Integral Ecology Research Center

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To Whom it May Concern,

Integral Ecology Research Center (IERC) has been generating health data pertaining to fishers since 2005. Previous to 2005, health information on this species was sparse or lacking for many parameters essential to understanding health threats to fisher populations[1]. To assist state and federal managers tasked with stewarding the public's natural resources and making best management decisions for this species and its habitat, IERC and collaborators began studies to generate much of the foundational health knowledge for this species, not only within the western distinct population segment but throughout its range. These investigations include serological examinations of individuals exposed to pathogens with fitness limiting capabilities, active infections to these same pathogens, exposure to toxicological agents such as heavy metals and pesticides, and determination of both proximate and ultimate causes of mortality. In turn, we have worked and generated threat assessments to these pathogens, parasites, and toxicants for these species.

It should be understood that all of the data generated and published with our organization as well as the unpublished data we present in this document pertaining to fishers were generated by strong and long-term collaborations.

We ask that all data previously published to be properly cited as appropriate, and for all new data presented in this report as "Gabriel, M.W. and G.M. Wengert, 2019 Unpublished Data."

IERC Co-Principal Investigators and Collaborators: University of California Davis, California Animal Health and Food Safety Laboratory, United States Forest Service-Pacific Southwest Research Station, Hoopa Tribe: Hoopa Tribal Forestry, California Department of Fish and Wildlife-Wildlife Investigations Laboratory, United States Fish and Wildlife Service, Sierra Pacific Industries, Wildlife Conservation Society, North Carolina State University, Green Diamond Resource Company, Washington State Department of Fish and Wildlife, National Park Service, Indiana University of Pennsylvania, and Idaho Department of Fish and Game.

Background and Basis of Collaborations

Between 2005 and 2008, IERC established cooperative agreements and memorandums of understanding with the three main demographic projects that were responsible for monitoring fishers in California: the Hoopa Fisher Project in northern California, the Sierra Nevada Adaptive Management Project (SNAMP, referred to in later years as Sugar Pine Project), and the Kings River Fisher Project implemented by the United States Forest Service in the southern Sierra Nevada. We were also tasked with providing health and toxicological data for the California Fisher Reintroduction Project headed by North Carolina State University, California Department of Fish and Wildlife, and Sierra Pacific Industries, as well as the health data for the initial Olympic National Park Fisher Reintroduction Project, Idaho Fish and Game Fisher Health Project, Pennsylvania Fisher Reintroduction Project, and opportunistically collected fishers from southern Oregon. Data for the California Fisher Reintroduction Project and non-California projects are not incorporated in this report but are currently being compiled for a comprehensive health publication for the species.

Toxicological Agents

Anticoagulant Rodenticide Data Review: Non-infectious disease agents, including toxins and toxicants, can incorporate both natural (e.g., heavy metal) and anthropogenically derived (e.g., pesticides) agents typically not associated with micro or macro parasites and tend to be inanimate in origin. Previous to the listing of fishers as a candidate species under the endangered species act in 2004[2], no data related to anthropogenically derived toxicants for the species was available.

In 2012, we published a foundational paper demonstrating that fishers in California were exposed and had died directly due to anticoagulant rodenticides (ARs)[3]. In that study, 79% (n =58) of fishers in California were exposed to AR with an average of 1.61 different ARs per exposed fisher, and four fishers that were being actively monitored in the three projects (described above) died due to AR toxicosis. In addition, this publication provided the evidence that an altricial kit that was 100% dependent on its mother's milk was exposed to AR, thus suggesting either neonatal or mother's milk transfer of the pesticide. This publication also provided evidence that the source point for ARs for these monitored fisher populations was likely cannabis cultivation sites on tribal and public lands and their associated use of ARs. Thompson et al. 2014, was able to further the concept that probable source points were cannabis cultivation sites by demonstrating that female fishers exposed to ARs had statistically higher numbers of cannabis cultivation sites in their 6-month 100% minimum convex polygon home ranges when compared to non-exposed female fishers from the same monitored population[4]. In 2015, we published another paper looking at proximate and ultimate causes of mortality for fishers from the three independent fisher monitoring projects in California[5]. This paper highlighted that the percentage of all fisher deaths due to AR toxicosis increased from the initial 5 year study of 5.6%[3]to 18.7% of all deaths annually within this additional 3 year period[5]. The exposure rate for fishers climbed from 79% (n=58) to 85% (n=101) in this period of time, which included both monitored and unmonitored fishers [3, 5]. Finally, it should be noted that two monitored fishers' deaths in this 2015 study were attributed to two different types of rodenticides. One death was linked to hypercalcemia attributed to the consumption of cholecalciferol rodenticide, while another fisher was suspected to be exposed to bromethalin, a neurotoxicant rodenticide.

