Evaluating how different sources of scientific evidence shaped the EPA's regulation of the herbicide Dacthal

By

Chloe Els

Public Health Program

University of Colorado at Boulder

Defense Date March 13, 2026

Thesis Advisor: Dr. Karen Bailey, Department of Environmental Studies

Honors Council Representative: Dr. Sigrid Van Den Abbeele, Public Health Program

Outside Reader: Dr. Susan Hendrickson, Department of Chemistry

TABLE OF CONTENTS

ABSTRACT

Per the 1946 Administrative Procedures Act, the 1970 Occupational Safety and Health Act, and the 1976 Toxic Substances Control Act, the Environmental Protection Agency (EPA) must be able to show that it makes its regulatory decisions based on the best available science. However, the lack of a standardized framework to guide the use of different sources of scientific evidence in EPA policymaking and ongoing concerns about biases associated with industry-generated data point to a continued need for more research on how the pesticide industry is able to influence the creation of evidence-based policy. Furthermore, because uncertainty remains regarding what specific sources of scientific evidence were prioritized during the EPA's decision to cancel Dacthal in 2024, the role of scientific evidence in this regulatory process warrants further investigation. To better understand the extent to which different sources of scientific evidence were prioritized during the EPA's regulation of Dacthal, a systematic review of the existing scientific literature regarding Dacthal's potential health hazards was conducted as well as document analysis of EPA Docket EPA-HQ-OPP-2011-0374. Triangulation of these findings, along with interview responses shared by former EPA employees revealed that the EPA primarily used independently collected scientific evidence during early problem formulation stages of reviewing Dacthal to assess research gaps and then relied solely on industry-supplied data during later stages of the regulatory process. Because the EPA relied on Dacthal's producer, AMVAC, to supply safety data rather than independent sources, AMVAC was able to stall the agency's regulatory process for years. This thesis highlights a critical weakness within the EPA's Registration Review Process for pesticides and points to a need for stricter enforcement of

submission deadlines, especially if the agency is going to continue to rely on industry-sponsored data going forward.

INTRODUCTION

Due to their inherently toxic nature, pesticides have long been a key public health concern; however, Dacthal flew under the regulatory radar for decades. Unlike more famous pesticides such as DDT or Roundup, Dacthal was not the subject of public outcry or class action lawsuits prior to 2024. In fact, for many years Dacthal was assumed to be a relatively safe pesticide. In 2008, fifty years after Dacthal was first registered for use, the Environmental Protection Agency (EPA) released a report announcing that there were no studies of the long-term effects of Dacthal's metabolites (or breakdown products) on human health, that no populations were particularly sensitive to Dacthal's metabolites, and that regulating these metabolites would not meaningfully reduce risks to human health ("Health Effects Support Document," 2008). But, in 2024, the EPA cancelled Dacthal in the agency's first emergency suspension in almost 40 years.

The events that led to this cancellation began in 1972, two years after President Nixon created the EPA. In 1972, the newly passed Federal Environmental Pesticide Control Act required that the EPA reregister all pesticides for continued use in America to ensure they were being regulated in accordance with more modern scientific evidence (Yen & Esworthy, 2012). Over twenty years later, the 1996 Food Quality Protection Act required the EPA to review all pesticides currently registered for use every fifteen years, making pesticide reregistration an ongoing process (Yen & Esworthy, 2012).

In 2011, the EPA began reviewing Dacthal (Table 1). Two years later, in 2013, the EPA requested safety data from American Vanguard Corporation (AMVAC, the manufacturer of Dacthal, referred to sometimes throughout this thesis as the registrant for Dacthal) to support the continued registration of Dacthal. AMVAC's failure to submit the required data prompted the EPA to issue a Notice of Intent to Suspend Dacthal in April of 2022, almost a decade after the initial request. Later that year, the EPA suspended the herbicide's registration.

After AMVAC submitted the required safety data in 2023, the EPA lifted the suspension on Dacthal's registration. However, by August of 2024, the EPA issued an emergency suspension of Dacthal due to safety hazards, particularly for unborn babies and pregnant women exposed to Dacthal ("EPA Finalizes Cancellation," 2024). This was the first emergency suspension issued by the EPA in almost 40 years ("EPA Issues Emergency Order," 2024). That same month, AMVAC voluntarily cancelled its production of Dacthal. It is important to note that it is not uncommon for pesticide companies to voluntarily cancel their products. As of 2019, over 72% of cancelled pesticides in America were cancelled voluntarily by their producers (Donley, 2019). However, the reasons for these voluntary cancellations vary.

Two months after AMVAC voluntarily took Dacthal off the market, the EPA finalized the cancellation of Dacthal and stated the following: "In making this decision, EPA relied on the best available science, which included robust studies demonstrating thyroid toxicity" ("EPA Finalizes Cancellation," 2024).

Table 1. Timeline of Dacthal Regulation in the U.S.

Date	Event
1958	Dacthal is first registered for use in the United States
2011	EPA begins reviewing Dacthal's registration
2013	EPA begins requesting safety data from AMVAC to support the continued registration of Dacthal
2022	EPA issues Notice of Intent to Suspend Dacthal based on AMVAC's failure to submit the safety data

	EPA suspends Dacthal's registration
2023	EPA lifts the suspension after AMVAC submits safety data
2024	EPA issues emergency suspension of Dacthal AMVAC voluntarily cancels global production of Dacthal EPA finalizes cancellation of Dacthal

This lengthy process is a striking example of how complicated pesticide regulation can be. What began as a simple request for safety data in 2013 set off a decade-long conflict between the EPA and AMVAC. This process also raises an important question about the role of scientific evidence in the EPA's regulation and eventual cancellation of Dacthal, particularly relating to the sources of this evidence. My thesis explores this topic by answering the following question: **To what extent was the EPA's regulation of Dacthal shaped by safety data provided by AMVAC, and to what extent was its regulation of Dacthal based on independently conducted studies (conducted without commercial or industry sponsorship) evaluating the potential health hazards of Dacthal?**

Because the EPA cancelled Dacthal so quickly after receiving safety data from AMVAC in 2023 (as demonstrated in Table 1), I hypothesize that the EPA's regulation and eventual cancellation of Dacthal was primarily shaped by industry data provided by AMVAC rather than independently conducted scientific studies.

To understand what led the EPA to cancel Dacthal, it is essential to understand what sources of scientific evidence can inform EPA regulatory policy. In accordance with the 1946 Administrative Procedures Act, the 1970 Occupational Safety and Health Act, and the 1976 Toxic Substances Control Act, the EPA must be able to demonstrate to the public that it makes its regulatory decisions based on the best available science. First, agency actions must be supported by "substantial evidence" (Administrative Procedures Act, 1946). Additionally:

> "The Secretary, in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life. Development of standards under this subsection shall be based upon research, demonstrations, experiments, and such other information as may be appropriate. In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field" (Occupational Safety and Health Act of 1970, 1970).

> "The Administrator shall use scientific information, technical procedures, measures, methods, protocols, methodologies, or models, employed in a manner consistent with the best available science" (Toxic Substances Control Act, 1976).

Furthermore, in the EPA's Scientific Integrity Policy, the agency describes science as being the "backbone of the EPA's decision-making" and emphasizes transparency and accountability regarding the use of science during its regulatory process (*Scientific Integrity*, 2012). The role of independent studies in EPA policymaking became controversial several years ago through the Trump Administration's 2021 "Secret Science" rule which would have caused the EPA to give less consideration to data that was not publicly available; although this rule was quickly struck down by a federal court, debates about scientific transparency remain ongoing (“The Downfall of the "Secret Science” Rule,” 2021).

As agencies like the EPA continue to push for evidence-based policy, it is crucial to understand what evidence is being considered in this process. This is especially urgent, as recent studies have found that scientists employed by the pesticide industry often generate data that aims to financially benefit the pesticide industry and have therefore advised policymakers to be skeptical of the safety data presented by pesticide companies and advocated for continued research on how the pesticide industry is able to influence the creation of evidence-based regulatory policy (Glenna & Bruce, 2021; Bruce et al., 2023).

Understanding what sources of scientific evidence influence the EPA’s regulation of pesticides is crucial in order to hold the agency accountable to its commitment to use the best available science during its regulatory decisions. This thesis will seek to better understand the role of both independent scientific studies and AMVAC safety data in the EPA’s regulation and eventual cancellation of Dacthal, focusing particularly on data regarding Dacthal’s potential health risks.

What is Dacthal?

Dacthal (International Union of Pure and Applied Chemistry (IUPAC) Name: dimethyl 2,3,5,6-tetrachlorobenzene-1,4-dicarboxylate) is the brand name for dimethyl tetrachloroterephthalate (DCPA), also known as chlorthal-dimethyl. It is a colorless, odorless, crystalline solid that has been sold in a variety of formulations, including liquid suspensions and powders. As illustrated in Figure 1b and 1c, Dacthal has two primary metabolites (breakdown products): monomethyl tetrachloroterephthalic acid (MTP) and tetrachloroterephthalic acid (TPA).

Figure 1a. The molecular structure of Dacthal

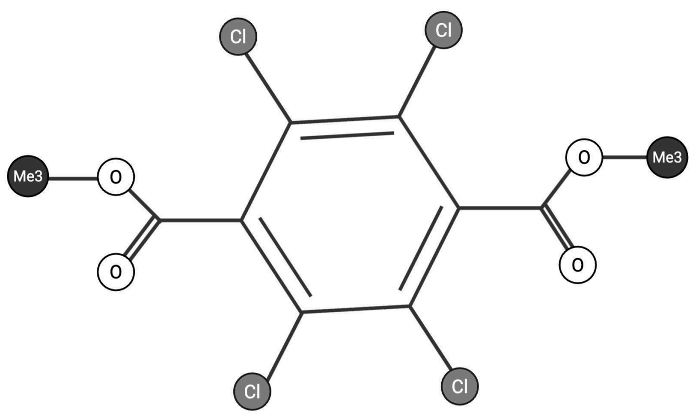


Figure 1b. The molecular structure of Dacthal's metabolite monomethyl tetrachloroterephthalic acid (MTP)

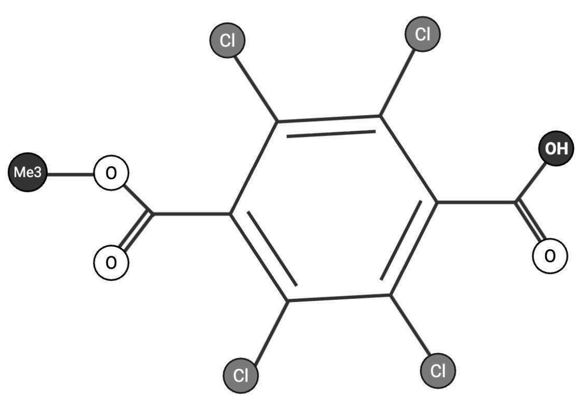
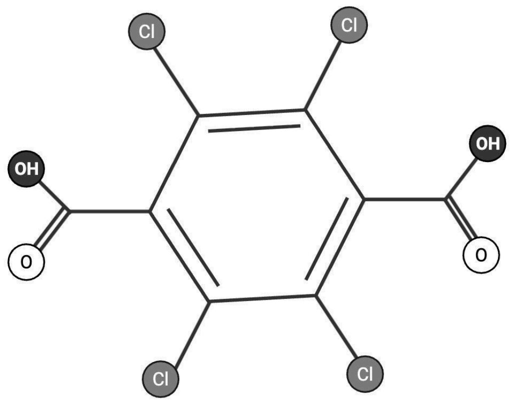


