GOVERNANCE ON THE GROUND:

Evaluating the Role of County Agricultural Commissioners in Reducing Toxic Pesticide Exposures

UCLA

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KEY TERMS/ACRONYMS

1,3-D	1,3-Dichloropropene; Telone
CAC	County Agricultural Commissioner
CEQA	California Environmental Quality Act
DPR	California Department of Pesticide Regulation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency (U.S.)
IPM	Integrated Pest Management
MIC	Methyl isocyanate
MITC	Methyl isothiocyanate
NOI	Notice of Intent
OEHHA	Office of Environmental Health Hazard Assessment
PCA	Pest Control Advisor
PRA	Public Records Act
PRAMR	Pesticide Regulatory Activities Monthly Report
RMP	Restricted Materials Permit
TAC	Toxic Air Contaminants

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EXECUTIVE SUMMARY

Highly volatile and toxic pesticides are widely used in California agriculture at high application rates to control soil pests for a number of high-value crops.[1] Use of these pesticides, however, presents substantial health risks to farm workers, bystanders and nearby residents, as well as significant ecological impacts. Primary responsibility for ensuring the safety of pesticides is split between two regulatory bodies. At the state level, before a pesticide can be sold or used in California, it must obtain registration from the California Department of Pesticide Regulation (DPR). As part of the registration process, DPR must evaluate the potential risks associated with the pesticide, including cumulative risks. The agency must also consider mitigation measures and safer alternatives, if any, needed to protect the health of agricultural workers and of other individuals who live, work or engage in activities nearby. DPR also classifies pesticides of significant concern as restricted materials.

At the county level, "on the ground" implementation of the pesticide regulations is performed by the 56 County Agricultural Commissioners (CACs). Farmers (or their representatives) planning to use a restricted pesticide at a particular location must obtain a restricted material permit from the CAC. In evaluating the proposed use of the restricted material, the CAC must "determine if a substantial adverse environmental impact may result from the use of such pesticide," and if so, must consider whether feasible alternative pesticides or mitigation measures would substantially reduce the adverse impact.[2] Where feasible alternatives or mitigation measures are available, the CAC must deny the application or condition approval on use of the mitigation measure. Each commissioner is responsible for knowing local conditions and utilizing such knowledge in making these determinations.

In two prior reports, we assessed the DPR pesticide registration program, focusing on best practices and deficiencies in how the agency deals with the aforementioned concerns of safer alternatives and cumulative exposures.[3,4] This report examines how the diverse set of fifty-plus CACs deal with the issues of safer alternatives and cumulative exposure during the restricted material permitting process and offers proposals for change. (In this report, "cumulative exposure" refers to exposures associated with simultaneous or sequential application of two or more materials at the same field or at adjacent fields.)

A. ALTERNATIVES EVALUATION

1. Methods

The study used a mixed-method approach to evaluate the permitting practices of the CACs regarding the issues of alternatives analysis. We first performed a broad, statewide assessment of existing permit evaluation policies of all CACs followed by a focused case study. The broad assessment involved the review of documents and information gathered through extensive online searches of relevant government websites. The gathered information, which included county work plans and pesticide use reports, was used to both characterize permitting practices by each of the CACs and to subsequently select a smaller, representative subset of CACs to use for the case study and examine their specific permitting decisions, using documents obtained through Public Record Act (PRA) requests.

Chlorpyrifos was selected as the alternatives analysis case study because of the demonstrated health risks associated with its use, its extensive yet decreasing use in California, and the availability of alternatives. Taken together, these factors create a situation that calls for alternatives analysis in the permitting process and the case study explores the extent to which the restricted material permitting process met that call. Counties were selected for the alternatives analysis case study based on our online review and characterization of how strongly CACs expressed consideration of alternatives during their permitting process. We also selected counties with widely differing levels of institutional capacities, based on hours spent on permitting duties.

To determine the type and depth of alternatives consideration in the selected CAC permitting processes for our case study, we examined two main types of data in the PRA documents requested from the selected counties: (1) written CAC policy or guidance regarding alternatives analysis and (2) documents submitted to or generated by the CACs in the course of issuing permits for chlorpyrifos application. We also conducted a limited set of interviews of CAC personnel and pest control advisors.

2. Results

For more than 40% of the CACs evaluated through our statewide online review, there was no indication of whether or how the CACs took potential alternatives into account in the permitting process. However, the online review showed that almost 30% of the CACs expressed a strong ostensible commitment to the use of alternatives. The remaining 30% of CACs exhibited limited commitment to alternatives evaluation.

The review of the permit files and records provided by the selected CACs in response to the PRA requests contradicts the expressed level of commitment to alternatives evaluation by the CACs. None of the responding CACs reported having office-specific written guidance relevant to alternatives evaluation. It appears that CACs typically delegate the responsibility to identify and evaluate potentially feasible alternatives to the applicant (or, more specifically, to the applicant's pest control advisor (PCA)). In addition, there was no evidence that the CACs engage in significant oversight of the private parties' alternatives evaluation activities.

3. Discussion

State law requires that government approval of pesticide registration and use must involve evaluation of safer alternatives to the pesticide in question.[5] Our review reveals two substantial deficiencies in the CACs' approaches to alternatives evaluation:

- The CACs improperly delegate their responsibility to identify and evaluate potential alternatives to third parties such as pest control advisors without CAC oversight.
- Even assuming that CACs are engaging in meaningful oversight and independent evaluation, no public records of the oversight and evaluation have been created; at least, none were submitted in response to our PRA requests. Rather, the nature of the evaluation and underlying justification for the decisions are impenetrable.

B. CUMULATIVE EXPOSURE EVALUATION

1. Methods

A similar mixed-method approach used for evaluating alternatives consideration was used to evaluate the permitting practices of the CACs regarding the issues of cumulative exposure. The broad, statewide assessment was used to characterize permitting practices regarding cumulative exposure consideration by each of the CACs. Use of chloropicrin, 1,3-dichloropropene (Telone), and metam sodium was selected as the cumulative exposure case study because of their frequent concurrent application and history of drift. For the cumulative exposure case study, counties were selected by identifying all "candidate cumulative exposure cases" (meaning cases in which application of different pesticides occurred relatively closely in time and location), determined from pesticide use data, and selecting the counties with the highest number of instances of potential cumulative exposure. Again, counties were selected with differing levels of institutional capacities.

To determine the type and depth of cumulative exposure consideration in the selected CAC permitting processes for our case study, we examined written CAC policy or guidance regarding cumulative exposure and documents submitted to or generated by the CACs in the course of issuing permits for chloropicrin, Telone, and metam sodium application. We also conducted a limited set of interviews of CAC personnel and pest control advisors.

2. Results

The statewide review indicated that CAC staff receive no guidance from DPR regarding cumulative exposure and that CACs do not consider cumulative exposure during the county restricted material permitting process. Additionally, the PRA documents provide no evidence of cumulative exposure evaluation by CAC personnel. There are no records memorializing discussions with applicants or their representatives regarding potential concerns about cumulative exposures. From our analysis of the documents provided in response to the PRA requests, when multiple fumigants are applied to the same or adjacent fields no special mitigation measures are imposed.

3. Discussion

The application of two different restricted pesticides at the same or adjacent fields triggers the CAC's obligation to evaluate cumulative impacts under state law.[6] Similarly, effects from the use of the same or different pesticides on adjacent fields—that is, from different projects—also fall within the definition of cumulative effects. The focused chloropicrin, Telone, and metam sodium case study review reveals deficiencies in the CACs' approaches to cumulative exposure evaluation:

- There are no written memoranda or notes indicating that CAC staff attempted to evaluate cumulative exposures, indicating failure to record these practices or complete lack of evaluation by the CAC.
- If cumulative exposure evaluation is done at all, it would appear that it must be at the level of the permittee or their PCA, but again, there were no records provided to demonstrate that such review occurs.

C. RECOMMENDATIONS

State law and best practices in environmental and public health policy require meaningful consideration of alternatives. Recommendations to improve alternatives analysis include:

- Aligning formal guidance by DPR and practice at the local level (either by CACs or PCAs) with the applicable law to ensure evaluation of potentially feasible and safer alternatives to the proposed restricted material in addition to consideration of mitigation measures at the state and county level
- Developing guidance by DPR setting out rigorous, systematic, yet tractable methods for identification and evaluation of potential alternatives
- Developing and supporting capacity at the CAC level for identifying and evaluating alternatives

State law also mandates that the pesticide program address cumulative impacts. Recommendations to improve consideration of cumulative exposures include:

- Adopting practices for timely identification of cumulative exposure scenarios at the registration and permitting stages
- Establishing principles for testing of mixtures during pesticide registration
- Establishing methods for assessing risks associated with cumulative exposures during registration through a task force
- Developing default standards at the state level for likely cumulative exposure scenarios at the registration stage
- Establishing a process for developing standards for cumulative exposures identified by CACs during the permitting process

I. INTRODUCTION

A. OVERVIEW

Pesticides are used in agriculture in California and other states to control soil pests, insects, weeds and other problems facing a range of high-value crops. Many of these pesticides contain toxic active ingredients which can evaporate into the air, seep into the soil and groundwater, or remain as residue on crops. Usage is widespread; in 2016 more than 190 million pounds of pesticide active ingredients were applied to land in California for agricultural purposes (see Figure 1). Thus, farm workers, residents near or around farms, and consumers are all at risk of being exposed to pesticides.