New Rodenticide Data: Post 2015 publication

New exposure rates and individual deaths attributed to ARs or other rodenticides have not been updated or published since Gabriel et al. 2015 publication[5]. Nevertheless, data from the three main fisher demographic projects in California were still being collected and we present the best available data regarding exposures and mortality attributed to rodenticides for fishers. All new data presented in this report were collected and analyzed under the same analytical methods published previously[3, 5].

It should be taken into account that due to the slow-down or termination of funding for the main fisher demographic projects, and the overturn of the proposed listing decision by USFWS in 2016, efforts and support to collect data for this species diminished. This was evident in many projects in which technician efforts were underfunded thus hampering the ability to collect radio-collared fisher mortalities within a timeframe that allowed for meaningful necropsy and organ sampling needed for rodenticide testing. Consequently, many fishers died while being monitored for these projects, but due to lack of effort to collect carcasses, data and fisher tissue from fisher mortalities were not obtainable or salvageable. A reduction in trapping efforts has also decreased the population of collared individuals from which to draw inferences on mortality causes and contributors.

Past and New Exposure Data, Southern Sierra Fisher Projects

Between 2007 to 2014, a total of 66 monitored fishers were submitted from the two southern Sierra Nevada projects to be analyzed for the presence of AR. Only fishers being actively monitored were included in the following table, no opportunistically collected fishers in or near the study area were included. During this time period, 57 of the 66 fishers (86%) were positive to ≥1 AR. For the years of 2015 to 2018, a total of 31 fishers were tested and of these, 26 were positive (84%) to ≥1 AR.

Years Sampled Sierra Fishers	Total # of Fisher Livers	Total Positive	Total Negative	% Total Positive
2007-2014	66	57	9	86%
2015-2018	31	26	5	84%
Total (2007 – 2018)	97	83	14	86%

Past and New Exposure Data, Hoopa Fisher Project

Between 2007 to 2014, a total of 31 monitored fishers were submitted from the Hoopa Fisher Project to be analyzed for the presence of AR. Only fishers being actively monitored were included in the following table, no opportunistically collected fishers in or near the study area were included. During this time period, 22 of the 31 fishers (71%) were positive for ≥1 AR. For the years of 2015 to 2018, a total of 17 fishers were tested and of these 14 were positive (82%) for ≥1 AR.

Years Sampled Hoopa Fishers	Total # of Fisher Livers	Total Positive	Total Negative	% Total Positive
2007-2014	31	22	9	71%
2015-2018	17	14	3	82%
Total	48	36	12	75%

Total Exposure AR, All California Fisher Projects

When combined across all California fisher projects, the number of fishers exposed to AR did not diminish throughout the years. Only fishers being actively monitored were included in the following table, no opportunistically collected fishers in or near the study area were included.

Years Sampled All California	Total # of Fisher Livers	Total Positive	Total Negative	% Total Positive
2007-2014	97	79	18	81%
2015-2018	48	40	8	83%
Total	145	119	26	82%

Anticoagulant rodenticide exposure in fetuses and neonatal fishers: New Data

In 2012 we published the account of an altricial kit that was 100% dependent on its mother's milk exposed to AR from either neonatal or mother's milk transfer of the toxicant. This was the sole kit documented to be exposed to a rodenticide from 2007-2014.