Figure 1c. The molecular structure of Dacthal's metabolite tetrachloroterephthalic acid (TPA)



Dacthal is also a phthalate, meaning that it is a man-made chemical compound that contains a benzene ring attached to two ester groups, as illustrated in Figure 1a. Based upon the current literature and a review article published in 2021, there appears to be a general consensus that many phthalates function as endocrine disrupters (Wang & Qian, 2021). An endocrine disrupter is a chemical that interferes with hormones in the body's endocrine system, causing adverse health outcomes, such as metabolic disorders, an increased risk of diabetes, preterm birth, abnormal puberty, and disrupted fertility ("Endocrine Disrupters," 2026). The endocrine system uses hormones as chemical messengers to control a variety of bodily functions such as development, reproduction, and metabolism. One key component of the endocrine system that this thesis will explore in greater detail is the thyroid which releases the hormones triiodothyronine (T3) and thyroxine (T4). Both thyroid hormones play an important role in regulating metabolism, body temperature, and heart rate, as well as growth and brain maturation in children ("In Brief," 2024).

As a pre-emergent herbicide, Dacthal is able to prevent the growth of weeds by inhibiting cell division (Shaner et al, 2014). Prior to its cancellation, farmers used Dacthal in moderate amounts. In 2020, farmers reported applying around 84,000 pounds of Dacthal per year to crops like broccoli and cabbage; this amount pales in comparison to the 280 million pounds of Roundup farmers report applying to their crops per year (“Assessment of Dimethyl,” 2023; “Glyphosate,” 2019). Dacthal was also used to control weeds in residential areas, typically on lawn and turf and in home gardens.

How has pesticide use changed over the years?

Over the last few centuries, pesticide use has changed enormously. Beginning in the 19th century, farmers primarily used arsenic-based pesticides such as Paris green (a copper acetoarsenite) and lead arsenate. Both were heavy metal insecticides that continued to grow in popularity throughout the 20th century (Davis, 2014). Then, between World War I and II, the American government began to limit farm size in an attempt to decrease food surpluses, ironically causing farmers to search for methods to increase crop production from their dwindling land (Bosso, 1987). One such method was increasing their reliance on pesticides as they applied greater amounts to their fields (MacIntyre, 1987).

Meanwhile, in laboratories rather than fields, scientists were beginning to synthesize organic pesticides, meaning that instead of toxic metalloids like arsenic, these pesticides were largely composed of carbon atoms covalently bonded to other atoms (Davis, 2014). While exciting, these creations hardly led to a total upheaval of the pesticide industry—that is, until one of them did (Davis, 2014).

In 1939, on the cusp of the second World War, everything changed when scientists discovered that a synthetic organic compound made up of chlorinated hydrocarbons called DDT was an extremely effective insecticide. DDT quickly took over the pesticide industry, eliminating crop-feeding insects in American fields while also being credited with keeping American troops malaria-free while they fought in the Pacific ("DDT Regulatory History," 1975). Following the success of DDT, more organic pesticides were developed and eagerly purchased for agricultural and household use (Davis, 2014). After the second World War, changes to the agriculture industry made pesticide-use key to success as an American farmer. Dr. Anthony J. Nownes, a professor of political science at the University of Kansas, summed up this golden era well when he wrote the following:

> "Farmers heralded the impressive accomplishments of chemical technology, producers anticipated profits and prosperity, and government shared a euphoric enthusiasm for pesticides" (Nownes, 1991).

During this time period, large amounts of pesticides were also being used abroad to increase crop yields in the Global South, resulting in massive increases in pesticide use on a global scale (Pimentel, 1996). This movement, led by Nobel Peace Prize winner and American agronomist Norman Borlaug, is known as the Green Revolution.

Of course, nothing this perfect can last forever. In 1972, less than 40 years after its introduction as a miracle insecticide, DDT was banned from use in America. However, this by no means marked the end of pesticide use in America. By the end of the 20th century, it was estimated that over a billion pounds of pesticides were still used each year in the United States (Alavanja, 2009). As the global population climbs, so do concerns about being able to feed everyone ("World Population Projected," 2017). Some farmers claim that banning pesticides altogether will lead to massive food shortages because of how much the agriculture industry relies on pesticides to produce the majority of the world's food (Stoddard, 2020). With these concerns in mind, pesticide usage remains an enduring public health issue that demands strong regulation.

How does the EPA regulate pesticides?

The EPA is currently responsible for regulating thousands of pesticide active ingredients (Exposure Assessment, 2025). The EPA defines pesticides as “any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest” (“What is a Pesticide?,” 2025). Therefore, *pesticide* is an umbrella term that encompasses a variety of substances, including herbicides. The EPA further classifies pesticides as either “restricted use” or “general use” based on their potential to cause harm to those exposed—as determined by the EPA (“Restricted Use Products,” 2025).

Upon its inception in 1970, the EPA assumed responsibility for regulating all pesticides in the United States. However, before the EPA’s creation, pesticide regulation was the responsibility of the U.S. Department of Agriculture (USDA). During this period (1910-1970), increased pesticide usage in America spurred the creation of new regulations. In 1910, the Insecticide Act required honesty and transparency during the production and sale of insecticides and fungicides (Yen & Esworthy, 2012). Less than three decades later, the rise of organic pesticide sales after World War II led Congress to develop the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which President Harry S. Truman signed into law in 1947 (Davis, 2014). As the sole regulator of pesticides in America, the USDA was responsible for enforcing this act until 1970, when it passed that responsibility on to the EPA. Since its enactment in 1947, FIFRA has been revised several times. The version of FIFRA that was signed into law in 1947 was most concerned with pesticide efficacy rather than safety and remained that way until its revision in 1972 (Yen & Esworthy, 2012). However, the act also required that toxic pesticides be clearly labelled as such to protect people from accidental poisoning (Davis, 2014). Twenty-five years later, FIFRA underwent a series of revisions that increased the government's involvement in regulating pesticide safety with a particular focus on protecting consumers from harm (Bosso, 1987).

Currently, FIFRA provides guidelines for pesticide registration and cancellation that the EPA must follow. FIFRA states that the EPA may register pesticides if the EPA is able to determine that the pesticide "will not generally cause unreasonable adverse effects on the environment" and may cancel pesticides if the pesticide "generally causes unreasonable adverse effects on the environment" in which "unreasonable adverse effects on the environment'' are defined as the following:

> "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 346a)" (FIFRA, 2012).

This approach to regulation is called cost-benefit analysis, and it first became integrated into government regulatory action in the late 1970s, within the same decade of the EPA's creation (Luken, 1985). Since then, cost-benefit analysis has played an essential role in EPA regulatory policy formation, and a variety of stakeholders are involved in determining the costs and benefits of keeping certain pesticides on the market.

In order to determine the costs and benefits of registering or re-registering a pesticide for use in the U.S., the EPA uses the Ecological Risk Assessment Framework which demonstrates a reciprocal relationship between problem formulation and risk characterization with the acquirement of data (“EPA's Guidelines,” 1998). This framework requires the EPA to formulate problems and characterize risks associated with using a particular pesticide, acquiring data from various sources as necessary. The EPA employs this framework throughout the regulatory process, as broadly outlined in Table 2. Although this framework provides a general overview of the EPA’s regulatory process, it does not tell the full story.

Table 2. EPA registration review process for pesticides (“Registration Review Process,” 2025)

Step	Action taken by EPA
1	Creation of Preliminary Work Plan (followed by a comment period open to the public) *The EPA defines this step as “summarizing information EPA has on the pesticide and the anticipated path forward” (“Registration Review Process,” 2025).*
2	Creation of Final Work Plan *This is an extension of the Preliminary Work Plan that takes into account any additional information shared during the public comment period (“Registration Review Process,” 2025).*
3	EPA issues Data Call-In *During this step, the EPA announces any additional studies the agency would like to receive to determine if the pesticide should remain on the market and identifies the entity responsible for providing that data (“Registration Review Process,” 2025).*
4	Creation of Draft Risk Assessment (followed by a comment period open to the public) *During this step, the EPA announces its preliminary assessment of the pesticide’s potential health risks based upon the data the agency received in response to the Data Call-In (“Registration Review Process,” 2025).*
5	Creation of Proposed Risk Interim Decision (followed by a comment period open to the public) *During this step, the EPA will summarize its Draft Risk Assessment and describe any risk*

	mitigation actions that need to be taken to ensure the pesticide " does not generally pose unreasonable risks" ("Registration Review Process," 2025).
6	Creation of Interim/Final Decision *During this step, the EPA announces its final decision for how the pesticide should be regulated ("Registration Review Process," 2025).*

Who can influence the EPA's regulation of pesticides?

The EPA makes its regulatory decisions based on a variety of concerns that affect the general American population, such as potential risks to human health or the economy (Cropper et al., 1992). These concerns are brought to the EPA by stakeholders who can then exert influence over the regulatory process through a system called *bureaucratic pluralism* (McGarity, 1991). Organizations that function under bureaucratic pluralism make decisions based on the combined priorities of these various stakeholders (Alford & Friedland, 2011). According to the EPA, a stakeholder can be defined as any entity that has an interest in the "processes and/or outcomes of a project, policy, action, or issue" ("Introduction to Embracing Collaboration," 2025). Over time, as the network of stakeholders has widened, it has become more difficult for just one stakeholder to control the regulatory process, especially as each stakeholder advocates for distinct, often competing priorities (Nownes, 1991). Some of the key stakeholders involved in the EPA's regulation of pesticides include pesticide manufacturers, farmers, and environmental groups. Each of these stakeholders is known to advocate for their own specific priorities at different points in the regulatory process (Cropper et al., 1992).

It is important to note that the EPA is not just influenced by external stakeholders. Internal stakeholders employed by the EPA also play an important role in developing policy. Within the EPA, there are 12 Headquarters Offices, one of which is the Office of Chemical Safety and Pollution Prevention (OCSPP). Within OCSPP is the Office of Pesticide Programs

(OPP). This office is specifically responsible for regulating pesticides in accordance with FIFRA and is further divided into Regulatory Divisions and Science Divisions. These divisions contain roles such as Regulatory Advisor, Physical Scientist, and Senior Science Advisor ("Organization Chart," 2025).