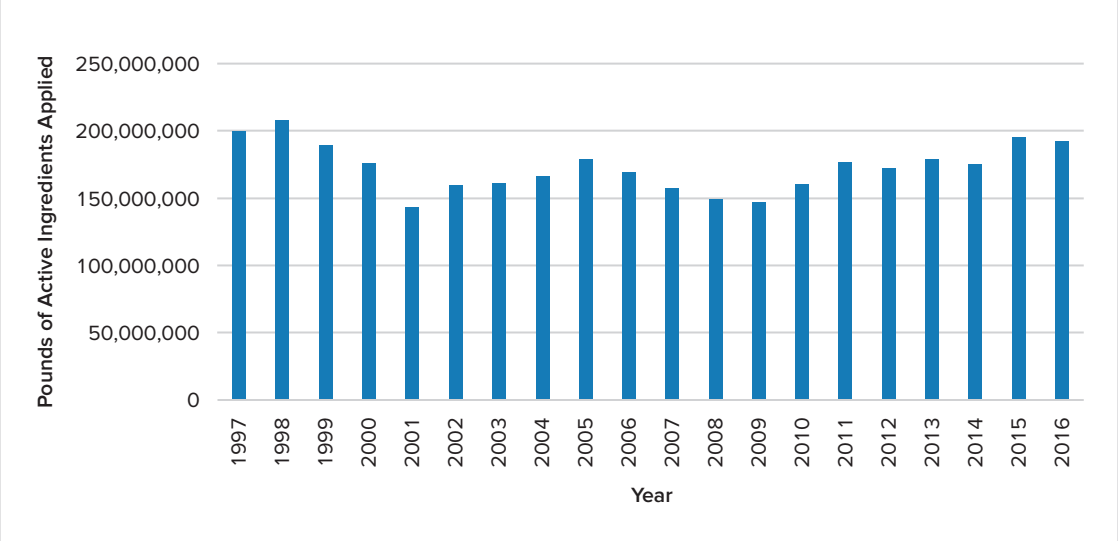

FIGURE 1
Agricultural Pesticide Use in California[7]

Primary responsibility for the safe use of pesticides is split between two regulatory bodies in California.[a] At the state level, before a pesticide can be sold or used in California, it must obtain registration from the California Department of Pesticide Regulation (DPR). Upon receiving an application for registration, DPR staff scientists evaluate the application and the scientific data concerning potential human and ecological exposures, and the human health and environmental effects of its use. Based upon the scientific reviews and risk assessment, and after consideration of comments from the public and interested parties, DPR management determines whether the pesticide can be used safely. In making that decision, the law requires that DPR consider potential safer alternatives to the proposed pesticide as well as potential mitigation options that could be used to ensure an adequate level of safety. Mitigation options typically include buffer zones, use limits, personal protective equipment and so on. If approved, the registration will set out the mitigation measures, if any, needed to protect the health of agricultural workers and of other individuals who live, work or engage in activities nearby (sometimes called "bystanders"). DPR classifies pesticides of significant concern as restricted materials (RMs).

At the county level, "on the ground" implementation of the pesticide regulations is performed by the 56 County Agricultural Commissioners (CACs). The CAC is appointed by the County Board of Supervisors. Growers (or their representatives) wishing to use a restricted pesticide at a particular location must submit an application for a permit to the relevant CAC prior to such use

[a] Other state agencies, such as the California Air Resources Board and the regional air quality regulators, play roles in the regulation of pesticide use. *See e.g., Harbor Fumigation, Inc. v. County of San Diego Air Pollution Control Dist.*, 43 Cal. App. 4th 854, 865–866 (1996).

either through a paper application or CalAgPermits, a statewide web-based pesticide permitting and reporting program. Restricted pesticides cannot be applied unless the grower or their licensed pest control advisor (PCA) certify that "alternatives and mitigation measures that would substantially lessen any significant adverse impact on the environment have been considered and, if feasible, adopted."[8]

The permit application does not specify the timing of the use, and the permit is usually effective for one year. When a grower is ready to apply the restricted pesticides, the grower submits a notice of intent (NOI) at least 24 hours (48 hours for fumigants) prior to application. The NOI describes the particular location, pesticides, and manner of application. In most counties, the NOI is submitted through CalAgPermits, which allows CAC staff to manage restricted material permits and NOIs and to view boundaries and features of the site at which the pesticides will be applied.[9]

In evaluating the permit application, the CAC must "determine if a substantial adverse environmental impact may result from the use of such pesticide," and if so, must consider whether feasible alternative pesticides or mitigation measures would substantially reduce the adverse impact.[10] Where feasible alternatives or mitigation measures are available, the CAC must deny the application or condition approval on use of the mitigation measure.[11] Each commissioner is responsible for knowing local conditions and utilizing such knowledge in making these determinations.[12]

Thus, DPR must initially consider risks, mitigation measures and potential alternatives as part of the registration of individual pesticide products. However, the CACs must also address these issues taking into account local conditions. For example, in some regions of the state, solarization may be a feasible alternative to fumigants used on strawberries even though it would not be effective in other areas. Likewise, local patterns of use for multiple pesticides at adjacent fields may require mitigation measures beyond those mandated by DPR in the registration of one pesticide.[13]

In two prior reports, we assessed DPR's registration program, focusing on best practices and deficiencies in how the agency deals with two concerns: the availability of safer alternatives and the risk of cumulative exposures to multiple pesticides.[14,15] Those reports set out recommendations for improvement. Yet the split responsibility for pesticide regulation means that effective oversight of pesticides also depends on the relevant county agencies. Despite their importance, research reveals few empirical studies of CAC implementation. This report begins to fill that gap, examining how the diverse set of fifty-plus CACs deal with the issues of safer alternatives and cumulative exposure, and offering proposals for change.

B. A BRIEF HISTORY OF CALIFORNIA PESTICIDE REGULATION

The joint state-county regulation of pesticides has been in place in various forms for more than a century. California has systematically regulated pesticides even longer, beginning with the State Insecticide and Fungicide Act of 1911. That law went beyond its contemporary federal counterpart, which was solely focused on mislabeling and adulteration of pesticide products. The state law covered those concerns but also required manufacturers to register their products with the University of California and to disclose the identity and concentration of the product's ingredients.[16] Later amendments up through the 1920s softened labeling and registration requirements, transferred regulatory authority to the recently formed Department of Agriculture, and provided for cancellation and refusal of registration for pesticides that were "generally detrimental" to public health.[17,18]

Initially, state level regulation concentrated on the evaluation of pesticides themselves, paying less attention to how pesticides were applied in agricultural fields. Instead the responsibility for overseeing pesticide application rested with CACs. Beginning in 1917, pesticide applicators were required to register with the commissioners and comply with their county regulations. In 1935,

concerned about a lack of uniformity across counties, the legislature directed the Department of Agriculture to issue state regulations concerning pesticide application but left applicator registration and enforcement in county hands.[19] Continuing problems with application practices led to further legislation in 1949, mandating state licensing of pesticide applicators and imposing recordkeeping and reporting requirements on those applicators.[20] In that same year, legislation provided additional state level rulemaking authority for "injurious materials," and established a permitting system for the use of such materials at the county level.[21]

That basic regulatory structure—registration of pesticide products at the state level coupled with permitting of individual pesticide use at the county level—remained in place going forward. Over the next few decades, agency responsibility and authority, including standards for registration at the state level, were expanded and strengthened. For example, in 1969 and 1970, further legislation mandated that the registration process for pesticides include a thorough evaluation of the potential adverse effects of pesticides and broadened the agency's power to establish testing requirements.

Notably, in 1980, regulations modified the registration and permitting programs to bring them into compliance with the California Environmental Quality Act (CEQA). Enacted in 1970, CEQA establishes a broad set of procedural requirements and substantive standards for decisions made by public agencies regarding "projects" conducted, financially supported, or approved by such agencies. Generally speaking, unless a covered project will have no significant adverse environmental impacts, the agency must prepare an environmental impact report (EIR) evaluating the project. Among other things, the EIR must include consideration of certain core issues, including significant cumulative impacts of the project and feasible mitigation measures and project alternatives. Recognizing that the often lengthy procedural aspects of CEQA were impractical for pesticide permitting, the legislature allowed the department to adopt a "functionally equivalent" process embedded in the registration and permitting programs—one that is more expeditious but which meets the core elements of CEQA review. As we discuss in more detail in later sections, for the CAC permitting process, the notion of functional equivalence means that CACs must consider the effects of cumulative exposure to pesticides as well as the availability of safer alternatives to the pesticide the farmer wishes to use.

C. PRIOR RELATED STUDIES OF PESTICIDE REGULATION IN CALIFORNIA

This is the third of a series of UCLA reports on pesticide regulation in California. The first, *Risk and Decision: Evaluating Pesticide Approval in California*, identified a variety of deficits in the Department of Pesticide Regulation's pesticide registration process and made recommendations to improve pesticide regulation in California. Using the approval of methyl iodide as a case study, the project examined the risk-governance approach used during the approval process, comparing it to best practices in regulatory settings, including risk-assessment practices developed by the National Research Council.

In addition to highlighting the deficits in the agency's process, the report made a number of recommendations aimed at better protecting public health, including:

- Perform cumulative risk assessments to consider all active ingredients in the pesticide. In the case of methyl iodide, DPR focused solely on the risks of methyl iodide rather than the methyl iodide–chloropicrin mixture that would be used in practice.
- Engage in meaningful review of safer chemical and non-chemical alternatives to the proposed pesticide. In the case of methyl iodide, DPR refused to consider potential alternatives for two reasons. First, the agency concluded that consideration of alternatives was not legally required where mitigation measures such as buffer zones and personal protective equipment substantially reduced the significant adverse impact. Second, and most importantly, DPR reasoned that an alternatives analysis was better conducted by CACs during the permitting process where the CACs could take into account specific conditions of use.

The second report, *Exposure and Interaction: The Potential Health Impacts of Using Multiple Pesticides,* investigated the interactive effects of widely used pesticides, evaluated the extent of exposure, determined the populations most at risk, and developed policy recommendations to ensure public health protection. The report recommended that DPR (and, to a lesser degree, CACs) evaluate pesticide mixtures and implement regulations to more adequately protect human health, including:

- Testing pesticides that are sold as part of a pre-mixed product for interactive toxic effects before approving their use.
- Requiring evaluation of products that are used in combination or sequentially with other pesticides to determine the likelihood of interactive effects.
- Considering pesticides' interactive effects in performing risk assessments and establishing management requirements.