Since the 2015 publication, IERC has tested three neonatal kits dependent on their mother's milk, and two fetuses removed from a single deceased fisher female from the southern Sierra Nevadas. All five fisher livers were submitted for AR testing. Of these, the two fisher fetuses were positive for AR. Since both of these fishers had to be removed from their dead mother's womb, the only potential route of exposure to AR was through transplacental transfer from the mother. Both fetuses and their mother were exposed to the same second-generation AR.

Exposure to other Rodenticides: Post-2015 publication

A total of 15 fisher tissue samples were submitted for testing for desmethyl bromethalin, which is the more potent metabolite of the parent compound and retail rodenticide product, bromethalin. The tissues submitted were adipose, kidney, and brain. Of these, two fishers had desmethyl bromethalin present in their respective tissues. One fisher was from the Hoopa Fisher Project in northwestern California, the other fisher was from the southern Sierra Nevada monitored fisher population. The detection of desmethyl bromethalin in these tissues is suggestive that the fisher was actively metabolizing bromethalin following the consumption of the parent compound. Clinical signs for this toxicant are central nervous system (CNS) dysfunction occurring hours to days from initial ingestion [6]. The clinical manifestation of CNS dysfunction can then progressively increase for days or weeks with ataxia, limb weakness and eventually paralysis leading to death. Unfortunately, there is no known antidote for bromethalin and once clinical signs develop, treatments and supportive care are generally ineffective [6].

For the northern California fisher exposed to bromethalin, proximate cause of death was predation. For the fisher from the southern Sierras, clinical findings suggest proximate cause of death was likely bromethalin toxicosis.

Fisher Mortalities Attributed to Rodenticide Toxicosis: Post 2015 publication

Between 2007 to 2014, a total of 13 fishers died directly attributed to rodenticides. Eleven were attributed to anticoagulant rodenticides, 1 to cholecalciferol, and 1 to bromethalin [3, 5]. New data from monitored fishers necropsied from 2015 to early 2018 show 6 new rodenticide mortalities attributed to these specific types of pesticides. Four of the 6 rodenticide mortalities were attributed to ARs, with two of these fishers from the southern Sierras and two from the northern California monitored population. The other two rodenticide deaths were the two fishers with desmethyl bromethalin detected in their tissues. For the Sierra fisher, the exposure to bromethalin was ruled the proximate cause of death due to the detection of desmethyl bromethalin in the brain tissue and histology. For the Hoopa fisher, predation was ruled as the ultimate cause of death, while the presence of desmethyl bromethalin in tissues was a contributing factor. This brings the total rodenticide-associated deaths to 19 for monitored fishers IERC has investigated in California.

Rodenticide Amounts and Types Discovered within Fisher Occupied Territory

IERC has been collecting data pertaining to the specific amounts and types of pesticides from clandestine cannabis cultivation from 2012-2018 under cooperative agreements with local, state and federal Law Enforcement agencies. Since then IERC has visited ≥ 300 cultivation sites throughout California. IERC has also visited a site in Oregon. These visits are typically classified into three categories: Visit, Partial Assessment, Full Assessment. A Visit is when an IERC scientist is on site briefly, collects no data or a minimum of abiotic and biotic data. A Partial Assessment is when one or more IERC scientist(s) collect abiotic and biotic data yet time or safety does not allow them to collect the full data regarding the landscape of the cultivation site. A Full Assessment is when one or more IERC scientist(s) collects the all abiotic and biotic data needed to document the complete extent of the cultivation site. To the best of our knowledge, this is the most comprehensive data set available for this extensive time period available to any party. These data provide the spatial and temporal resolution of pesticide use necessary for evaluating the threats and risks to species directly or indirectly associated with cannabis cultivation.

Locations: The majority of these cultivation sites are located on public lands; however, a subset of our data are from private timberlands and private unpermitted cannabis cultivation sites.

Data Used for the Following Analysis: Due to the extensive data set as well as the brief time allotment to provide agencies this pertinent information, we can only provide information from public and private timberland trespass cultivation sites that have Full Assessment status and all relevant data needed for these analyses from this specific category. Though Visits and Partial Assessment sites have rodenticides discovered during IERC investigations, we include only Full Assessments in this report. Therefore, amounts of rodenticide discovered and trends are likely conservative estimates.