The EPA began employing scientists shortly after the agency was created in 1970; these scientists were hired to work in laboratories that specifically examined the effects of various substances on human and environmental health (Jasanoff, 1994). In addition to these scientists employed by the EPA, the EPA's Scientific Advisory Board (SAB) provides expert advice on a broad range of scientific topics ("About EPA's Science," 2025). Members of this panel have included Dr. Jeremy Sarnat (an Associate Professor in Emory University's Gangarosa Department of Environmental Health), Dr. Hui Li (a Professor of Environmental Soil Chemistry in Michigan State University's Department of Plant, Soil and Microbial Sciences), and Dr. Lea Hildebrandt-Ruiz (an Associate Professor in the University of Texas at Austin's McKetta Department of Chemical Engineering). In total, this board has around 45 members with the goal of representing a wide variety of scientific disciplines ("EPA Announces Selection," 2024). While the majority of SAB members are employed at academic institutions, some members have industry jobs. For example, former member Austin Omer worked as a Sustainable Systems Agronomist for Bayer (the company that produces Roundup) during the time he served on the SAB from 2023-2025 ("EPA Science Advisory Board," [n.d.]).

And, in addition to the SAB, the EPA also employs a group of scientists who provide expert advice specific to pesticides. This is called the FIFRA Scientific Advisory Panel (SAP). This panel, created in 1975, is made up of seven scientists who help the EPA evaluate scientific evidence regarding pesticide safety ("FIFRA Scientific Advisory Panel," 2025).

According to political scientist John W. Kingdon, scientists are considered to be one of the most important stakeholders in the policymaking process (Kingdon, 2003). Sheila Jasanoff, a pioneer in the field of Science and Technology Studies, has argued that scientists who contribute to regulatory decisions, particularly in the EPA and Food and Drug Administration (FDA), can be thought of as their own branch of government, rather than as a separate non-political entity due to the influence their evaluation of scientific evidence has on the formation of regulatory policy (Jasanoff, 1994).

The Advocacy Coalition Framework, a prominent theory for studying policy process, asserts that scientific evidence is able to influence the belief systems held by various stakeholders at various stages of the policymaking process (Sabatier & Weible, 2014; Howlett et al., 2016). Therefore, a stakeholder involved in the EPA's regulatory process does not have to be a scientist in order to be influenced by scientific evidence. Based upon the Advocacy Coalition Framework, it is clear that scientific evidence *can* influence the EPA's regulatory process. Now, the question remains: *how* does scientific evidence influence the regulatory process?

What role does scientific evidence play during the EPA's regulation of pesticides?

In accordance with the 1946 Administrative Procedures Act, the 1970 Occupational Safety and Health Act, and the 1976 Toxic Substances Control Act, the EPA must be able to demonstrate that it makes its regulatory decisions based on the best available science. There are several sources the EPA can turn to for this information. In addition to safety data submitted by pesticide manufacturers, the EPA also reports using emerging scientific evidence to assess the safety of different pesticides, prioritizing scientific evidence that is confirmed by a variety of sources ("Understanding the Science," 2025). According to the EPA, the agency often conducts systematic reviews of existing scientific studies to evaluate potential risks pesticides may pose to human health ("Understanding the Science," 2025). A 2025 systematic review found that the EPA is more likely to use articles during its policy analysis process if those articles are considered to be popular, if they are available via open access, and if they were written by the EPA (Scott et al., 2025). The EPA then uses a Weight of Evidence (WOE) analysis, making conclusions based on a preponderance of evidence ("Office of Pesticide Programs' Framework," 2016).

The EPA is also responsible for developing and enforcing procedures that screen pesticides for possible disruptions to normal endocrine functions, particularly through disruptions to hormones like estrogen, in accordance with the 1996 Food Quality Protection Act. In 1996, the EPA formed the Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), an interdisciplinary group made up of government and industry professionals, environmental advocates, and academics who advised the EPA on regulating chemicals that might disrupt the endocrine system. In 1998, the EPA formally announced the creation of the Endocrine Disrupter Screening Program (EDSP) which outlined the procedures for a variety of assays (analytical laboratory procedures) to determine the potential effects of chemicals on the endocrine system ("Endocrine Disrupter Screening," 2026). The EDSP would later become important in the EPA's regulation of Dacthal as Dacthal was found to have significant effects on the endocrine system. The EPA does not appear to have a screening program like this for any other body systems or health outcomes, making the EDSP unique within the agency.

By incorporating scientific evidence into its regulatory process, the EPA works to create evidence-based policies. The idea of creating evidence-based policies first became popular following World War II and is defined as applying rigorously constructed scientific evidence to create effective policies (Baron, 2018). Although this practice is now embraced as being the gold standard of policy formation, creating evidence-based policy is not always straightforward. Despite attempts to create frameworks for implementing scientific evidence in policymaking, there is currently no standardized method for using scientific evidence to influence the EPA's regulatory process (Kano & Hiyashi, 2021). A 2025 systematic review found that governments around the world struggle to integrate scientific evidence into their regulatory processes due to various political, structural, and institutional barriers (Suazo-Galdames et al., 2025).

Another 2025 systematic review noted that the perceived importance and legitimacy of scientific evidence to stakeholders can have a profound impact on how that scientific evidence influences policymaking (Cao et al., 2025). However, an earlier paper notes the difficulty policymakers experience when trying to evaluate the legitimacy of scientific evidence due to there being multiple valid ways to evaluate legitimacy which can each lead to different conclusions (Clark et al., 1985). Sheila Jasanoff explores this idea in her book *The Fifth Branch* in which she claims that science used in government regulation is shaped by judgement, uncertainty, and stakeholder priorities (Jasanoff, 1994).

Compounding this issue, Harvard legal scholar Carl Sunstein notes that scientists themselves can reach opposing conclusions about whether a product poses certain risks to human health (Sunstein, 2002). A lack of consensus across scientific evidence has been known to disrupt the policymaking process. Both environmentalists and manufacturers have been known to use a lack of scientific consensus to stall the policymaking process, both demanding that the other side bolster their case with more compelling evidence (Wargo, 1996). Marcus Paroske, a rhetoric of science researcher at the University of Michigan, calls this phenomenon an "epistemological filibuster" (Paroske, 2009).

Gaps in evidence can also challenge the formation of evidence-based policy. This is particularly apparent in the case of DDT. Scientific evidence played an important role in the banning of DDT. However, following the publication of *Silent Spring* in 1962, even as public concerns about the safety of DDT surged, there remained a lack of consensus regarding the risks pesticides posed to human health due to insufficient epidemiological evidence, stalling regulatory action (Jasanoff, 1994; Murphy, 2017). When DDT was finally cancelled in 1972, EPA Administrator William Ruckelshaus noted that this decision was based primarily on evidence of adverse environmental effects and not human health effects which remained sparse (Dunlap, 1981). Therefore, while a lack of epidemiological data challenged the formation of evidence-based policy to regulate DDT, it did not fully prevent the formation of evidence-based policy. More recently, a lack of epidemiological data regarding the health risks of the pesticide chlorpyrifos has contributed to an ongoing conflict over whether or not to ban chlorpyrifos in the U.S. (Sellers et al., 2025).

In some cases, a single scientific study can greatly influence the EPA's regulation of a pesticide. In the 1970s, the herbicide 2,4,5-T (an active ingredient used in Agent Orange) was cancelled on the basis of a single independent study that found a correlation between spraying 2,4,5-T and increased rates of miscarriage (Jasanoff, 1994). This case also demonstrates how scientific evidence (often presumed to be entirely objective) can become controversial and how the pesticide industry will fuel controversy to protect its products. Dow Chemical, the producer of 2,4,5-T, heavily criticized the EPA for cancelling the herbicide without sufficient evidence. As public controversy grew regarding the validity of the study the EPA had used to make its decision to cancel 2,4,5-T, the EPA worked to generate additional data but could not convincingly demonstrate that low-dose environmental exposures posed significant human health risks (Jasanoff, 1994). Eventually, in 1983, the EPA cancelled 2,4,5-T for good after Dow Chemical decided it was no longer financially beneficial to keep producing this herbicide. In 2020, Ecologist Dave Goulson commented on an ongoing pattern he perceives in the regulation of pesticides in which the pesticide industry acts in favor of its own interests by constantly challenging emerging evidence of pesticides harming human health and/or the environment in order to continue selling those pesticides for as long as it is financially beneficial (Goulson, 2020).

The ongoing regulation of Roundup builds upon this tension. In the case of Roundup, it has been found that industry-collected data is often preferred by regulators to independently conducted studies (Novotny, 2022). Additionally, because the producers of Roundup have been implicated in research misconduct, which sought to hide the true relationship between exposure to Roundup and one's likelihood of developing non-Hodgkin's lymphoma, a 2021 study advised policymakers to be skeptical of the safety data presented by pesticide companies (Glenna & Bruce, 2021). Furthermore, because survey findings indicated that scientists employed by the pesticide industry often generate data that aims to financially benefit the pesticide industry, a 2023 study pointed to a continued need for more research on how the pesticide industry is able to influence the creation of evidence-based regulatory policy (Bruce et al., 2023).

With these concerns in mind and without a standardized framework to guide the use of scientific evidence in EPA policymaking, the role of scientific evidence in the EPA's regulation of pesticides should be reviewed on a case-by-case basis. At the time of writing this review, there is little, if any, research regarding the role of scientific evidence in the EPA's regulation of Dacthal. Because uncertainty remains regarding what specific sources of scientific evidence were prioritized during the EPA's regulation of Dacthal, the role of different sources of scientific evidence in this regulatory process warrants further investigation.

Objectives

To better understand how different sources of scientific evidence shaped the EPA's regulation of Dacthal, I will do the following:

1) Consistent with methods employed by the EPA to evaluate the potential health risks of pesticides, I will perform a systematic review of the independently conducted scientific studies published through October 2024 that evaluate Dacthal's potential health risks. This will allow me to determine what independently conducted scientific evidence existed during the EPA's regulation of Dacthal and thus could have potentially influenced regulation.
2) I will conduct interviews with former EPA employees.
3) I will examine what scientific evidence influenced the EPA's regulation of Dacthal by systematically reviewing EPA docket EPA-HQ-OPP-2011-0374 (which contains all of the EPA documents relevant to the regulation of Dacthal)

DATA AND METHODS

To investigate the extent to which different sources of scientific evidence shaped the EPA's regulation of Dacthal, both systematic reviews and semi-structured interviews were conducted.

Search for Independent Assessments of Dacthal's Potential Health Effects

To determine what independently conducted scientific evidence existed during the EPA's regulation of Dacthal and thus could have potentially influenced regulation, a systematic review was conducted of studies regarding Dacthal's potential human and environmental health hazards. The systematic review was conducted through the search engines PubMed and Web of Science.