Taken together, these two prior reports raised significant questions about the role of CACs in pesticide governance, particularly with respect to the separate yet related concerns of cumulative exposure and use of safer alternatives. As noted earlier, the capacity of the CACs to deal with such concerns is essential for meaningful and effective implementation of the pesticide regulatory program, yet research reveals no relevant empirical studies of the nature and effectiveness of CAC implementation.

D. GOALS OF THIS STUDY

This study shifts focus to the role of the CACs, addressing two questions:

(1) To what extent do CACs effectively evaluate restricted material permit applications with respect to (a) availability of alternatives to the requested pesticides and (b) potential adverse cumulative exposures?

(2) What policy and institutional changes, if any, are necessary to improve DPR's and the CACs' practices regarding the evaluation of alternatives and of cumulative exposure?

Section II of the report focuses on CACs' practices regarding the evaluation of alternatives. It describes our research methods, followed by presentation and discussion of the results. Section III turns to CAC practices with respect to cumulative exposure, covering our research methods, results, and discussion. (In this report, "cumulative exposure" refers to exposures associated with simultaneous or sequential application of two or more materials at the same field or at adjacent fields.) The report concludes in Section IV with recommendations for policies regarding alternatives and cumulative exposure, respectively.

II. ALTERNATIVES EVALUATION

A. RESEARCH METHODS

This section summarizes the methods used. The study used a mixed-method approach to evaluate the permitting practices of the CACs statewide regarding the issues of alternatives analysis. We first performed a broad, statewide assessment of existing permit evaluation policies of all CACs, followed by a focused case study regarding restricted material permitting for chlorpyrifos. The broad assessment involved the review of documents and information gathered through extensive online searches of relevant websites. The case study then examined specific permitting decisions by a smaller, representative set of CACs, using documents obtained through Public Record Act (PRA) requests and a limited set of interviews.

1. Statewide Assessment

With 56 CACs covering 58 counties in California, the aim was to first get a general understanding of the CACs' capacities and restricted material permitting (RMP) programs, before selecting a smaller set of representative CACs for closer evaluation. Online research was conducted on each CAC to capture any available documents or information that addressed five main topic areas: (1) the permitting process generally, (2) mitigation/authority to mitigate, (3) cumulative exposure, (4) alternatives, and (5) institutional capacity.

These searches combined results from CAC websites and informational resources, the California Department of Pesticide Regulation (DPR) website, and the Google online search engine. Searches for each topic area used specific sets of key terms (such as restricted material, notice of intent, cumulative risk, and feasible alternative) to ensure the online research was thorough and consistent. Results were recorded in an Excel spreadsheet.

Documents and information found through the online research were reviewed in more detail to identify the extent to which the CACs claimed that alternatives analysis occurred during the permitting process, as described in the collected documents. Based on that review, each county was placed in one of five "Alternatives Analysis Approach" categories based on the evident strength of commitment to promoting or requiring alternatives analysis (see Table 1). In the case study portion of this report we compare actual practice of representative CACs with their claimed level of commitment to alternatives evaluation.

TABLE 1: Alternatives Analysis Approaches as Claimed by CACs

Claimed Alternatives Analysis (AA) Approach	AA Code	Description
Strong ostensible expression of commitment	**S**	CAC provides strong expression of commitment to promoting/requiring assessment and use of alternatives
Applicant discussion	**D**	CAC states that alternatives are discussed (sometimes specifically with applicant) prior to issuance
Considered and implemented when appropriate	**CI**	CAC states that alternatives are considered and implemented where appropriate
Applicant (pest control advisor) certification	**C**	CAC states that it requires certification by applicant (pest control advisor) that alternatives were considered
No consideration specified	**NC**	Documents contain nothing relevant to alternatives in RMP process

Lastly, counties were placed into three categories regarding institutional capacity, using the number of hours each county allocated to restricted materials permitting as a proxy. Such hours included time spent on issuing permits, reviewing NOIs, and conducting pre-application inspections. These data were drawn from the Pesticide Regulatory Activities Monthly Report (PRAMR) that each CAC must submit to DPR.[22] See Table 2.

TABLE 2: Institutional Capacity of CACs

Institutional Capacity Category	Hours of RM Permitting	Counties
1	**5,000 to 13,000**	Fresno, Tulare, Kern, Monterey, Butte, Ventura, Merced, Imperial, San Luis Obispo
2	**1,000 to 5,000**	San Joaquin, Stanislaus, Sutter, Kings, Los Angeles, Santa Barbara, Madera, San Diego, Santa Cruz, Yolo, Riverside, Glenn, Solano, Sacramento, San Benito, Orange, Yuba, Colusa
3	**<1,000**	San Bernardino, Tehama, Contra Costa, Sonoma, Siskiyou, Shasta, Placer, Alameda, Santa Clara, Napa, San Mateo, Modoc, Lassen, Amador, Inyo-Mono, Calaveras, Alpine-El Dorado, Plumas-Sierra, Marin, Mariposa, Tuolumne, Lake, Humboldt, Nevada, Mendocino, San Francisco, Del Norte, Trinity

2. Case Study Selection

Chlorpyrifos was selected as the alternatives analysis case study because of the demonstrated health risks associated with its use, its extensive yet decreasing use in California, and the availability of alternatives. Taken together, these factors—each of which is discussed in this section—create a situation that calls for alternatives analysis in the permitting process. The case study explores the extent to which the restricted material permitting process met that call. (What follows provides background for the selection of chlorpyrifos as a case study; it is not intended to be a comprehensive review of chlorpyrifos use, risks or alternatives.)

Chlorpyrifos is an organophosphate pesticide. Recent studies document the pesticide's ability to damage children's developing brains, resulting in a higher risk of attention disorders, autism, lowered IQ and tremor in young children.[23,24,25] It can also inhibit the enzyme acetylcholinesterase (AChE), which is essential for normal nerve function in humans, "leading to an overstimulated nervous system causing nausea, dizziness, confusion, and respiratory paralysis and death at very high exposures."[26]

Chlorpyrifos is usually sprayed on crops, and both workers and nearby residents are at risk of exposure while working in fields or living or going to school nearby. In a 2016 risk assessment, the U.S. Environmental Protection Agency (EPA) documented the risk for agricultural users.[27] Bystanders, defined as persons who experience health effects from a pesticide application but are not involved in the application (such as field workers, residents near fields and students and staff at nearby schools) are also at risk. A DPR review of chlorpyrifos in 2017 reviewed pesticide illnesses from 2004 to 2014 and found that bystanders were the ones sickened in 89% of the 246 cases.[28]

RECENT STATE REGULATORY ACTION ON CHLORPYRIFOS (CPF) AS OF 2018

2015: CA DPR named CPF a "restricted material" (RM), requiring licensing, training, and oversight by CACs.[34,35]

2017: CA started a public process to put greater restrictions on the use of CPF, considering possible identification of the pesticide as a toxic air contaminant (still ongoing).

2017: The CA Office of Environmental Health Hazard Evaluation (OEHHA) added CPF to the state's Prop 65 list of chemicals known to the state to cause reproductive toxicity.[36]

2017: The California Attorney General joined with six other states to file legal objections for the federal government's rescinding the ban on CPF.[37]

2018: The State of Hawaii banned all uses of CPF in that state.[38]

2018: CA DPR issued proposal to list chlorpyrifos as a toxic air contaminant.[39]

FEDERAL REGULATORY ACTION ON CPF SINCE 2000

2000: U.S. EPA banned the use of CPF inside homes.[40]

2007: Pesticide Action Network of North America (PANNA), Natural Resources Defense Council (NRDC) and others petitioned U.S. EPA for a ban on CPF.[41]

2016: U.S. EPA proposed a ban on CPF by revoking all food tolerances.[42]

2017: U.S. EPA rescinded the proposed ban.[43]

2017: NRDC and PANNA filed a lawsuit against U.S. EPA to reinstitute the ban.[44]

2018: United States Ninth Circuit Court of Appeals overturned EPA's decision, ordering the agency to ban chlorpyrifos within 60 days;[45] EPA's petition for rehearing is pending.[46]

For more than 10 years, major efforts by environmental organizations to ban this widely used pesticide have resulted in a search for alternatives and significant regulatory action at the national and state level (see sidebar). Although a ban was proposed by U.S. EPA in 2016, it was rescinded in 2017 when a new Administration at EPA declared "that the science addressing neurodevelopmental effects remains unresolved . . . "[29] The EPA decision came after the pesticide's manufacturer, Dow AgroSciences, submitted a petition from farmers all over the United States asking EPA not to ban what they considered a critical tool against pests in agriculture.[30] However, in response to a lawsuit, the United States Ninth Circuit Court of Appeals overturned EPA's decision in August 2018, ordering the agency to ban chlorpyrifos within 60 days.[31] EPA's petition for rehearing of the case is pending.[32,33]

As a broad-spectrum organophosphate insecticide, chlorpyrifos targets multiple pests for each crop, which is part of the reason why it has been so widely used. California is the top user of chlorpyrifos in the United States, with most pounds of chlorpyrifos (by active ingredient) applied. In 2016, California applied nearly one million pounds of chlorpyrifos—about 28% of all chlorpyrifos used in the United States.[47] The top five crops (in descending order) on which chlorpyrifos was used in California in 2016 are oranges, almonds, walnuts, cotton and alfalfa (see Table 3).[48] These crops alone account for 68% of all chlorpyrifos used in the state annually. In 2014 these crops covered 2.4 million acres of cropland throughout the state and represent a significant value to the California economy at $10 billion in annual revenue.[49]

TABLE 3: Chlorpyrifos—Pounds of Active Ingredient (AI) Used in California in 2016 for the Top Crops and Target Pests[50]