Amount of Rodenticide Discovered Annually: 2012-2018

We placed rodenticides for this report into three categories, First-generation Anticoagulant Rodenticides (FGAR), Second-Generation Anticoagulant Rodenticides (SGAR), and Neurotoxicant Rodenticides (NR) which solely includes bromethalin. There are other types of rodenticides discovered at cannabis cultivation sites including zinc phosphide, aluminum phosphide and strychnine; these are not evaluated for this analysis.

First-Generation Anticoagulant Rodenticides

The amount of FGAR varied year to year and specific types of FGAR varied as well. When averaged for the number of public and private timberland trespass cultivation sites that fit the Full Assessment category, the amount of FGAR used per site varied with a visual increase of use following the 2014 California Department of Pesticide and Regulations restrictions on the purchase, possession, and use of SGARs (Figure 1).

Second-Generation Anticoagulant Rodenticides

The amount of SGAR varied year to year with none discovered in 2017. Specific types of SGAR varied as well. When averaged for the number of public and private timberland trespass cultivation sites that fit the Full Assessment category, the amount of FGAR used per site varied with a visual decrease of use following the summer of 2014 California Department of Pesticide and Regulations restrictions on the purchase, possession, and use of SGARs (Figure 1).

Neurotoxicant Rodenticides

The amount of NR varied year to year with the lowest amount discovered in 2013 and the highest in 2018. When averaged for the number of public and private timberland trespass cultivation sites that fit the Full Assessment category, the amount of NR used per site varied with a visual increase of use following the summer of 2014 California Department of Pesticide and Regulations restrictions on the purchase, possession, and use of SGARs (Figure 1).

