entrepreneurs and criminals to take advantage of blind spots and blurred lines.

As far as Gabriel and many others are concerned, only a uniform national marijuana policy could potentially resolve the issue. But if President Trump's cabinet nominations are any indication, we may instead be in for a revival of the old-school drug war that President Obama let languish. Many of Trump's cabinet picks, including Jeff Sessions as Attorney General and Scott Pruitt to head the Environmental Protection Agency, have opposed marijuana reform or legalization in various ways during their careers. Even more ominously, a bill introduced in the House in January proposes to completely eliminate the law enforcement functions of the Forest Service and Bureau of Land Management and turn those duties over to the states. And some members of Congress have been pushing to entirely de-fund the Drug Enforcement Administration's marijuana eradication program, whose budget has already dropped from \$18 million to \$14 million. California received more than a third of the funds in 2015.

As long as pot is still illegal in some parts of the U.S., the demand for illegally grown marijuana will persist. And as long as there are places where it's cheaper and less risky to grow it, that is where it will happen. In the meantime, wildlife and the environment—and likely pot smokers themselves—will pay a price we're only beginning to understand.

<https://www.theatlantic.com/science/archive/2017/03/backcountry-drug-war/521352/>

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