Because Dacthal can be referred to by a variety of names ("Dacthal", "Dimethyl tetrachloroterephthalate", "DCPA", "chlorthal-dimethyl", and "dimethyl 2,3,5,6-tetrachlorobenzene-1,4-dicarboxylate"), each name was entered separately in each search engine to determine which ones pulled up the most relevant results. Additionally, because Dacthal was banned in 2024, a custom range was set to only include studies published through that year.

Following this preliminary search, "dimethyl 2,3,5,6-tetrachlorobenzene-1,4-dicarboxylate" was excluded as a keyword because it retrieved articles regarding molecular crystal structure rather than health hazards. "Dimethyl tetrachloroterephthalate" was also excluded because it was most often paired with either DCPA or Dacthal within studies. Additionally, this potential keyword was not associated with studies about health. Instead, it focused on the function of Dacthal as a weed killer. Studies that examined the health risks of this pesticide also contained the keywords “Dacthal” or “DCPA”, making the potential keyword “Dimethyl tetrachloroterephthalate” redundant. “Chlorthal-dimethyl” was kept because it is not always used in combination with “Dacthal” and retrieves some relevant results to risk assessment, particularly for international studies. “DCPA” was excluded because it is often used with “Dacthal” and most results retrieved by this keyword are not relevant to this thesis. It also often refers to other herbicides besides Dacthal such as 2,4-DCPA and 3,4-dichlorpropionanilide (DCPA).

The keywords “Dacthal” and “chlorthal-dimethyl” were then used to perform searches on both PubMed and Web of Science. The keywords were joined with the Boolean operator “OR” and the date range was set to retrieve studies published through 10/22/2024 (the day the EPA finalized the cancellation of Dacthal). The studies retrieved through this process were then exported to Excel, screened for duplicates via Excel, and then screened for inclusion in accordance with the criteria listed in Table 3.

Table 3. Inclusion and Exclusion Criteria For Dacthal Studies

Inclusion Criteria	Exclusion Criteria
The study must be focused on testing Dacthal which can be referred to by a variety of names, such as: “Dacthal”, “Dimethyl tetrachloroterephthalate”, “DCPA”, “chlorthal-dimethyl”, and “dimethyl 2,3,5,6-tetrachlorobenzene-1,4-dicarboxylate”	The study does not concern Dacthal
The study must be primarily concerned with assessing or measuring human and/or animal and/or environmental health hazards (including environmental accumulation and/or residues) associated with exposure to Dacthal	The study mentions Dacthal but does not specifically test or measure its human and/or animal and/or environmental health impacts; for example, the study focuses on other properties of Dacthal, such as molecular

	structure, or the study is primarily concerned with evaluating a method for assessing Dacthal and not with the assessment of Dacthal itself, or the study focus solely on Dacthal's effects on target organisms (weeds, pests)
The study must be peer-reviewed and published in a peer-reviewed scientific journal	The document is not a peer-reviewed study but is instead a brief, policy, book chapter, thesis, or dissertation
The study must be in English	An English translation of the study is not available
The study must be accessible through open-access or through CU Boulder	The study is not accessible through open-access or through CU Boulder
The study must have been published prior to the final cancellation of Dacthal in October, 2024	The study was published after the final cancellation of Dacthal in October, 2024

Data Extraction and Analysis

Studies that were selected for inclusion were organized in an Excel sheet (Appendix). The contents of relevant studies were reviewed to determine their assessment of Dacthal's potential health hazards. Collectively, the documents were evaluated as representing the relevant independent scientific data available during the EPA's regulation of Dacthal. Then, studies were sorted into one of two categories: human/animal health effects of Dacthal exposure or environmental health effects of Dacthal exposure.

Analyzing the Role of Different Sources of Scientific Evidence in the EPA's Regulation of Dacthal

To assess the extent to which independently collected scientific data influenced the EPA's decision to ban Dacthal, a systematic review of all of the EPA documents relevant to the banning of Dacthal was conducted. The documents were accessed through the website Regulations.gov and under the docket title EPA-HQ-OPP-2011-0374. This docket contained 119 documents; the first was posted on June 29, 2011.

The full text of each document was reviewed following the READ document analysis approach —a systematic approach to document analysis in which R stands for "ready your materials," E stands for "extract data," A stands for "analyze data," and D stands for "distil your findings" (Dalglish et al., 2020, p. 1). Explicit references to scientific data during the regulatory process were recorded as either belonging to an independently conducted study of Dacthal's health effects, AMVAC's safety data set, or a study performed to assess the safety of a chemical similar to Dacthal in accordance with the criteria described in Appendix Figure A1.

During docket review, key events in the regulatory process were identified using Table 2 as a general framework, and the scientific evidence cited during those events was recorded.

The methodology of linking evidence to key events with the goal of understanding how this evidence influenced the outcomes of these events is called *process tracing*. Originally adapted from cognitive psychology practices by political scientist Alexander L. George, process tracing is defined as being the analysis of event sequences within a case to evaluate potential causal mechanisms (Bennett & Checkel, 2014). It is commonly used to analyze case-specific qualitative data (Collier, 2011). Different variations of process tracing exist. The specific variant used in this study was explaining-outcome process-tracing. According to political science professors Derek Beach and Rasmus Brun Pedersen, the goal of explaining-outcome process-tracing is to explain the causes of a specific outcome within a specific case (Beach &

Pedersen, 2013). Process tracing was employed in this study because it provides a case-oriented framework for systematically assessing specific events in which scientific data was used in order to determine who it was used by and what outcomes resulted from its use.

Interviewing EPA Employees to Assess Their Perspectives

To provide firsthand perspectives that could contextualize the systematic review, a selection of EPA employees with public facing email addresses within Headquarters Leadership for EPA Pesticide Program were contacted to participate in semi-structured interviews in accordance with an IRB-approved protocol (Protocol # 25-0509). All declined to participate.

Interviewing Former EPA Employees to Assess Their Perspectives

Five former EPA employees were contacted through the Environmental Protection Network (EPN), a non-profit made up of former EPA employees who provide pro bono environmental policy analysis services ("About EPN," 2026). These former EPA employees were invited to participate in semi-structured interviews in accordance with an IRB-approved protocol (Protocol # 25-0509). Interviews were held over Zoom. Topics discussed during the interviews include the process of regulating and cancelling pesticides, the role of science in this process, and the role of science in the regulation of Dacthal (Appendix Figure A2). After each interview, responses were transcribed and de-identified. The responses were reviewed and analyzed for recurring themes and/or patterns within and between participants.

Triangulating the Findings

Responses from the interviews were then used to contextualize the systematic review findings via *data triangulation*. Data triangulation is when multiple sources of qualitative data are brought together to study the same phenomenon, thereby enhancing the quality and comprehensiveness of the research (Patton, 1999; Carter et al., 2014). By triangulating the systematic review findings with the responses shared by former EPA employees, scientific evidence could be connected to specific outcomes during the EPA's regulation of Dacthal, bolstered by the testimony of former EPA employees.

RESULTS

To better understand how different sources of scientific evidence shaped the EPA's regulation of Dacthal, I first conducted a systematic review of the independently conducted scientific studies that evaluate Dacthal's potential health risks before systematically reviewing EPA docket EPA-HQ-OPP-2011-0374 and interviewing five former EPA employees to discuss the role of science in the EPA's regulation of pesticides like Dacthal. The results of this study are organized in two main sections. The first section details my findings from the systematic review of the independently conducted scientific studies that evaluate Dacthal's potential health risks (summarized in Table 4). These findings are organized thematically. The second section details my findings from the systematic review of EPA docket EPA-HQ-OPP-2011-0374, and the results in this section are coupled with my findings from interviewing former EPA employees. These findings are organized chronologically, using the timeline structure outlined in Table 2 as a guide.

Reviewing the independently collected data that could have influenced the EPA's regulation of Dacthal

Of the 255 studies originally identified through PubMed and Web of Science, 66 were selected for inclusion (Figure 3). These studies were published from 1966 through 2024 with peaks in publications occurring in 2007, 2008, and 2010 (Figure 4). Studies selected for inclusion were then sorted into one of two categories: human/animal health effects of Dacthal exposure or environmental health effects of Dacthal exposure; 20 were categorized as human/animal health effect studies and 46 were categorized as environmental health effect studies (Figure 5). In order for a study to be categorized as an environmental study, the primary focus of the study had to be on assessing/measuring the environmental health hazards (including environmental accumulation and/or residues) associated with exposure to Dacthal; In order for a study to be categorized as a human/animal study, the primary focus of the study had to be on assessing or measuring human and/or animal health effects associated with exposure to Dacthal (as described in Table 3). A list of the studies included in this review can be found in the Appendix (Figure A3).

Figure 3. PRISMA diagram depicting the selection of relevant independently conducted Dacthal studies.

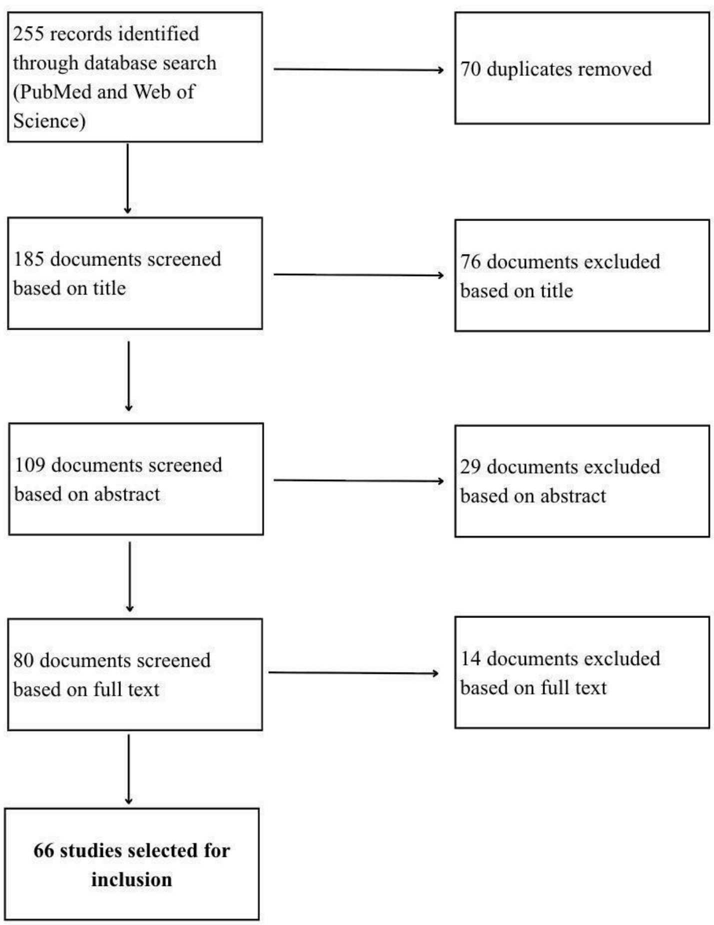


Figure 4. The number of independently conducted studies evaluating Dacthal's potential health hazards published per year (1966-2024).