Crop	Lbs AI Used	Target Pests
Orange	178,666	Sugar-feeding and protein-feeding ants, Asian citrus psyllid, black scale, broad mite, California red scale, citricola scale, citrus bud mite, citrus leafminer, citrus rust mite, earwigs, false chinch bug, fuller rose beetle, katydids, mealybugs
Almond	142,621	Ants, European fruit lecanium fuller rose beetle, leaf rollers, leaffooted bug, navel orangeworm, oriental fruit moth, peach twig borer, San Jose scale, stink bugs, ten-lined beetle, tree borers
Walnut	125,705	Walnut aphid, ducky-veined aphid, codling moth, fristed scale, European fruit lecanium, San Jose scale, walnut husk fly, walnut scale
Cotton	95,958	Beet armyworm, brown stink bug, cotton aphid, cutworm, lygus, pink bollworm, seedcorn maggot, sweet potato whitefly, wireworm
Alfalfa	67,370	Alfalfa caterpillar, alfalfa weevil, beet armyworm, blue alfalfa aphid, cowpea aphid, cutworm, leafhoppers, pea aphid, spotted alfalfa aphid, webworm, yellow-striped armyworm

Over the years, growers in California have slowly moved away from chlorpyrifos as mounting research shows its health and environmental effects and as regulation has increased. In 2005, the total pounds of chlorpyrifos applied on crops in California was almost two million pounds; in 2016, about 900,000 pounds of chlorpyrifos were applied. That is over a 50% decrease compared to 2005 levels (see Figure 2).[51]

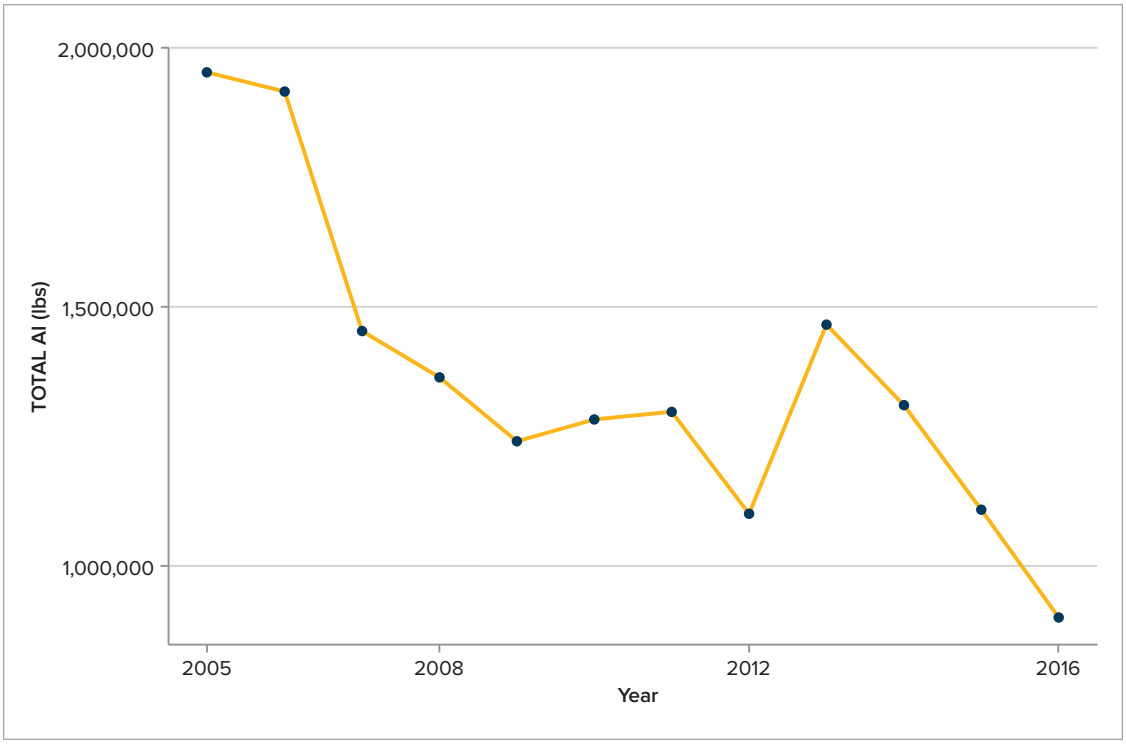

FIGURE 2
Total Pounds of Chlorpyrifos Active Ingredient (AI) Applied in California from 2005 to 2016[52]

Several studies have also identified potential chemical and non-chemical alternatives to chlorpyrifos. A 2014 report prepared by the University of California Statewide Integrated Pest Management Program (UC IPM) conducted an extensive evaluation of the critical uses of chlorpyrifos in citrus, almonds, cotton and alfalfa and the potential alternative pesticides or practices that exist for specific pests.[53] The report included a "Critical Use Matrix" which categorizes pests for these crops according to the availability of chemical alternatives to chlorpyrifos (see Figure 3).

Crop	Tier 1 Key Pests with No or Few Alternative Active Ingredients	Tier 2 Important Pests with Alternative Active Ingredients	Tier 3 Occasional Pests with Alternative Active Ingredients	Totals Pests Identified
Alfalfa	3	3	4	10
Almonds	2	6	4	12
Citrus	2	12	0	14
Cotton	2	4	4	10

FIGURE 3
Critical Use Matrix[54]

Importantly, the UC IPM report concludes that while certain key pests to these crops have few to no chemical alternatives to chlorpyrifos (Tier 1 from the Critical Use Matrix), most pests have both alternative active ingredients and alternative agricultural practices. Some of the alternative practices that can reduce or eliminate the use of chlorpyrifos include "use of resistant varieties, mating disruption, field sanitation, conservation of natural enemies, pruning, [and] weed control."[55] In 2017, the non-profit organization Pesticide Action Network of North America (PANNA) also published a report summarizing methods that are potential alternatives to chlorpyrifos, including integrated and/or ecological pest management.[56] The report also includes case studies of farms that are using these methods in place of spraying the insecticide.

3. Selection of Counties

As noted in Section II.A.1 above, each of the 56 CACs was placed in one of five categories based upon the CAC's stated commitment to alternatives analysis in permitting. The CACs were also broken down into three categories with respect to institutional capacity. To obtain a representative set of CACs for the case study, for each of the five "Alternatives Analysis Approach" categories, a maximum of three candidate counties from each of the three "Institutional Capacity" categories were selected. Candidate counties in the same combined Alternatives Analysis Approach/Institutional Capacity categories were then screened based on the county's level of chlorpyrifos use in 2015, retrieved from the California Pesticide Information Portal (CalPIP), and presence of crops for which potential alternatives exist (i.e., alfalfa, almond, cotton, and orange).[57,58] Kern County was also included because it had the highest use of chlorpyrifos in pounds. The final selections are summarized in Table 4.

TABLE 4: Alternatives Case Study Counties

County	Alternatives Consideration[b]	Institutional Capacity[c]	Top Crops
Fresno	S	1	Almonds, oranges
Kern	S	1	Alfalfa, almonds, cotton, citrus (lemons, oranges, tangerines), walnuts
Solano	S	2	Alfalfa, almonds, cotton, walnuts
Tehama	S	3	Alfalfa, almonds, walnuts
Santa Barbara	D	2	Alfalfa, oranges, lemons, strawberries, broccoli
Sonoma	D	3	Wine grapes
Merced	CI	1	Alfalfa, almonds, cotton, oranges
Yolo	CI	2	Alfalfa, almonds, oranges, walnuts
Placer	CI	3	Alfalfa, oranges, mandarin, walnuts
Lassen	C	3	Alfalfa
Tulare	NC	1	Alfalfa, almonds, cotton, oranges, grapes, tangerines, walnuts, lemons
Riverside	NC	2	Alfalfa, cotton, citrus (oranges, grapefruit, lemons)
San Bernardino	NC	3	Alfalfa, oranges, lemons

[b] See Table 1 for definitions.
[c] See Table 2 for definitions.

4. Data Collection and Analysis

Data collection regarding alternatives analysis approaches for the selected counties focused on the existence of generally applicable written policy and on actual practice in the case of permitting for chlorpyrifos. Public Record Act (PRA) requests (or informal record requests) were submitted to each of the 13 selected CACs asking for the following materials:

- Documents (including e-mails and other digital documents) discussing whether and how potential alternatives to restricted materials should be identified, evaluated and/or implemented by the CAC, permit applicants or the applicants' advisors as part of the permitting process
- For each restricted material permit application for the use of products containing chlorpyrifos submitted to the CAC between January 1, 2017 and December 31, 2017, all documents (including e-mails and other digital documents) that were (a) submitted to the CAC by or on behalf of the applicant or (b) generated by the CAC relating to such applications and related Notices of Intent (NOIs).

All responses received were reviewed to identify whether the CAC had general guidance or policy on alternatives analysis in place, and the extent to which the CAC engaged in alternatives analysis in evaluating permit applications and NOIs. The results of the reviews were recorded in an Excel spreadsheet. Two CAC offices provided an interview with a knowledgeable staff member in lieu of providing documents in response to the PRA request. Contemporaneous written summaries of those interviews were generated during the interviews.

We identified and contacted 20 pest control advisors (PCAs) drawn from documents received in response to the PRA requests. We conducted interviews of three PCAs regarding their knowledge and practices regarding alternatives as well as cumulative exposure. The remaining 17 pest control advisors either declined to be interviewed or did not respond to our request. Several of those who declined explained that they had been prohibited from participating in interviews by their employer. We also contacted the California Association of Pest Control Advisors (CAPCA) by e-mail to request an interview but received no response. We offered DPR, the CACs included in the case studies, and Californians for Pesticide Reform (CPR) the opportunity to review and comment upon the draft report when complete. Only DPR and CPR provided comments, which comments we addressed in preparing this final report. In summary, Table 5 below shows the methods used for alternatives evaluation in this study.