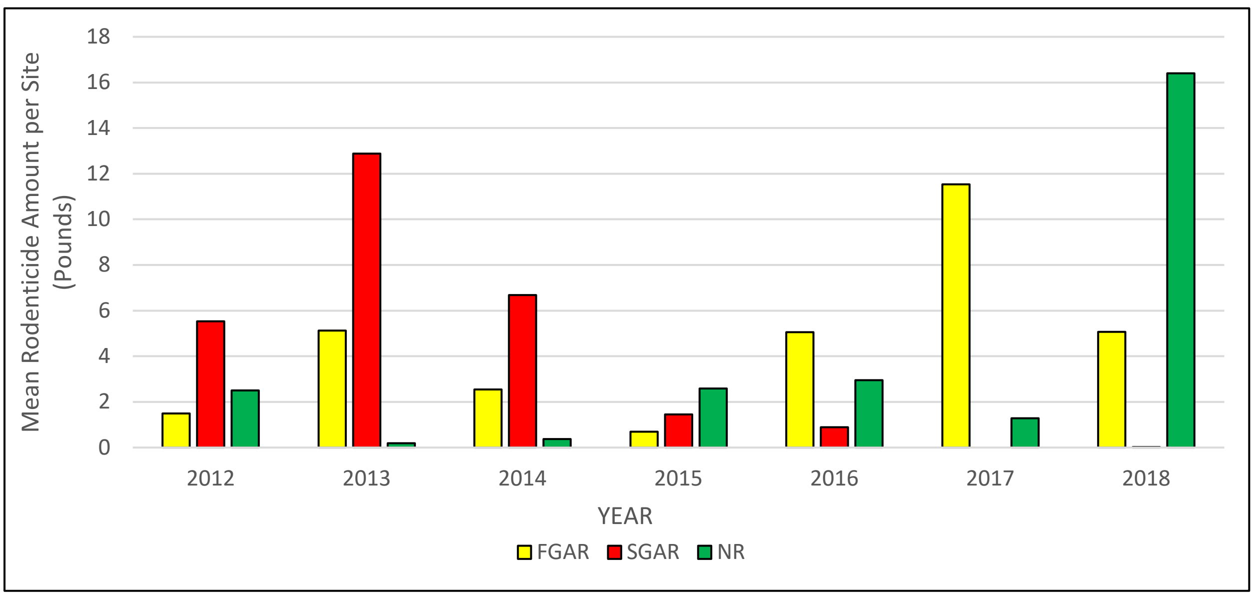

Figure 1. Mean amount of rodenticides (pounds) including FGAR, SGAR and NR discovered per cannabis cultivation site on public and private timberlands where IERC scientists conducted full assessments from 2012 to 2018. These averages do not include phosphide rodenticides, nor IERC investigations on private unpermitted sites or categories of Visits and Partial Assessments where rodenticides were discovered. Therefore, conservative amounts and estimates are provided only in this report. Nevertheless, data demonstrate that following the restrictions on the purchase, possession, and use of SGARs in the summer of 2014 in California[7], SGAR greatly diminished in their use on cannabis cultivation sites. In addition, the use and amounts of FGAR and NR increased following the summer of 2014 restrictions

placed by the California Department of Pesticide and Regulation. It should be noted that several fisher mortalities attributed to either AR and NR occurred post-2014 restrictions. IERC will be investigating and interpreting data further to see for example if FGAR exposures for fishers increased following this regulatory change for SGARs.

Amounts of Rodenticides Outside of California

OREGON: Data is limited for the amount of pesticides used at sites outside of California. There are numerous anecdotal accounts of material being discovered at sites in the states of Oregon and Washington, however, the systematic collection under rigorous protocols for landscape level analysis is not occurring thus data similar to California is not currently available. Nevertheless, IERC was able to collect data from one cultivation location in southern Oregon within suitable habitat currently occupied by fishers and northern spotted owls. This sole location had 54 pounds of FGAR and 8 pounds of the NR bromethalin.

Landscape Impact for Fishers

Equally important as understanding the pesticide and associated threat characteristics of individual cannabis cultivation sites to fishers is the cumulative impact across the landscape from the collective amount of Law Enforcement discovered cannabis cultivation sites in California. Between 2012 and 2018, the years for which we tracked information on pesticide use at cannabis cultivation sites, there were estimated 617 cultivation sites discovered within the current fisher range in California. From 2004 to 2018, the number of cultivation sites discovered within the current fisher range in California is 2,039. This is the low estimate since this threat is compounded by the equally as many undiscovered cultivation sites that likely litter the same landscape. To identify the spatial risk to fishers across their range from trespass cannabis cultivation practices, we modeled risk by using a comprehensive LE dataset containing the known locations of cannabis grow sites throughout forested regions of California and southwestern Oregon to identify additional likely areas of grow site activity based on biotic, abiotic, and anthropogenic features. Maximum Entropy (MAXENT) modeling was chosen as the modeling platform for its flexibility in requiring only presence locations. We identified regions of high and moderate grow site likelihood (vs. the much more expansive area of low likelihood) and overlayed them with a fisher habitat model developed by Dr. Wayne Spencer (et al. unpublished data) allowing us to relate the likelihood of grow site presence to habitats essential for fisher.

In our area of interest which expanded from the southern Sierra Nevada through the Klamath region and into southwestern Oregon, we found that 44.4% of the habitat modeled as selected by fisher fell into high and moderate likelihood areas of grow site presence (Figure 2). When we assessed grow site risk only within the current range of the fisher in California and Oregon, we found that 45.6% of selected habitat for fisher was overlapped by regions of high and moderate grow site likelihood (Figure 2). When we limited our analysis separately to the current range of fishers in northern California and southern Oregon, then the southern Sierra Nevada, we found that selected fisher habitat was overlapped by high and moderate grow site likelihood at 53.6% and 22.0%, respectively (Figures 3 and 4).

Clearly, the risk to fishers and habitats selected by fishers from the threats associated with trespass cannabis cultivation is significant if overall > 45% of fisher habitat in current fisher-occupied regions is at high risk from the pesticides and other threats so common at cultivation sites. But the risk is even more significant in the current northern California range of fishers where over half of the selected habitat is at high risk of cultivation threats.