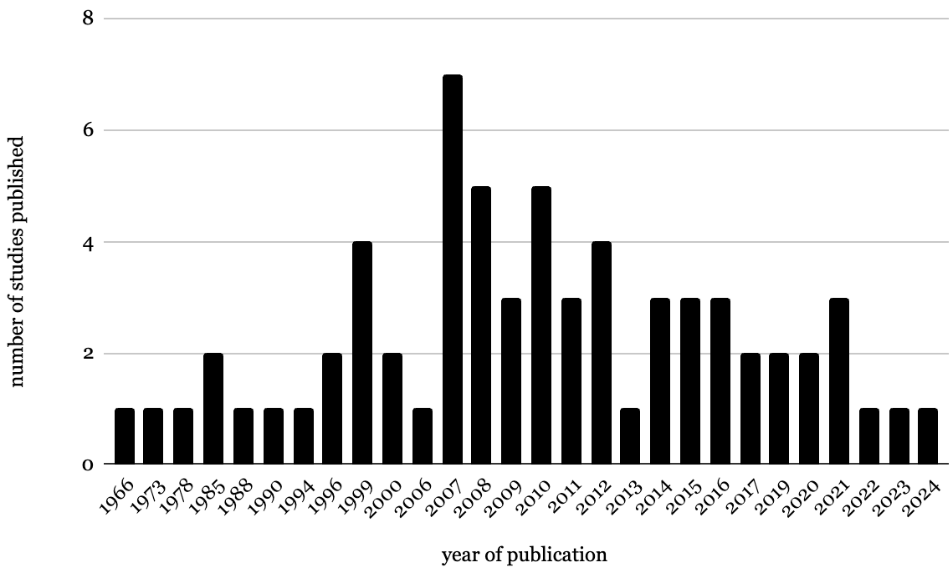
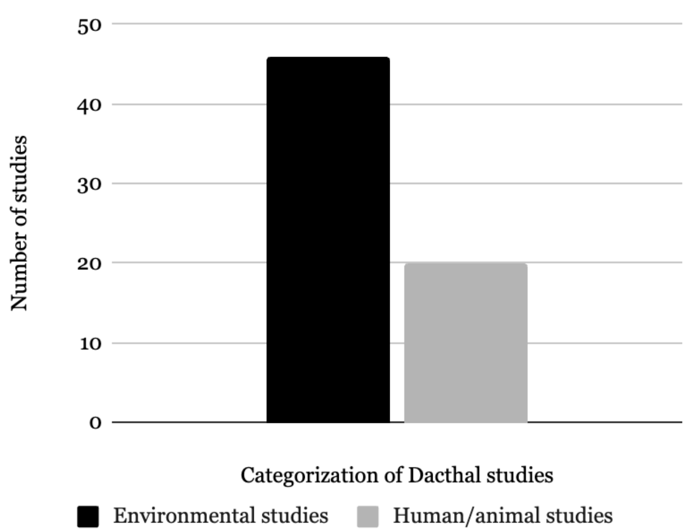


Figure 5. Studies investigating the environmental and human/animal effects of Dacthal exposure



Environmental Studies

The environmental studies reviewed can be further broken down into subcategories depending on the specific part of the environment Dacthal was detected in. The subcategories are: crops/vegetation, air/atmosphere, water/precipitation, sites of air/water interaction, broader environment and soil, and house dust. The locations around the world where Dacthal has been detected via independently conducted studies are illustrated in Figure 6.

Dacthal was measured in crops/vegetation

In 1974, strawberries were treated with Dacthal and analyzed for residues of the pesticide via electron capture, and it was found that the residues on the strawberries were below established tolerances of 2 ppm which the researchers reported reflected the relative "safety and effectiveness" of the pesticide (Waldron, 1974, p. 1). Several years later, Dacthal residues were measured on carrots, and researchers reported that residues detected on the carrots were linked to application rate of the pesticide and Dacthal metabolites were rarely detected on these crops (Gilbert & Lisk, 1978). Ten years later, researchers applied Dacthal to Chinese cabbage (bok choi) and found that while residues were low overall on this crop, they were lowest on cabbages that had reached maturity compared to cabbages that had not yet reached maturity (Sweet et al., 1988). Dacthal residues were detected in samples of rice taken from Eastern India, leading researchers to suggest ongoing efforts to reduce or eliminate pesticide contamination in food sources (Bhoi et al., 2022).

Dacthal was detected in the air/atmosphere

In 2000, Dacthal was detected in 100% of samples taken at a site on the shore of Lake Superior that was reported to be well-distanced from agricultural areas (without noting the actual distance), suggesting Dacthal has potential for long-range atmospheric transport (Foreman et al., 2000). Eight years later, it was reported that concentrations of Dacthal up to 352 pg/m3 were detected in air masses at Oregon's Mt. Bachelor Observatory and that these increased concentrations were significantly associated with increased air mass time in agricultural areas of the Pacific Northwest (Primbs et al., 2008). Note that an air mass is characterized as a large body of air with uniform temperature and humidity and air mass time refers to the amount of time that air mass lingers over a particular region; often, the longer an air mass remains in one space, the more characteristics the air mass will then adopt from that region. Dacthal was also detected in the atmosphere in southern Ontario at relatively high concentrations (Yao et al., 2006). On the other side of the world, Dacthal was detected in Saharan dust air masses across West Africa, Cape Verde, and the eastern Caribbean (Garrison et al., 2014).

Dacthal was detected in water/precipitation

In 1994, it was reported that Dacthal had been detected in sediment in the Mississippi River (Rostad et al., 1994). Dacthal was detected in a small agricultural watershed in Manitoba, Canada despite not being used in the surrounding region, suggesting that the detected levels of this pesticide were due to long-range transport (Rawn & Muir, 1999). That same year, it was reported that relatively high concentrations of Dacthal were detected in precipitation samples taken around the Great Lakes (James & Hites, 1999). Additionally, it was reported that Dacthal had once again been detected in Mississippi River sediment (Rostad et al., 1999). Dacthal was detected in 53% of weekly precipitation samples taken from a site on the shore of Lake Superior (in Eagle Harbor, MI) and 22% of weekly precipitation samples taken along the Mississippi River at an average concentration of 0.09 $\mu g/m^2$ (Majewski et al., 2000). In 2003, Dacthal was "frequently detected" in 12/14 snowpack samples taken from national parks in the western United States at concentrations ranging from 0.0039 mg/L to 5.3 ng/L (Hageman et al., 2006). Dacthal was "frequently detected" in all nine rain samples and 23/25 snow samples taken from national parks in the Western United States at concentrations ranging from 3.0 to 9.3 ng/L and 0.27 to 2.2 ng/L, respectively (Mast et al., 2007). Relative to other current-use pesticides like Diazinon and permethrin, Dacthal was more frequently detected in the sediment of rivers that feed into California's Salton Sea Basin, particularly during the fall which matched prior seasonal use patterns as Dacthal is more commonly applied in the fall than in other seasons (LeBlanc & Kuivila, 2008). Dacthal was commonly detected (over 50% of the time) in rainfall samples taken in agricultural areas of Maryland, Indiana, Nebraska, and California (Vogel et al., 2008). Dacthal was measured at relatively low concentration levels (<1 ng/L) in four alpine lakes in California's southern Sierra Nevada mountains (Bradford et al., 2010). Dacthal was detected in the core of a major ice field in Svalbard, Norway known as Holtedahlfonna (Rugirello et al., 2010). Dacthal was detected in snowpack samples taken from eight different national parks in the Western United States from 2003-2005 (Hageman et al., 2010). Dacthal was "frequently detected" in samples taken from the Devon Ice Cap in Nunavut, Canada with concentrations ranging from 3-40 pg/L (Zhang et al., 2013). Dacthal was detected at equilibrium concentrations of 0.19 ± 0.15 pg L^{-1}, meaning there was very low net deposition of this pesticide, in China's Bohai and Yellow Seas and this was reported to be reflective of its low consumption levels in surrounding areas (Zhong et al., 2013). The next year, it was reported that Dacthal had been detected in 17% of sediment samples taken from China's Bohai and Yellow Seas (Zhong et al., 2014). It was reported that Dacthal (among other pesticides) was being delivered to Arctic melt ponds with the help of sea ice (Pućko et al., 2015). Dacthal was detected in 8 out of 11 precipitation samples taken from the environment surrounding Lake Victoria in East Africa (Arinaitwe et al., 2016). Dacthal was detected in 100% of water samples taken from New Zealand's Lake Brewster which is known to be fed by alpine glaciers (Wu et al., 2017). Dacthal was detected at relatively high levels (concentration of 95 ± 71 pg L^{-1}) in melt ponds in the Canadian Arctic (Pućko et al., 2017). Dacthal was reported to be below method detection limits in most samples taken from the North Pacific and Arctic Oceans (Gao et al., 2019). Dacthal was detected in relatively low levels in the surface waters of Shanghai, China (Chen et al., 2020). Water samples taken from South Africa's Roodeplaat Dam tested positive for Dacthal (Barnhoorn & van Dyk, 2020).

Dacthal was detected at sites of air/water interaction

Dacthal was detected in all oceanic air samples collected by researchers examining air-sea exchange of current-use pesticides in East Asia and the Arctic Ocean with the highest levels (>100 pg/m3) being measured in the Sea of Japan (Zhong et al., 2011). Dacthal was detected in relatively low levels in both the air and seawater of the North Sea in spring and summer of 2010 which researchers hypothesized could be due to Europe phasing out the use of this herbicide (Zhong et al., 2012). Dacthal was detected in both the air and water of the Western Arctic Ocean between 1993 and 2013 (Jantunen et al., 2015).

Dacthal was detected in the broader environment and soil

Dacthal was detected in the air and soil of mountainous regions in western Canada (Daly et al., 2007). It was reported that Dacthal demonstrated high persistence in soils (half life of

154.38 ± 13.20 days for sterilized soil and 24.58 ± 1.71 days for fertilized soil) after researchers studied the behavior of Dacthal in soil samples taken from Southeast Spain (Melgar et al., 2009). Dacthal was detected in plant and animal life across the Arctic (Hoferkamp et al., 2010). Dacthal was detected in precipitation, lake sediment, and lichen/zooplankton samples taken from California's Yosemite National Park (Mast et al., 2012). Dacthal was detected at "elevated concentrations" from the surface of the Barva and Poas volcanoes in the Caribbean, suggesting that the pesticide was transported through the atmosphere from nearby banana plantations (Daly, 2007).