TABLE 5: Methods Used for Statewide Assessment and Focused Case Study on Alternatives to Chlorpyrifos

Study Components	Data Sources	Analysis
Statewide Assessment	▶ CAC websites ▶ DPR website ▶ Google online searches ▶ California Pesticide Information Portal (CalPIP) ▶ CAC Pesticide Regulatory Activities Monthly Reports ▶ CAC Pesticide Use Enforcement Program Work Plans ▶ CAC Pesticide Regulatory Activities Monthly Reports	▶ Evaluation of CAC reports and websites to assess claimed level of alternatives evaluation during permitting ▶ Evaluation of county reports to assess each CAC's "institutional capacity" ▶ Evaluation of CalPIP data to assess county chlorpyrifos use ▶ Selection of smaller subset of CACs for focused case study
Focused Case Study on Chlorpyrifos	▶ Public Record Act (PRA) request responses regarding – Written CAC policy or guidance regarding alternatives evaluation – Documents submitted to or generated by the CACs in the permitting process for chlorpyrifos use ▶ Interviews of Pest Control Advisors (3) ▶ Interviews of CAC personnel (2)	▶ Determine type and depth of alternatives considerations by selected CACs through – Review of CAC PRA responses regarding guidance and practices – Review of CAC personnel interviews – Examination of specific CAC permitting decisions

B. RESULTS AND ANALYSIS

The project examined the CACs' practices with respect to alternatives evaluation at two levels: (1) a statewide but limited review of all CACs based upon information available online, and (2) a deeper examination of a smaller set of CACs based upon information from PRA requests and interviews. This section presents the results of those examinations and compares the identified CAC practices to the legal requirements for alternatives evaluation and implementation.

1. Statewide Review

As Figure 4 illustrates, the broad review showed that, at least in public statements, the 56 CACs adopt a range of approaches to alternatives evaluation.

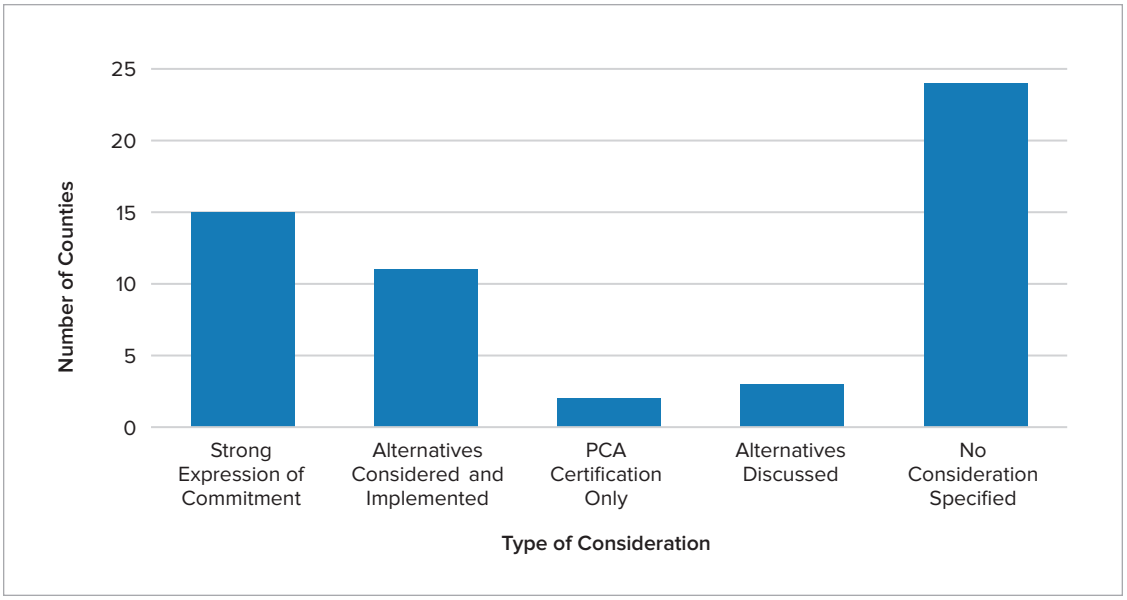

FIGURE 4
Stated Approach to Alternatives by County

For more than 40% of the CACs, there was no indication of whether or how the CACs took potential alternatives into account in the permitting process. However, the online review showed that almost 30% of the CACs expressed a strong *ostensible* commitment to the use of alternatives. For many of them this took the form of explicit statements of policy in their Pesticide Use Enforcement Program Work Plan, submitted to DPR periodically and detailing each county's performance and priorities in improving pesticide use enforcement, compliance, and permitting. In some cases the statements laid out a specific process for CAC staff to follow, as illustrated by the Fresno CAC statement regarding alternatives:

> "Staff place emphasis on determining potential hazards to using restricted pesticides and then decide whether the hazards present a likelihood of substantial environmental effects. In addition, biologists must determine if a feasible alternative (other chemical or non-chemical procedures which can reasonably accomplish the same pest control function with comparable effectiveness and reliability) to using restricted pesticides exists. When no feasible alternative exists, biologists issue the permit based on utilization of identified measures that significantly reduce the risks."[59]

In other cases of strong claims of commitment, the work plan set out a policy of denying permits where feasible alternatives exist, as reflected in the San Joaquin CAC work plan:

> "The county denies permits or notices of intent (NOIs) when there are feasible alternatives to reduce adverse environmental impacts."[60]

For the remaining almost 30% of CACs, the commitment to alternatives evaluation is expressed in less explicit terms. Eleven CACs simply stated that alternatives are "considered and implemented when appropriate." Two CACs explicitly stated that they require that PCAs certify that alternatives have been considered; three others note that alternatives are discussed with applicants.[d,e]

[d] It is worth noting that in accordance with DPR regulations, all CACs require such certification by PCAs or growers. *See* California Code of Regulations Section 6556: Recommendations. For these two counties, this was the only practice relating to alternatives that was available online.

[e] In some cases, the online review showed that a CAC adopted several approaches to alternatives evaluation. For example, a DPR performance evaluation of the Glenn County CAC concluded that staff considered and implemented relevant alternatives, and other Glenn County CAC documents indicated that any private PCA involved in permitting was required to certify that that advisor had considered alternatives. In such cases, we coded the CAC as falling into the category reflecting the strongest commitment to alternatives adoption.

This broad review thus suggests that a large majority of CACs engage in at least some form of alternatives evaluation. However, this conclusion is based largely upon CAC self-statements (primarily enforcement work plans) and DPR performance evaluations. To understand what alternatives evaluation looked like "on the ground," we used the focused case study. The focused case study tells a distinctly different story regarding the emphasis placed upon alternatives evaluation.

2. Focused Case Study Review

The focused case study review examined restricted materials permitting for the use of chlorpyrifos in thirteen CACs. As noted in Section II.A.2, chlorpyrifos, which is used to deal with a broad range of pests for a variety of crops, is a particularly toxic material. Alternatives—chemical and non-chemical—exist for many of these applications, although the suitability of an alternative depends upon the particular local conditions. Indeed, the ban on the use of chlorpyrifos in Hawaii illustrates that the chemical is capable of being replaced. Accordingly, we posited that the CAC evaluation of permit applications for use of chlorpyrifos would include significant attention to alternatives.

To determine the type and depth of alternatives evaluation in the individual CAC permitting processes, we examined three types of data: (1) written CAC policy or guidance regarding alternatives evaluation; (2) documents submitted to or generated by the CACs in the course of issuing permits for chlorpyrifos application; and (3) limited interviews of CAC staff and PCAs involved in the permitting process. Analysis of the data, as discussed in detail below, indicates that the CACs typically delegate the responsibility to identify and evaluate potentially feasible alternatives to the applicant (or, more specifically, to the applicant's PCA). In addition, there was no evidence that the CACs engage in any significant oversight of the private parties' alternatives assessment activities.

Turning first to the question of written guidance, none of the thirteen CACs reported having office-specific written guidance relevant to alternatives evaluation. Five CACs stated that they relied upon requirements and guidance generated by DPR, and particularly the Pesticide Use Enforcement Program Standards Compendium, which is discussed below. The remaining eight CACs did not identify any guidance documents or policies relating to alternatives evaluation.

The permit files and records provided by the CACs in response to the PRA requests provide no evidence of alternatives evaluation by CAC personnel. There are no records memorializing discussions with applicants or their representatives regarding potential alternatives. There are no written memoranda or notes indicating that CAC staff attempted to identify potential alternatives or evaluated any potential alternatives. In fact, several PRA request responses specifically stated the position that identifying and recommending alternatives for consideration by CACs would be inappropriate. For example, San Bernardino responded that "[a]s a regulatory agency, we do not provide recommendations on pesticide use."[61] The two CAC staff interviews are consistent with the record review. The CAC staff members (who work in different counties) confirmed that the CAC staff do not engage in alternatives evaluation, and each reiterated the view that CACs are precluded by law from identifying or recommending consideration of particular potential alternatives.

It appears that the CACs typically rely upon the permittee or their PCA to identify, evaluate and, where appropriate, select alternatives. One CAC records request response noted that "As we are a regulatory agency, we do not advise on what chemicals to apply. This advice comes from their Pest Control Advisor or a Farm Advisor. We will advise the growers when chemicals are not allowed on a particular commodity."[62] The standard permit application form (PR-ENV-125) contains a certification signed by the applicant stating, among other things: "I have considered alternatives and mitigation measures pursuant to Title 3, California Code of Regulations, section 6426. Taking into account economic, environmental, social, and technological factors, I have adopted those that are feasible and would substantially lessen any significant adverse

impact on the environment." However, there was no indication that CACs review the alternatives evaluations performed by PCAs or growers, or even confirm that such evaluations are actually performed.

The three PCA interviews align with the results from the file review. None of the three PCAs reported any significant interaction with CAC staff regarding alternatives. All three PCAs sometimes engage in alternatives evaluation, albeit under different circumstances. PCA A would search for alternatives if the current pesticide was not performing well or if new pests were entering the field, while PCA B seeks alternatives if the pests are growing resistant to the current pesticide. PCA C considered a number of factors, including efficiency, cost, environmental and health concerns and pest resistance. Regarding chlorpyrifos, PCA A and PCA B have begun to use alternatives while PCA C continues to recommend chlorpyrifos due to concerns over cost and pest resistance associated with known alternatives.