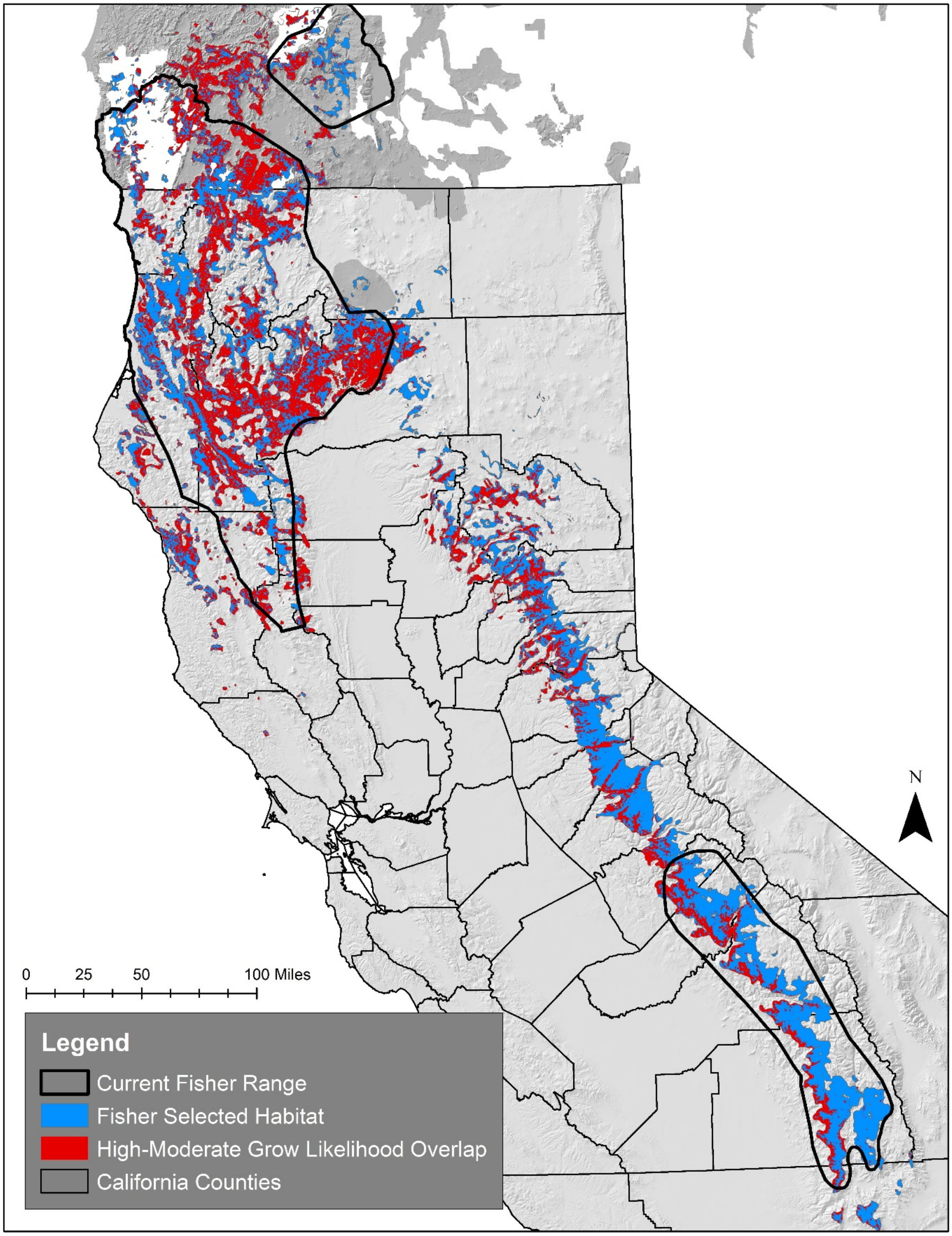

Figure 2. Habitat selected for by fishers (*Pekania pennanti*) in California and southern Oregon (as modeled by Spencer et al. unpublished data), which is overlapped by high and moderate cannabis grow site likelihood.