Dacthal was detected in house dust

Dacthal was detected in the homes of people living in Salinas Valley, California (Bradman et al., 2006). A few years later, an additional study found that Dacthal was only being detected in the homes of farmworkers in California, linking this contamination to agricultural applications of the pesticide (Quirós-Alcalá et al., 2011). That same year, it was reported that levels of Dacthal detected in carpet dust were higher in residences located near areas with frequent agricultural applications of Dacthal (Gunier et al., 2011). And in 2024, it was found that agricultural applications of Dacthal increased the likelihood of detecting Dacthal in California homes 5-10 times (Madrigal et al., 2024).

Figure 6. Locations where Dacthal has been detected around the world via independently conducted studies.

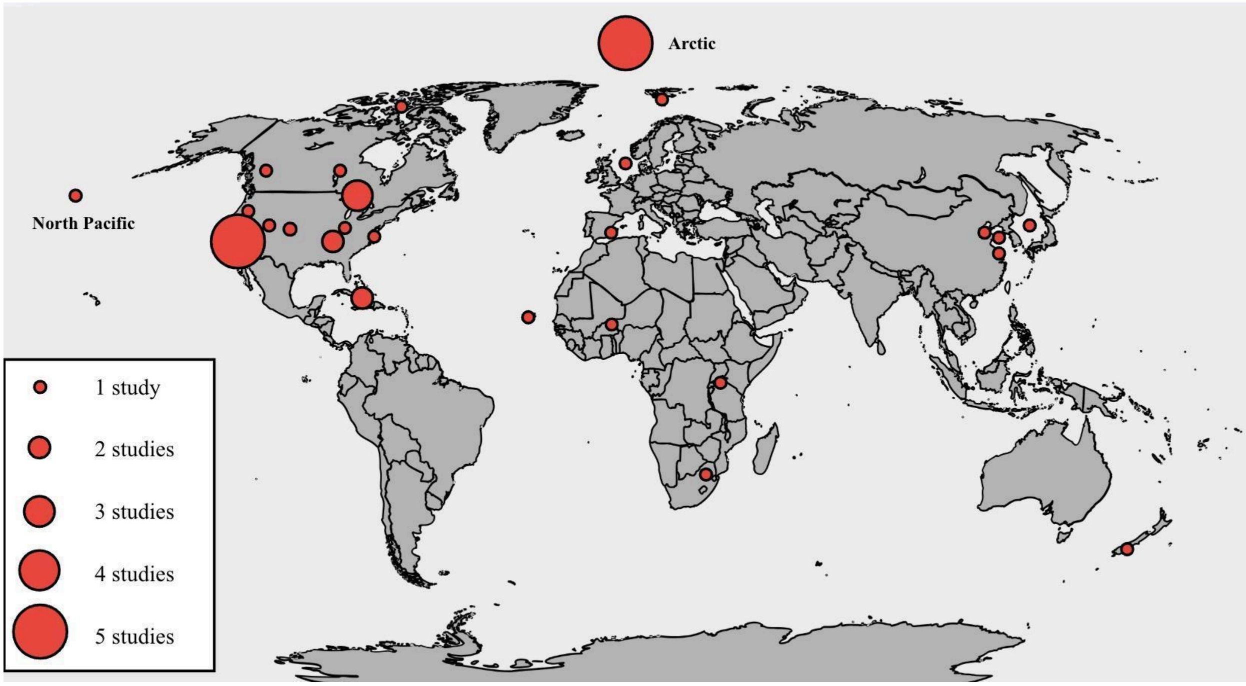
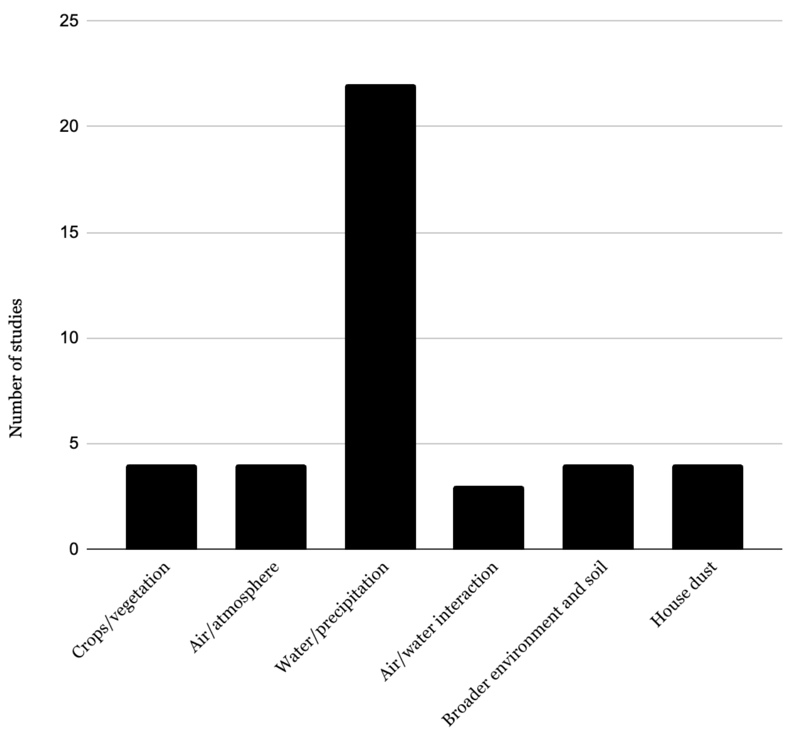


Figure 7. Number of independently conducted studies in each environmental subcategory.



Animal Studies

Overall, 16 studies examined how Dacthal accumulates in animals, and 10 of these studies examined how Dacthal accumulates in fish.

Dacthal was detected in fish

Dacthal was measured in finfish from Maryland waters from 1976–1980 and all levels were within the U.S. Food and Drug Administration guidelines (Eisenberg & Topping, 1985). From 1980-1981, very small amounts of Dacthal were detected in US freshwater fish as part of the National Pesticides Monitoring Program (Schmitt et al., 1985). A study published in 1990 again revealed that very low concentrations of Dacthal were measured in freshwater fish across the US from 1976-1984 as part of the National Contaminant Biomonitoring Program (NCBP) (Schmitt et al., 1990). From 1992-1993, Dacthal was detected in fish tissue at more than 25% of sites in America's South Platte River Basin (Tate & Heiny, 1996). A 1999 study found that while concentrations of Dacthal in U.S. freshwater fish remained low, incidence of detecting Dacthal in the tissue of freshwater fish had increased from only 46% of samples in 1984 to 61% in 1986 (Schmitt et al., 1999). Dacthal was frequently detected in fish from the Gila River at concentration levels > 0.0005 μg/g) in 24 of 48 samples taken; researchers described these concentrations as relatively high but noted that aquatic toxicity thresholds for Dacthal were not available (Hinck et al., 2007). From 1995-2004, Dacthal was detected in both carp and bass in large U.S. rivers; however, researchers could not determine if this pesticide or other pesticides measured in these fish were the cause of various health problems like ovarian tumors and intersex traits (Hinck et al., 2008). Around the same time, it was found that there were generally low levels of Dacthal in fish in large U.S. river basins across the country (Dacthal = 46/135 above detection threshold) (Hinck et al., 2009). Around 10 years later, Dacthal was found in the muscle tissue of Oreochromis mossambicus and Clarias gariepinus fish in South Africa's Roodeplaat Dam (Barnhoorn & van Dyk, 2020). Dacthal was detected at relatively low concentrations in polar cod sampled from Greenland's Bessel Fjord and no significant correlation was found between pesticide concentration levels in the polar cod and any morphological traits (Spataro et al., 2021).

Dacthal was detected/measured in other animals

A Holstein cow was fed Dacthal at the 5-ppm level for four days, and no Dacthal residues were detected in the milk of this cow (Gutenmann & Lisk, 1966). Over thirty years later, a study reported that "the observed rodent carcinogenicity of Dacthal is probably due to its impurities" as opposed to any innate characteristics of the pesticide itself (Klopman et al., 1996, p. 83). Around 10 years later, Dacthal was detected in osprey eggs, suggesting that Dacthal can accumulate in these birds and their eggs via the food chain (Chu et al, 2007); osprey are fish-eating birds of prey. Dacthal was one of the most "frequently detected" residues in Cascades frogs; however, there is no evidence that Dacthal contributed to the decline of Cascades frogs in northern California (Davidson et al., 2012). Relatively high concentrations of Dacthal were detected in the vegetation-caribou-wolf food chain in the Bathurst region of northern Canada (Morris et al., 2014). Two years later, it was found that Dacthal had the largest biomagnification factor compared to endosulfans, chlorothalonil, chlorpyrifos, and pentachloronitrobenzene measured in the capelin:plankton trophic relationship in northern Canada; this indicates that Dacthal enters the arctic food chain through algae and plankton before reaching higher-level organisms like fish, thereby exposing a variety of arctic organisms to this contaminant (Morris et al., 2016). In

2023, it was reported that Dacthal had been detected in European eels (*Anguilla anguilla*) sampled from a Mediterranean hypersaline coastal lagoon for the first time (Martínez-Gómez et al., 2023).

Human Studies

Two studies examined Dacthal concentrations in pregnant women and newborn babies. One of these studies found that within the 8% of maternal serum samples in which Dacthal was detected and the 29.1% of umbilical cord samples in which Dactal was detected, there were relatively high concentrations of Dacthal in maternal serum (mean = 3.73 ng/ml) and umbilical cord serum (mean = 2.06 ng/g) compared to other pesticides; however, there was not a statistically significant relationship between the concentration levels of Dacthal and birth weight, head circumference, abdominal circumference, or birth length of the newborn babies (Barr, et al., 2010). Another study found that pregnant women who used Dacthal in their homes tended to have higher maternal serum and umbilical cord serum concentrations of Dacthal; however, no birth defects were associated with these higher pesticide levels (Yan et al., 2009). Relatively low concentrations of Dacthal were measured in the breastmilk of women living in both rural and urban parts of California compared to the levels of other pesticides (Weldon et al., 2011). And in a study which used silicone wristbands to measure pesticide exposure among young Latina girls in California farming communities, Dacthal was among the most frequently detected pesticides in the wristbands and that participants who lived closer to agricultural fields tended to have higher levels of Dacthal in their wristbands (Harley et al., 2019).

A study published in 2016 found that exposure to Dacthal was associated with a decreased likelihood of developing ALS (OR=0.34) (Klopman et al., 1996). Two studies published in 2021 found an association between Dacthal exposure and an increased risk of childhood leukemia (Wheeler et al., 2021; Wheeler et al., 2021). None of the studies examined a link between Dacthal and thyroid toxicity.

Summary of the independently collected data that could have influenced the EPA's regulation of Dacthal

Independent studies published through 2024 addressed both human/animal and environmental health hazards of Dacthal, focusing primarily on the accumulation of the herbicide in various organisms and environments. Dacthal was detected in a variety of environmental mediums around the world, primarily in the Northern Hemisphere. The presence of Dacthal residues in animals was not linked to the occurrence of any adverse health effects. Two studies published in 2021 found an association between Dacthal exposure and an increased risk of childhood leukemia (Wheeler et al., 2021; Wheeler et al., 2021). None of the studies examined a link between Dacthal and thyroid toxicity (Table 4).