3. Discussion

A CAC's obligation to consider alternatives flows from two sources. First, the state Food and Agriculture Code prohibits the issuance of a restricted material permit for a pesticide if "there is a reasonable, effective, and practicable alternate material or procedure that is demonstrably less destructive to the environment."[63] Second, the California Environmental Quality Act (CEQA) imposes an obligation to consider alternatives and to articulate the content and outcome of that evaluation in a public report. The regulations implementing CEQA in this context mandate that public reports "contain a statement and discussion of reasonable alternatives which would reduce any significant environmental impact."[64] The substantive CEQA obligation to evaluate alternatives and the procedural requirement to explain the outcome of that evaluation in a public report apply even to "functionally equivalent" programs such as the pesticide regulatory system.[65]

The DPR has consistently taken the position that alternatives evaluation under CEQA is only required if mitigation measures (such as buffer zones, tarping, or personal protective equipment) are unable to adequately reduce adverse environmental impacts from pesticide use.[66] The agency applies the same approach to restricted material permitting; DPR's Pesticide Use Enforcement Program Standards Compendium provides that "[i]f none of the potential mitigation measures . . . are feasible and a likelihood of significant adverse environmental impact remains . . . the CAC must now consider alternatives."[67] In 2017 the California Court of Appeals rejected that position in the context of pesticide regulation, relying upon a well-established precedent that consideration of feasible alternatives is required ***even if*** a project's significant environmental impacts will be avoided through mitigation measures."[68]

The focused case study review reveals three deficiencies in the CACs' approaches to alternatives evaluation. First, to the extent that a county's permitting program relies upon private parties such as PCAs to identify and evaluate potential alternatives without CAC oversight, the program improperly delegates the CAC's responsibility and discretion to those third parties. Both the Food and Agriculture Code and CEQA mandate that CACs exercise independent judgment regarding potential alternatives after meaningful evaluation. Second, even assuming that CACs are engaging in meaningful oversight and independent evaluation, no public records of the oversight and evaluation seem to have been created; at least, none were submitted in response to our PRA requests. Rather, the nature of the evaluation and underlying justification for the decisions are impenetrable. Third, to the extent that CACs are simply relying upon mitigation in lieu of engaging in alternatives evaluation, they are undermining the express language and underlying goals of the Food and Agriculture Code and CEQA.

III. CUMULATIVE EXPOSURE EVALUATION

A. RESEARCH METHODS

This study used a mixed-method approach to evaluate the permitting practices of the CACs statewide regarding cumulative exposure. As with our review of alternatives evaluation, we performed a statewide assessment of cumulative exposure policies and practices of all CACs. This was followed by a focused case study of restricted material permitting by a smaller, representative set of CACs for three pesticides in particular: chloropicrin, 1,3-dichloropropene (Telone) and metam sodium.

1. Statewide Assessment

As with the statewide assessment for alternatives evaluation, online research was conducted on each CAC to identify documents or information relevant to cumulative exposure. These searches included all CAC websites and informational resources, the DPR website, and the Google online search engine. Searches for each topic area used specific sets of key terms (such as restricted material, notice of intent, cumulative exposure, and cumulative risk) to ensure consistency and completeness. The search results were reviewed to determine whether and how the CACs considered potential cumulative exposures, as part of the restricted materials permitting process.

2. Case Study Selection

In this report, cumulative exposure refers to exposures associated with simultaneous or sequential application of two or more materials at the same field or at adjacent fields. The cumulative exposure case study focuses on chloropicrin, Telone and metam sodium because they are key fumigants in use in California (see Table 6). These pesticides are highly toxic, and their use is associated with significant health risks, including cancer, eye and respiratory irritation, and developmental toxicity.[69,70,71,72,73,74] All three fumigants are considered toxic air contaminants (TACs) in CA and both Telone and metam sodium are on CA's Prop 65 list. As the prior report in this series (*Exposure and Interaction*) demonstrated, exposure to mixtures of fumigants or their degradation products is routine. Fumigants are often applied in combination, with commonly marketed fumigant products including mixtures of chloropicrin and Telone in varying proportions.

TABLE 6: Ranking of Top Pesticides by Pounds Used in California in 2016, Showing the Three Fumigants

Pesticide	Pounds Used[75]	Rank	Top Five Crops/Sites Pesticide is Used On (descending order)
Telone	14.1 million	3	Almonds, soil fumigation/preplant (unspecified), strawberries, carrots, sweet potatoes[76]
Chloropicrin	8.6 million	6	Strawberries, soil fumigation/preplant (unspecified), raspberries, almonds, peppers[77]
Metam sodium	3.3 million	11	Carrots, potatoes, peppers, processing tomatoes, strawberries[78]

These pesticides have common mechanisms of action that may enhance toxicity.[79] All three pesticides are animal carcinogens, and exposure to Telone has also been linked to pancreatic cancer in one epidemiologic study. There is also existing evidence of genotoxicity for all three pesticides in a variety of in vitro systems. The effects of these pesticides on genotoxicity may be more than additive. Telone and chloropicrin are both strong electrophiles (electron-seeking) and capable of reaction with proteins, DNA and other macromolecules and may create toxic effects via similar mechanisms. Metam degradation products MITC, MIC, and hydrogen sulfide are all highly toxic gases and respiratory irritants that impair pulmonary function. These common toxic endpoints (cancer, impaired respiratory function) create the potential for interactive effects that could increase toxicity. Toxicity may be enhanced by interactions that affect the agent's metabolism as well as DNA damage. The results of the cancer studies available for the three fumigants indicate that a fumigant mixture containing chloropicrin and Telone and/or metam sodium represents a multiple-organ carcinogenic risk to exposed populations.[80,81]

The California Office of Environmental and Human Health Assessment (OEHHA) raised concerns about the cumulative effects of chloropicrin and Telone during recent rulemaking regarding the latter fumigant, noting that they are often used together.[82] The agency also raised concerns about the cancer potency of the two fumigants, stating that "Just like 1,3-D, chloropicrin also caused lung cancer in test animals but with a much higher potency." OEHHA stated that risk management measures required by DPR for Telone should address the "likelihood that many bystanders exposed to 1,3-D will simultaneously be exposed to chloropicrin."[83] There has been recent regulatory action on two of these three fumigants as a result of these risks (see sidebar).

REGULATORY ACTION IN CA ON CHLOROPICRIN AND TELONE

2010: DPR agreed that chloropicrin should be a TAC, citing sufficient evidence of cancer.[84]

2013: DPR argued that the carcinogenicity of chloropicrin was "equivocal,"[85] which a number of environmental justice and community organizations have challenged.[86]

2015: DPR issued new rules for chloropicrin, including what time of day it can be applied, limits on acreage, requirements for tarps and more.[87]

2017: New DPR rules for Telone went into effect, including new limits on usage, and making the cancer risk, known as a DPR regulatory target, more lenient, from the previous 0.14 ppb limit to 0.56 ppb.[88]

3. Selection of Counties

The first step in selecting counties for the case study was to identify "candidate cumulative exposure cases," meaning cases in which application of different fumigant pesticides occurred relatively closely in time and location. Information on the date and location that chloropicrin, Telone and metam sodium were applied was obtained from DPR's California Pesticide Information Portal (CalPIP) for 2015. That information was mapped using ArcGIS, and filtered to identify cases in which at least two of the three chemicals were applied in the same one square mile area within 72 hours of each other. Applications where the product used was a pre-mixed combination of the identified chemicals were removed so that only separate applications of individual chemicals were included as candidate cumulative exposure cases in our study.

Second, the candidate cumulative exposure cases were sorted by county and tallied to identify counties with the highest number of instances of potential cumulative exposure. The counties with the highest number of instances were then selected to be included in this study. In order to obtain wide representation of CACs, a minimum of three CACs from each "Institutional Capacity" category[f] were included (see Table 7).

[f] See Table 2 for definitions of Institutional Capacity categories.

TABLE 7: Counties Included in Cumulative Exposure Case Study

County	Number of Candidate Cases	Institutional Capacity
Fresno	61	1
Kern	65	1
Monterey	266	1
Ventura	38	1
Butte	19	1
Merced	19	1
San Luis Obispo	16	1
Santa Cruz	246	1
San Joaquin	14	2
Santa Barbara	36	2
Stanislaus	18	2
Yuba	13	2
Shasta	4	3
Placer	6	3
Napa	3	3
Grand Total	824	—

4. Data Collection and Analysis

For this case study, data collection addressed the existence of generally applicable written policy and of actual practice with respect to cumulative exposure. The specific CAC permit numbers associated with each candidate cumulative exposure case were identified. Through a combination of formal Public Record Act (PRA) requests and informal requests, the following information was requested from each of the fifteen counties included in this case study:

- Documents (including e-mails and other digital documents) discussing whether and how potential cumulative exposures to restricted materials should be identified, evaluated and/or mitigated by the CAC, permit applicants or the applicants' advisors as part of the permitting process.
- For each restricted material permit identified, all documents (including e-mails and other digital documents) submitted to the CAC by or on behalf of the applicant and all documents generated by the CAC relating to such applications and related Notices of Intent (NOIs).

All responses received were reviewed to identify whether the CAC maintained general guidance or policy regarding when and how to evaluate and address cumulative exposure, and the extent to which the CAC dealt with potential instances of cumulative exposure in evaluating permit applications and NOIs. The results of the reviews were recorded in an Excel spreadsheet.

As with the review of alternatives evaluation practices, staff members from two different CAC offices and three PCAs were interviewed. A contemporaneous written summary of each interview was prepared. In summary, the methods used in this study's cumulative exposure evaluation are shown below in Table 8.