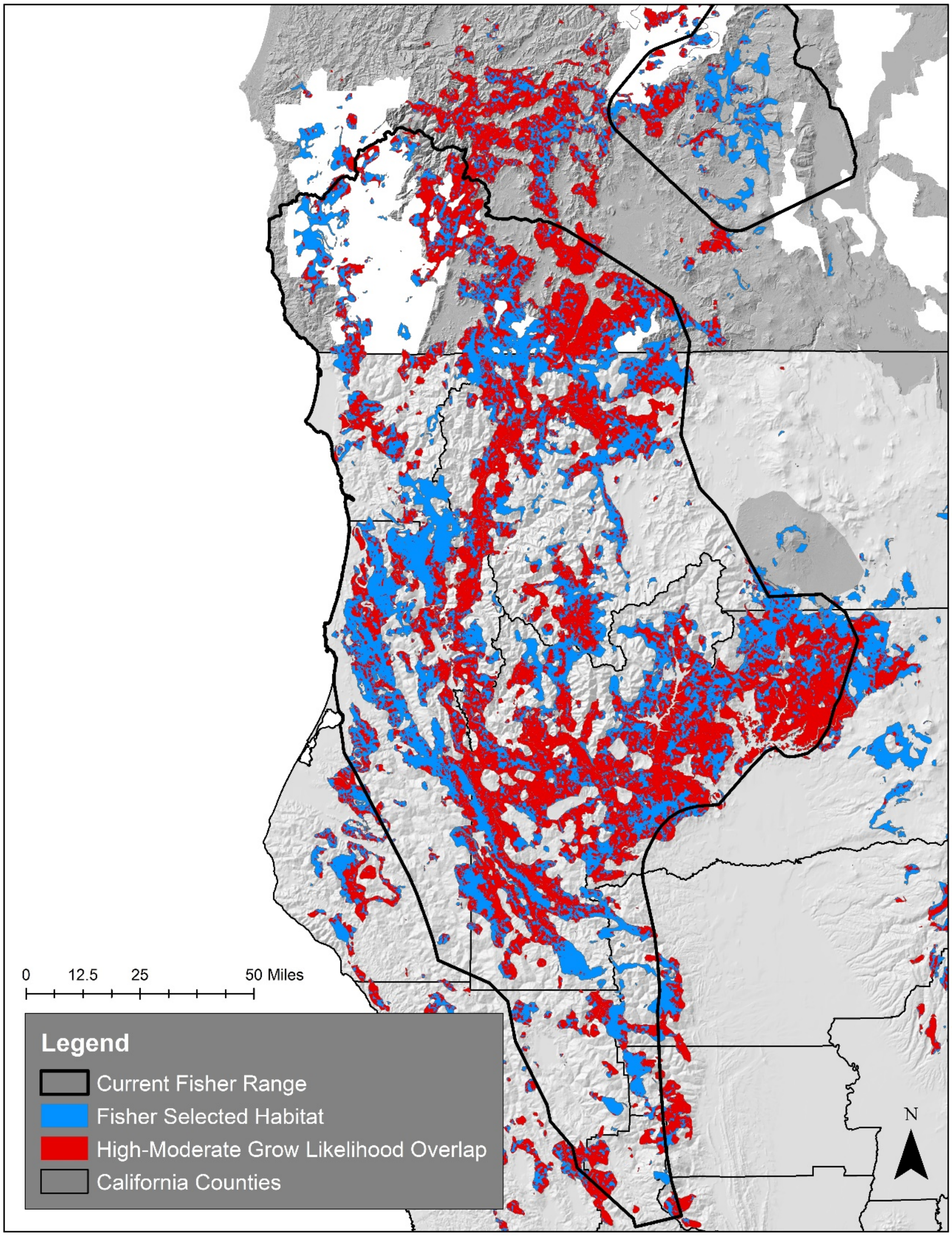

Figure 3. Habitat selected for by fishers (*Pekania pennanti*) in northern California and southern Oregon (as modeled by Spencer et al. unpublished data), which is overlapped by high and moderate cannabis grow site likelihood.