Table 4. Percent of independently conducted studies that detected Dacthal, linked Dacthal to an adverse health outcome, and linked Dacthal to thyroid toxicity.

Type of study	**Category**	**% of studies that detected Dacthal**	**% of studies that linked Dacthal to an adverse health outcome**	**% of studies that linked Dacthal to thyroid toxicity**
Environmental studies	Crops/vegetation	100%	0%	0%
	Air/atmosphere	100%	0%	0%
	Water/precipitation	100%	0%	0%
	Air/water interaction	100%	0%	0%

	Broader environment and soil	100%	0%	0%
	House dust	100%	0%	0%
Human/animal studies	Animals	100%	0%	0%
	Humans	100%	66%	0%

Analyzing the Role of Different Sources of Scientific Evidence in the EPA's Regulation of Dacthal

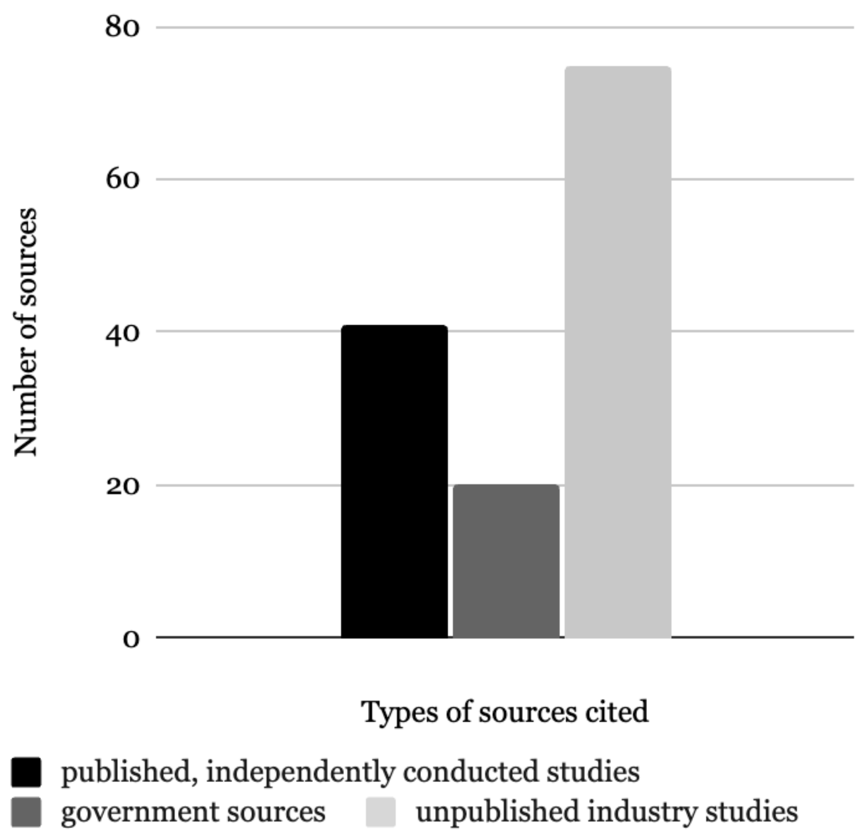
After determining what independently conducted scientific evidence existed during the EPA's regulation of Dacthal and thus could have potentially influenced regulation, I examined the extent to which independently conducted scientific studies and safety data generated by AMVAC influenced the EPA's regulation of Dacthal by analyzing EPA docket EPA-HQ-OPP-2011-0374 (Appendix Figure A4) and conducting interviews with former EPA employees. I organized my findings based on the steps outlined in Table 2 with a few deviations that will be further described later in this section.

Independently conducted studies were cited in the EPA's Preliminary Work Plan

Within the EPA docket, the EPA's Preliminary Work Plan is illustrated in the document "May 31, 2011 - Registration Review – Preliminary Problem Formulation for the Ecological Risk Assessment of Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA)." This preliminary work plan details the EPA's plan for reviewing the potential health hazards of Dacthal in accordance with the Food Quality Protection Act of 1996 and FIFRA. If independently conducted scientific evidence and AMVAC safety data shaped this step, we would see citations from both types of sources throughout this document.

Throughout this document, the EPA references 136 sources, of which 75 are unpublished studies supplied by companies such as SDS Biotech Corp and Diamond Shamrock Agricultural Chemicals and 41 are published, peer-reviewed, independently conducted studies (Figure 8). The EPA does not reference any data provided by AMVAC.

Figure 8. Types of sources cited during the EPA's Preliminary Work Plan Phase for Dacthal



The EPA summarizes ecological toxicity studies the agency required following its 1998 Reregistration Eligibility Decision for Dacthal which included a dietary study with mallard ducks, an avian reproduction study using the mallard duck and bobwhite quail, and vegetative vigor and seedling emergence studies. According to the EPA, a company called Ricerca, Inc.

submitted the dietary study with mallard ducks and the company Wildlife International Ltd. submitted avian reproduction studies using the mallard duck and bobwhite quail. These studies are unpublished. Ricerca Inc. also supplied vegetative vigor and seedling emergence studies; however, the EPA notes that because these studies do not supply sufficient evidence to satisfy the agency's data requirements, these are considered to be gaps in the literature either because data were missing or limited. In the document "May 31, 2011 - Registration Review – Preliminary Problem Formulation for the Ecological Risk Assessment of Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA)," the EPA provided the following summary of these data gaps:

> "No aquatic chronic studies have been submitted for DCPA. DCPA is relatively persistent in the environment and has a tendency to bioaccumulate in aquatic organisms. Therefore, availability of chronic studies using DCPA is important to an ecological risk assessment. In addition, a number of the aquatic studies that were formerly considered to be acceptable have been downgraded to unacceptable because of evidence that the test substance was not fully dissolved and no measurements were made to confirm test concentrations. Additional acute aquatic studies were downgraded from acceptable to supplemental, due to the failure to centrifuge the measured concentrations. The chemical properties of DCPA indicate that although the test concentrations were measured, without centrifugation the dissolved soluble test concentrations could not be estimated" (p. 2).

Interview participants reported that the EPA usually conducts a literature review early on in the pesticide reregistration process to identify research gaps. For example, a former deputy office director of the EPA's pesticide program, whom I will refer to as Former Employee B, stated the following:

> *"When EPA conducts a registration review, they go through a series of steps. The first of which is a problem formulation step,* where they say, 'where are the data gaps that we have with regard to this chemical?*' And as part of that exercise, they will do a literature search and identify studies that have been conducted by people who are not registrants." (Former Employee B)*

Building upon this, a former EPA employee, who worked in Research and Development at the EPA before transitioning to Risk Assessment, whom I will refer to as Former Employee J, said:

> *"The EPA will look at all information that's available: what is publicly available as well as information that's been submitted to the agency confidentially. A lot of the information from the registrar is submitted under confidential business information. What makes it confidential is not necessarily the study or the results, but it's the chemical formulation of the pesticide, because they want to protect their interest in being able to manufacture and sell that particular pesticide." (Former Employee J)*

According to another former EPA employee, whom I will refer to as Former Employee P, the EPA began integrating this process into the registration renewal process for pesticides within the last 20 years as the agency became "more systematic about screening the outside literature."

Together, this evidence confirms that the EPA used both independently-collected and industry-supplied scientific evidence during the creation of the Preliminary Work Plan for regulating Dacthal and offers strong support that the EPA did not rely on AMVAC safety data during this step.

Independently conducted studies were referenced in the EPA's Final Work Plan

Within the EPA docket, the EPA's Final Work Plan for Dacthal is illustrated in the document "11/20/2011 DCPA Final Work Plan Registration Review." The Final Work Plan details the literature gaps identified in the Preliminary Work Plan regarding Dacthal's potential health hazards. In accordance with the timeline shown in Table 2, the Final Work Plan was created and published after a public comment period. In this case, the public comment period was 60 days, and the EPA did not receive any comments during that time to influence the creation of the Final Work Plan.

Based upon the gaps in the literature identified in the Preliminary Work Plan, the EPA identified 49 data requirements for Dacthal (27 for Dacthal itself and 22 for Dacthal's metabolite TPA), including a "Comparative Thyroid study" denoted in the document as being a "Special Study" (p. 11). In this document, the EPA did not indicate who would be responsible for providing this data. Additionally, the EPA also reported that the agency was required to subject Dacthal to the Endocrine Disruptor Screening Program (EDSP).

The EPA's Data Call-In was based on its review of independently conducted studies

Within the EPA docket, the EPA's issuance of a Data Call-In for Dacthal is illustrated in the document "DCPA Generic Data Call In (GDCI-078701-1140)" which was published to the docket on July 3, 2013, nearly two years after the publication of the agency's Final Work Plan. The Data Call-In is a document in which the EPA details all of its data requests for the pesticide under review and identifies the entity responsible for fulfilling these data requests. If independently conducted scientific evidence and AMVAC safety data were requested during this step, we would see requests for additional data from both AMVAC and independent institutions.

On page 40 of the document DCPA Generic Data Call In (GDCI-078701-1140), the EPA provides a list of all registrants sent this data call-in and lists AMVAC Chemical Corporation as the sole recipient. In this Data Call-In, the EPA requested that AMVAC submit 35 studies related to Dacthal's safety, one of which being a comparative thyroid toxicity study with 24 months allotted by the agency for AMVAC to submit that particular study.

Interview respondents reported that the EPA often turns to the registrant to supply studies that fulfill the agency's data requirements due to the high cost of performing the studies and a lack of funding for independent researchers to perform these studies. For example, Former Employee J stated the following:

> *"The main avenues are that the EPA would go to the registrant, or they could potentially go within ORD [Office of Research and Development]. There's other federal organizations too that conduct research: the Department of Agriculture, Department of Interior, Department of Health and Human Services. So there's a variety of options within the government or with industry, and then also looking to see who's doing what elsewhere around the world. Because academia, you know, they won't do research unless they get a grant to support that." (Former Employee J)*

Another former EPA employee who worked for the agency's Pesticides Office as a political appointee until 2024, whom I will refer to as Former Employee L, stated the following:

> *"If you think about it, what would be the incentive for a university or an NGO to perform very expensive studies? It's a real barrier, right? And thyroid studies are actually quite expensive to do." (Former Employee L)*

A former EPA employee with years of experience in the agency's National Water Program and Superfund Program, whom I will refer to as Former Employee D, further contextualized the lack of funding for independent research entities by stating the following:

> *"But who's going to fund a study of pollutants that we're already being exposed to? We're breathing them, we're drinking them, we're eating them. Why study that? I mean, what are you going to do? The only thing that would come out of that would be to try to ban or restrict or control somehow the exposures to that chemical. And nobody makes money off of that. So there's no one other than the federal government who would have the public health interests to fund such a study." (Former Employee D)*

The EPA received the safety data it requested from AMVAC following the Data Call-In

As a result of the EPA's Data Call-In, AMVAC submitted some of the requested data which the EPA posted public evaluations of, beginning in 2015 (Figure 9). On September 11, 2015, the EPA posted a document titled "DCPA Data Evaluation Records (DERs) for EDSP Tier 1 Assays." This document detailed the results of 11 EDSP Tier 1 assays for Dacthal. Each assay was sponsored by AMVAC, meaning that AMVAC supplied the funding for each assay, making this an industry supplied study. During the interview process, Former Employee P responded that one of the key factors that likely prompted the EPA to cancel Dacthal was running the EDSP.