TABLE 8: Methods Used for Statewide Assessment and Focused Case Study on Cumulative Exposure

Study Components	Data Sources	Analysis
Statewide Assessment	▶ CAC websites ▶ DPR website ▶ Google online searches ▶ California Pesticide Information Portal (CalPIP) ▶ CAC Pesticide Regulatory Activities Monthly Reports ▶ CAC Pesticide Use Enforcement Program Work Plans ▶ CAC Pesticide Regulatory Activities Monthly Reports	▶ Evaluation of CAC reports and websites to assess claimed level of cumulative exposure evaluation during permitting ▶ Evaluation of county reports to assess each CAC's "institutional capacity" ▶ Evaluation of CalPIP data to identify candidate cumulative exposure cases; i.e., cases in which application of different fumigant pesticides occurred relatively closely in time and location ▶ Selection of smaller subset of CACs for focused case study
Focused Case Study on Cumulative Exposure	▶ Public Record Act (PRA) request responses regarding – Written CAC policy or guidance regarding alternatives evaluation – Documents submitted to or generated by the CACs in the permitting process for the candidate cumulative exposure cases ▶ Interviews of Pest Control Advisors (3) ▶ Interviews of CAC personnel (2)	▶ Determine type and depth of cumulative exposure evaluation by selected CACs through – Review of CAC PRA responses regarding guidance and practices – Review of CAC personnel interviews and PCA interviews – Examination of specific CAC permitting decisions

B. RESULTS AND ANALYSIS

As with alternatives, our study examined the CACs' practices with respect to cumulative exposure evaluation at two levels. First, a broad but limited review of all CACs based upon information available online, and second, a more in-depth examination of a smaller set of CACs based upon information from PRA requests and interviews. This section presents the results of those examinations and compares the CAC practices to the legal requirements for cumulative exposure evaluation and implementation.

1. Statewide Review

The statewide review indicated that CAC staff receive little guidance from DPR and no instruction or documentation at the county level regarding consideration of cumulative exposure during the permitting process. The only documentation found that discussed cumulative exposure was from DPR regarding the adjustment of restricted entry intervals during the application of two or more organophosphate pesticides at the same time on the same field. (A "restricted entry interval" is the period of time after a field is treated with a pesticide during which restrictions on entry are in effect to protect workers and others from exposure.) Title 3 of the California Code of Regulations section 6774 states:

> "Whenever a mixture of two or more organophosphate pesticides is applied, the restricted entry interval shall be lengthened by adding to the longest

> applicable restricted entry interval listed in 6772, 50 percent of the next longest applicable restricted entry interval."

However, no such guidance was found regarding any other type of pesticide, including restricted material pesticides. No evidence was found through online searches during the statewide assessment that any of the CACs consider cumulative exposure risk outside of the organophosphate restricted entry interval.

2. Focused Case Study

The focused case study review examined restricted materials permitting for the use of chloropicrin, Telone and metam sodium in fifteen CACs. As noted earlier, these fumigants are also considered toxic and all are carcinogens. This report looks at how the CACs deal with combinations of any of these three pesticides being used on the same or adjacent fields. The information we requested from CACs entailed fumigants used together on fields—as separate active ingredients, not as a premixed material. We posited that the CAC evaluation of permit applications for use of the three fumigants would include significant attention to cumulative exposures. To determine the type and depth of cumulative exposure evaluation in the individual CAC permitting processes, we examined three types of data: (1) written CAC policy or guidance regarding cumulative exposure evaluation, (2) documents submitted to or generated by the CACs in the course of issuing permits for fumigant application, and (3) interviews of two CAC personnel and several PCAs involved in the permitting process.

Turning first to the question of written guidance, none of the fifteen responding CACs reported having office-specific written guidance relevant to cumulative exposure evaluation. Seven stated that they rely upon requirements and guidance generated by DPR. For example, Yuba County responded:

> "The information about 'cumulative exposure' that you requested . . . is not something that we have. These topics are under the purview of the California Department of Pesticide Regulation (DPR) and any request for information should be directed to them."[89]

The records received from the responding CACs showed various combinations of chloropicrin, Telone, and metam sodium being applied on the same and adjacent fields. These applications consisted of single applications applied at the same time as well as multiple applications applied within 48 hours of each other. There were 49 instances of such applications on the same field site along with 13 instances on adjacent fields. The permit files and records provided by the CACs in response to the PRA requests provide no evidence of cumulative exposure evaluation by CAC personnel in those instances or any others. There are no records memorializing discussions with applicants or their representatives regarding potential concerns about cumulative exposures. There are no written memoranda or notes indicating that CAC staff attempted to evaluate cumulative exposures.

The two CAC staff interviews were consistent with these results. Both staff members stated that DPR is responsible for dealing with potential cumulative exposures; CACs only enforce the requirements set out by DPR. One staff member noted that while his office had no systematic method for identifying potential cumulative exposures, such exposure could be identified through informal communication within the office. He also pointed out that his office would not be aware of pesticide use on fields in adjacent counties. Even though CalAgPermits is used statewide, an individual CAC can only access data and maps for their own county. If cumulative exposure evaluation is done at all, it might be done by the grower or their PCA.

3. Discussion

The CAC's decision to issue a restricted materials permit is subject to CEQA, which requires that the CAC engage in meaningful substantive review of the proposed pesticide application. Among other things, such review includes consideration of significant cumulative impacts.[90] The CEQA

Guidelines, which are regulations issued by the Natural Resources Agency to implement CEQA, define cumulative impacts as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts."[91]

The application of two different restricted pesticides at the same field clearly triggers the CAC's obligation to evaluate cumulative impacts. The potential additive or interactive effects of combined exposures in a single project by definition could very likely "compound or increase" the environmental impacts resulting from the individual substances alone. Similarly, effects from the use of the same or different pesticides on adjacent fields—that is, from different projects—also fall within the definition of cumulative effects. The CEQA Guidelines note that "[t]he cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects."[92]

The courts are clear about what constitutes adequate consideration of potential cumulative impacts. In each case, the relevant agency must "make at least a preliminary search for potential cumulative environmental effects, and, if any such effect were perceived, at least a preliminary assessment of its significance."[93] Where one or more significant potential cumulative effects are identified, the agency is obliged "to give careful consideration to those effects" in determining whether to grant approval.[94] In other words, the agency must, at a minimum, look for and appropriately evaluate potential cumulative environmental effects.[95]

The focused case study review confirms the lack of cumulative exposure assessment and management identified in the CACs' restricted permitting processes by the statewide assessment. This report shows that many growers in California apply multiple pesticides simultaneously or sequentially to the same or adjacent fields. Yet these pesticides are evaluated for risk only on a one-by-one basis, rather than looking at potential cumulative exposures resulting from the pesticides being applied together, at the same time, or within hours of each other.[96]

Although the risk assessment literature talks about the need for cumulative exposure assessment, the reality is that few practical attempts at conducting such assessments have been made.[97] Yet to protect farmworkers, nearby residents, and nearby sensitive receptors (school children, people in hospitals and nursing homes), regulators must begin to find ways to address the issue of cumulative exposure in the regulatory arena. A range of quantitative and qualitative approaches to assessing cumulative exposure have emerged over time in a variety of settings.[98,99] Yet cumulative risk assessment presents significant methodological and practical challenges, even at the national and international level.

Exposure and Interaction describes attempts by U.S. EPA and the European Commission to assess cumulative toxicity.[100] That report notes that the Food Quality Protection Act of 1996 (FQPA) mandated that EPA include exposure through multiple pathways and routes in its risk assessment of pesticides, in particular looking at groups of pesticides with common mechanisms of toxicity (termed CMGs). To date, EPA has used this method to develop cumulative risk assessments for organophosphate pesticides and four other groups of pesticides.[101] In 2016 EPA finalized a document called *Pesticide Cumulative Risk Assessment: Framework for Screening Analysis,* providing "guidance for screening available information to identify groups of pesticides that may have common" CMGs.[102] The tiered approach to classifying pesticides into CMGs draws upon an approach of the World Health Organization (WHO) International Programme on Chemical Safety (IPCS).[103] The framework relies upon "Mode of Action" (MOA) and "Adverse Outcome Pathway" (AOP) to address cumulative risk. A letter to EPA about the proposal, signed by more than two dozen environmental groups, criticized EPA's approach on multiple levels, including that the framework does not include chemicals that contribute to a common adverse health impact.[104] In its response to this comment, EPA said the FQPA "requires the agency to take into account evidence concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity. As such, the agency

has a statutory requirement to assess cumulative risk based on common mechanism of toxicity. Accordingly, the agency must first assess cumulative risk in this way."[105]

Over the past decade, the European Food Safety Agency (EFSA) has developed criteria for inclusion of pesticide compounds in common assessment groups (CAGs), those with similar toxicity properties in a specific organ or system. EFSA announced that it expects to have two assessments completed by June 2019, including assessments looking at the cumulative effects of exposure to pesticides in food on the human nervous and thyroid systems.[106] The agency credits its academic public health and technology partners in the Netherlands for development of a software program for the assessments called the Monte Carlo Risk Assessment (MCRA) tool, originally funded by the European Commission.[107]

Also using some of the techniques suggested in the WHO/ICPS approach, in 2017, Canada's Pest Management Regulatory Agency (PMRA) proposed a Cumulative Risk Assessment Framework, in line with a mandate in the country's Pest Control Products Act of 2006 to consider "available information on . . . cumulative effects of . . . pest control products that have a common mechanism of toxicity."[108] The proposal stated that the program aims at "identifying the risks associated with co-exposures to two or more chemicals that cause a common toxic effect(s)."[109] The proposal suggested a "weight-of-evidence" tiered approach to placing pesticides into groups based on common mechanisms of toxicity. In a comment letter, environmental advocates suggested that the precautionary principle be applied when there was uncertainty about placing pesticides into common mechanism groups (CMGs).[110] The Framework was adopted in April 2018.[111] In response to the comments above, the agency responded that "it does not consider the weight-of-evidence approach and the precautionary approach to be mutually exclusive," noting that professional judgment plays a role in the weight-of-evidence approach.[112] The letter from advocates makes it clear how complicated cumulative exposure assessment is, arguing that in the future, the agency should also consider the following: cumulative health risks associated with pesticide formulations; mixtures of pesticides with disparate mechanisms but similar toxic effects; and synergistic effects of pesticide mixtures, regardless of their mechanisms of toxicity and individual toxic effects. In response to those comments, the PMRA noted that its current focus is to promptly address pesticides with a common mechanism of toxicity, but acknowledged that methodologies in conducting cumulative risk assessments will continue to evolve.