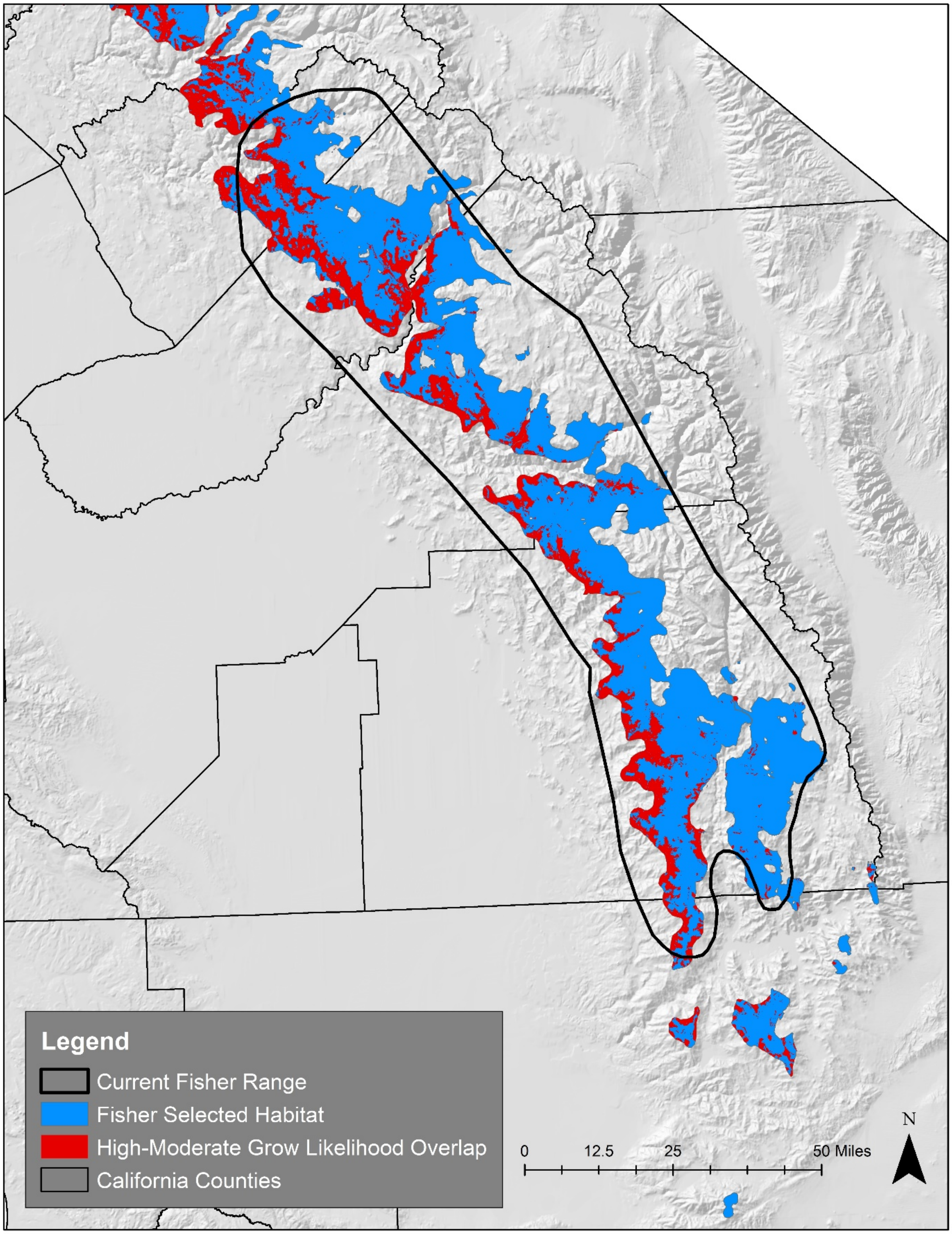

Figure 4. Habitat selected for by fishers (*Pekania pennanti*) in southern Sierra Nevada of California (as modeled by Spencer et al. unpublished data), which is overlapped by high and moderate cannabis grow site likelihood.

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