IV. RECOMMENDATIONS

A. ALTERNATIVES EVALUATION

This section offers a set of recommendations that address the three main substantive and structural deficiencies in the CACs' current alternatives evaluation practices. The recommendations take into account constraints that CACs face in performing their statutory responsibilities. Most notably, in some cases, the availability of feasible alternatives depends heavily on the specific decision context; namely, the particular crop and pest involved as well as local conditions that can affect suitability of potential alternative agricultural practices or alternative chemical/non-chemical pesticides. In such cases, the identification and evaluation of alternatives in individual cases can be difficult and resource-intensive, and require experience and training not currently available to CAC staff. Nonetheless, the law (and best practices in environmental and public health policy) require meaningful consideration of alternatives. The recommendations that follow balance these two concerns.

1. Align Formal Guidance and Informal Practice with the Applicable Law

As a substantive matter, CEQA and the Food and Agriculture Code require the government to meaningfully evaluate alternatives, and to deny a restricted material permit application where reasonable, effective, and practicable safer alternate material or procedure exists. Existing guidance and practice violates these requirements in two major ways. First, the formal guidance issued by DPR undermines these mandates by shunting alternatives evaluation aside. The Pesticide Use Enforcement Program Standards Compendium, which is widely relied upon by CACs, calls for consideration of alternatives only if the CAC determines that mitigation measures are ineffective. Second, in practice, the CACs generally do not engage in alternatives evaluation, but instead rely upon PCAs to consider alternatives. The PCAs and/or the growers who employ them are required to certify that they have done so; but there is no evidence that the CACs audit or otherwise review the substance of the certifications.

DPR and the CACs should adopt the following changes to bring formal policy and practices into alignment with legal requirements and best practices:

- Revise the state-level pesticide registration process to include evaluation of potentially feasible, safer alternatives to the proposed pesticide product by DPR staff. For some pesticide products, it may be possible to identify and evaluate potential alternatives at the registration stage; for example, where local conditions are not relevant to the evaluation. In cases in which a safer, feasible and effective alternative exists, the registration should be denied. This policy is consistent with CEQA and the Food and Agriculture Code, with the preference for safer alternatives reflected in other state health and environmental programs, and with the well-established public health principle of primary prevention.
- Revise the county-level restricted material permitting process to include evaluation of potentially feasible, safer alternatives to the proposed restricted material in addition to consideration of mitigation measures. If the evaluation is performed by the applicant or its advisor, the evaluation should be conducted in accordance with DPR/CAC methods and subject to meaningful, substantive review by the CAC. In cases in which a safer, feasible and effective alternative exists, the restricted material permit should be denied.

2. Establish Methods for Identifying and Evaluating Alternatives

Alternatives evaluation can be a challenging process, requiring the decision-maker to evaluate and resolve difficult trade-offs presented by the choice between the proposed pesticide and potential alternatives. Challenges include identifying potential alternatives, collecting and managing the data required for the comparison, articulating and resolving the value-based trade-offs presented by the choices. DPR should take the following steps to ensure that alternatives identification and evaluation is suitably performed, whether at the state or county level:

- Develop guidance setting out rigorous, systematic, yet tractable methods for identification and evaluation of potential alternatives. EPA, the California Department of Toxic Substances Control, the European Chemical Agency and other governmental, institutional and private parties have developed a variety of alternatives evaluation methods and tools.[113] DPR should draw upon those sources to develop methods that fit the needs of the pesticide program and its stakeholders. Likewise, DPR should involve relevant stakeholders and experts in alternatives analysis in the development process for the guidance.
- Require submission by the registrant/permittee of data and information regarding potential alternatives needed to perform an alternatives evaluation, including health and environmental impacts, technical performance and cost.

3. Develop and Support Capacity at the CAC Level for Identifying and Evaluating Alternatives

CACs have limited resources to support their respective restricted material permitting programs. Moreover, the pace and volume of the restricted material permitting process provides limited time for alternatives identification and evaluation. CACs will need to develop sufficient internal capacity and receive substantial technical support to implement alternatives evaluation effectively. State and county officials should adopt the following measures to ensure that the CACs are up to the job:

- DPR should develop and maintain a clearinghouse of known potential alternatives for existing restricted materials, including non-chemical alternatives. The data for the clearinghouse should be drawn from international, federal, state and local government sources, as well as other authoritative sources. The clearinghouse should be integrated with CalAgPermits to highlight potential alternatives for CAC staff during the permit application review process.
- The CACs should engage in outreach to growers and other stakeholders to identify known alternatives to restricted materials used in California and regularly submit such information to the clearinghouse.
- CAC staff, PCAs, and growers should receive more extensive initial and continuing training in alternatives identification and evaluation methods and tools.
- Formal and informal networks between CAC staff, UC Cooperative Extension staff, and other stakeholders should be maintained and expanded.

B. CUMULATIVE EXPOSURE

Any recommendations for improving CAC policy and practices regarding cumulative exposure must take into account the complexities presented by cumulative risk assessment. As the brief literature review above illustrates, even large and sophisticated national and international scientific agencies face significant challenges in incorporating cumulative risk into their risk assessment and risk management programs. CACs are not scientific agencies when it comes to pesticide regulation; they cannot be expected to engage in advanced cumulative risk assessment. However, CEQA mandates that the pesticide program address cumulative impacts, and DPR has chosen to meet its CEQA obligations through the combined state-level registration process and CAC restricted material permitting process. In crafting the recommendations that

follow, we kept this tension in mind, suggesting respective roles for DPR and the CACs that best fit their institutional strengths and capacities.

1. Adopt Practices for Timely Identification of Cumulative Exposure Scenarios

Effective assessment and management of cumulative risks depends upon the timely identification cumulative exposure scenarios at both the DPR registration stage and the CAC restricted materials permitting stage. Identification at the registration stage is essential if DPR is to meaningfully and comprehensively characterize the actual risks of pesticide products and develop management standards to be implemented and enforced by the CACs. Identification at the restricted material permitting stage is critical; the CAC must be aware of cumulative exposures in order to identify and enforce the applicable standards. DPR and the CACs should adopt the following policies and practices to enhance identification of cumulative exposures:

- DPR should identify and assess mixtures of active ingredients in pesticide products seeking registration. As noted in *Exposure and Interaction*, pesticide products often include more than one active ingredient, yet DPR does not currently consider the potential interactive effects of such mixtures.[114]
- During the registration process, DPR should identify reasonably likely field mixing (contemporaneous application of two or more pesticides) and single-site sequential applications (application of one material followed shortly after by application of a different material). DPR can obtain this information from the manufacturer of the product seeking registration as part of the documentation submitted in support of the registration, and from consultation with PCAs, growers, county agricultural extensions, and the CACs, respectively.
- During the registration process, DPR should identify reasonably adjacent field use (application of one material at one site close in time and location to application of the same or different material at a second site). DPR can obtain this information from consultation with PCAs, growers, county agricultural extensions, and the CACs.
- As part of restricted material permitting, each CAC should develop and implement a systematic process for identifying potential cumulative exposure occurrences within the county and across counties. For example, when requesting a restricted material permit, the grower identifies the pesticide to be used and the location, and records this information in the CalAgPermits program. This information could be used to identify potential cumulative exposure scenarios at single-sites and adjacent sites, perhaps even with CalAgPermits alerting CAC staff and prompting action. In some cases, the adjacent site may be located in a different county, requiring coordination and information sharing among adjacent counties.

2. Establish Principles for Testing of Mixtures

Exposure and Interaction sets out a series of recommendations for testing of interactive effects from cumulative exposure at the registration stage, which we summarize here:

- For products sold as a mixture or field mixed, testing for potential interactive effects should be mandatory. DPR has broad authorities to require testing of "pesticides" and "pesticide products," terms which explicitly include mixtures of two or more active ingredients or other substances.
- For products used simultaneously or sequentially at the same or nearby sites, *Exposure and Interaction* recommended a two-step approach: (1) determine whether there is reason to believe there will be interactive effects, and (2) either perform testing or adopt stringent restrictions to avoid the likelihood of health impacts. In a world with no resource or time constraints, testing would be required in all cases as the second step. However, as *Exposure and Interaction* observed, there are limited resources for pesticide testing

and evaluation, and use of those limited resources on potential interactive effects could detract from efforts to assess other potential issues. Also, testing delays could have significant impacts on growers. To balance those concerns against the overarching mandate to protect human health and the environment, sufficiently stringent risk management conditions could be placed on the co-use of pesticides in lieu of testing. For example, in the case of sequential application of two different pesticides at one site or adjacent sites, the timing of the second application could be delayed to allow substantial removal of the first pesticide (e.g. a delay of five half-lives would result in a nearly 97 percent reduction in active ingredient).

3. Establish Methods for Assessing Risks Associated with Cumulative Exposures

If the testing identifies interactive effects that would adversely impact human health, those effects must be incorporated into the risk assessment performed as part of the registration process. This is a substantial challenge. While national and international agencies have developed a range of cumulative assessment frameworks and tools, there is no standard method available. DPR should establish a task force to review and evaluate existing frameworks and methods, and to recommend cumulative risk assessment methodologies appropriate for this context. The task force should include academic and agency scientists, representatives of selected CACs, as well as knowledgeable representatives of relevant stakeholder groups. Building upon the recommendations of the task force and in consultation with OEHHA, DPR should develop and implement a peer-reviewed cumulative risk assessment policy.

4. Develop Default Standards for Likely Cumulative Exposure Scenarios During Registration

At present DPR establishes restrictions on the use of individual restricted materials such as buffer zones, re-entry restrictions, and use limitations. CACs enforce those restrictions through the restricted material permitting program. DPR should adopt the same approach to the likely cumulative exposure scenarios identified as part of the registration process (see Recommendation 1 above relating to timely identification of cumulative exposure scenarios). By way of illustration, if DPR determines during the registration process that Pesticide A will typically be applied with or in close temporal or spatial proximity to Pesticide B, then DPR should establish appropriate restrictions on that use.

5. Establish a Process for Developing Standards for Cumulative Exposures Identified by CACs

In some cases, CACs may identify cumulative exposures that were not previously anticipated in the registration stage (see Recommendations 1 and 4). In such cases, the CAC should consult with DPR regarding any necessary testing, risk assessment and restrictions. DPR should develop a streamlined but rigorous and protective method for assessment and standard setting under those circumstances.

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