On April 28, 2022, the EPA posted 24 documents to the docket detailing the agency's review and evaluation of the data provided by AMVAC (Figure 9). In addition to a Comparative Thyroid Assay Range-Finding Study, AMVAC submitted data related to the potential toxicity of Dacthal (and its metabolites) to algae (*Anabaena flos-aquae, Navicula pelliculosa, Pseudokirchneriella subcapitata, Skeletonema costatum*), freshwater invertebrates (*Daphnia Magna, Hyalella azteca, Chironomus dilutus*), marine mollusks, Mysid shrimp, Terrestrial Vascular Plants (seedling emergence and vegetative vigor), Aquatic Vascular Plants, fish (*Cyprinodon variegatus, Oncorhynchus mykiss*), and Zebra Finch.

As noted in Table 1, the EPA issued a Notice of Intent to suspend Dacthal based on AMVAC's failure to submit all of the requested safety data. This document is titled "Suspension of Registration of Pesticide Product (EPA Registration Number 5481- 495) for Failure to Comply with the Data Call-In (GDCI-078701-1140, issued January 31, 2013)" and was published to the EPA docket on April 28, 2022.

On April 29, 2022, the EPA posted a document to the docket titled "DCPA. A Review of the Existing Thyroid Toxicity Data and Residual Uncertainty Related to the Lack of a Definitive Comparative Thyroid Assay." In this document, the EPA explained that the data submitted by AMVAC up to that point was insufficient to evaluate Dacthal's potential health hazards and stated the following:

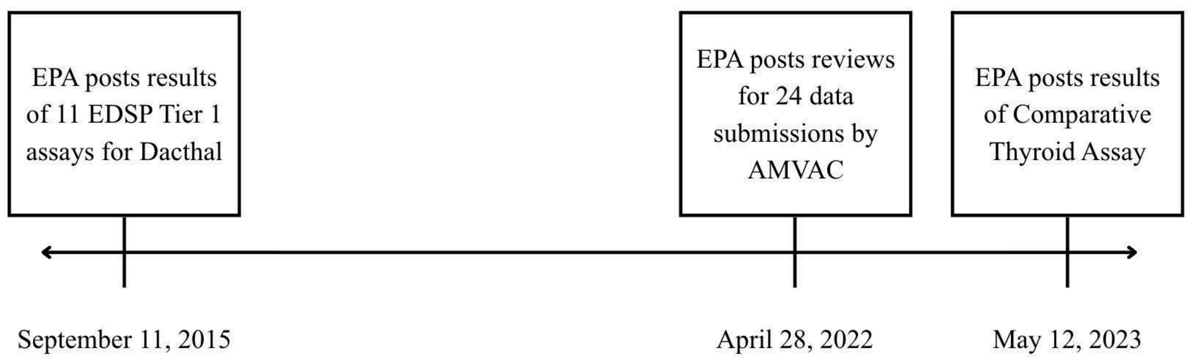
> "In 2011, HED identified the CTA as a data gap and affirmed its 2002 recommendation that the study be required (D386637, C. Olinger, 27- MAY-2011). Furthermore, the Endocrine Disruptor Screening Program (EDSP) Tier I Assay Weight of Evidence Review Committee (T1WoERC) of the Office of Pesticide Programs (OPP) and the Office of Science Coordination and Policy (OSCP) concluded based on a weight-of evidence (WoE) approach that DCPA demonstrated a potential for interaction with the thyroid hormone pathway and recommended that the registrant conduct a CTA."

In other words, the EPA noted that the results of the EDSP Tier 1 assays for Dacthal provided evidence that Dacthal might impact the thyroid hormone pathway; therefore, the EPA needed AMVAC to perform a Comparative Thyroid Assay (CTA) to determine Dacthal's actual effects on thyroid hormones.

On May 12, 2023, the EPA posted a document titled "DCPA Data Evaluation Record of a submitted definitive study to fulfill the Comparative Thyroid Assay study requirement MRID No. 51957801" (Figure 9) This document detailed the results of a CTA, sponsored by AMVAC, in which female Sprague-Dawley rats were orally administered Dacthal. According to the results listed in this document, the fetal offspring of these rats that were exposed to ≥1 mg/kg/day of Dacthal beginning at gestational day 20 exhibited a 35-52% decrease in the thyroid hormone triiodothyronine (T3) and a 29-66% decrease in the thyroid hormone thyroxine (T4). According to the EPA, "These changes in T3 and T4 were considered adverse" (p. 5). Based upon these results, the EPA established a developmental Lowest-Observed-Adverse-Effect Level (LOAEL) of 1 mg/kg/day and a No Observed Adverse Effect Level (NOAEL) of 0.1 mg/kg/day (p. 5).

These AMVAC-sponsored (industry supplied) results were reviewed by two EPA employees: JohnPatrick Rogers (Risk Assessment Branch VII, Health Effects Division) and Krystle Yozzo (Risk Assessment Branch III, Health Effects Division). The study was classified as acceptable and therefore fulfilling the EPA's CTA requirement from AMVAC.

Figure 9. Timeline of When the EPA Reviewed Dacthal Safety Data Supplied by AMVAC.



Regarding the EPA's review of data submitted by pesticide companies, Former Employee B stated the following:

> *"Most of the data that EPA uses in its regulatory decision making come from studies that are conducted by pesticide companies. And when the companies submit data, they provide very extensive reports that are reviewed either by EPA scientists or by contractors working for the agency. Those reviews go through the reports that the companies submit and answer the question. First of all, does it look like the studies were conducted in a manner that is scientifically valid? Can we trust the results that are being given to us in the report? Secondly, does the study address all of the scientific issues or*

questions that EPA needs to know about in connection with this kind of study?" (Former Employee B)

The EPA's Draft Risk Assessment was based on data supplied by AMVAC

Within the EPA docket, the EPA's issuance of a Draft Risk Assessment is contained in the document "Pesticide Registration Review: Dimethyl Tetrachloroterephthalate: Draft Occupational and Residential Risk Assessment." This document was published to the docket on June 1, 2023. If independently conducted scientific evidence and AMVAC safety data shaped the EPA's regulation of Dacthal during this step, we would see references to data provided by both AMVAC and independent institutions within this document as the EPA explains its draft risk assessment of Dacthal.

Within this document, the EPA explained that the CTA (sponsored by AMVAC) revealed "potential risks for people exposed to DCPA during their work and leisure activities" (p. 2), prompting the agency to publish this risk assessment promptly. The EPA did not explicitly reference independently conducted studies as being influential in this decision.

The EPA's Proposed Interim Decision (a rare emergency order) was based on data supplied by AMVAC

Within the EPA docket, the EPA's issuance of a Proposed Interim Decision is contained in the document "Emergency Order: Suspending the Registrations of All Pesticide Products Containing Dimethyl Tetrachloroterephthalate." This document was published to the docket on August 7, 2024. In this document, the EPA announces its decision to cancel the use and sale of all Dacthal products in the U.S. Because this document is an emergency order (and the first emergency order published by the EPA in almost 40 years), posting this document marks a deviation from the EPA's typical timeline as illustrated in Table 2. If independently conducted scientific evidence and AMVAC safety data shaped the EPA's regulation of Dacthal during this step, we would see references to data provided by both AMVAC and independent institutions within this document. In this document, the EPA states the following:

> "In evaluating the risks which DCPA would pose during the time needed to conduct a cancellation hearing, EPA has placed the greatest emphasis on the results of the CTA submitted to the Agency, which indicates that very low levels of DCPA (at least 10-fold lower than a dose that did not cause adverse thyroid effects in maternal animals in the CTA) causes thyroid hormone perturbations in fetal rats."

The EPA did not explicitly reference independently conducted studies as being influential in this decision.

The EPA's Final Decision was based on data supplied by AMVAC

Within the EPA docket, the EPA's issuance of an Interim/Final Decision is contained in the document "Pesticide Product Registration: Dimethyl tetrachloroterephthalate: Final Cancellation Order." This document was published to the docket on October 23, 2024. In accordance with the timeline shown in Table 2, the Final Decision was created and published after a public comment period and is a direct follow-up to the agency's emergency order, issued on August 7, 2024. In this document, the EPA announces that the cancellation of Dacthal has been finalized and that AMVAC has offered to voluntarily cancel the sale and production of Dacthal in the U.S.

Regarding the EPA's final decision to cancel all sales and usage of Dacthal in America, Former Employee L provided the following context:

> *"When an agency's staff tend to focus on something at a particular time, they also become more excited to work on that same issue if it comes up in other contexts, right? So we're deep in the throes of asking what we can do to demonstrate progress towards regulating potentially endocrine disrupting chemicals, and Dacthal sort of came through as a somewhat egregious example of a registrant who has kind of run the red light for many years. The EPA, to its fault, didn't do enough about it in the past. So I do think there is some connection in a sense of us being more motivated to pursue this issue aggressively because we already had a plan at the time for needing to comply with the Endocrine Disruptor Screening Program." (Former Employee L)*

Former EPA Employee Perspectives on the Process

Throughout the interview process, former EPA employees acknowledged that the EPA's regulation of Dacthal was unusually long, largely due to AMVAC's refusal to submit the requested safety data. Former Employee B, who advocated for the EPA to cancel Dacthal through their work at the EPN, stated the following about the EPA's regulation of Dacthal from 2011-2024:

*“I think this was out of the ordinary. I think that two things were going on. One is that the company didn't want to do the study, because they suspected, I'm guessing, that it would be bad news for their registration. The second thing is that EPA, because they have such a huge throughput, kind of dropped the ball in terms of following up on making the company do the study. And so part of the delay would be, and I'm making it up, you may be able to reconstruct this from the administrative record. The company would say: ‘*we don't think you really need that study. Here's another piece of information that tells you what you need to know*,’ and the EPA then has to look at it and say, ‘*Yeah, that works*.’ Or*, *‘*no, you really do need to do this study*.’ But that new piece of information comes in and sits on somebody's desk for six months because they've got all the other materials that have been sitting on their desk for even longer.” (Former Employee B)*

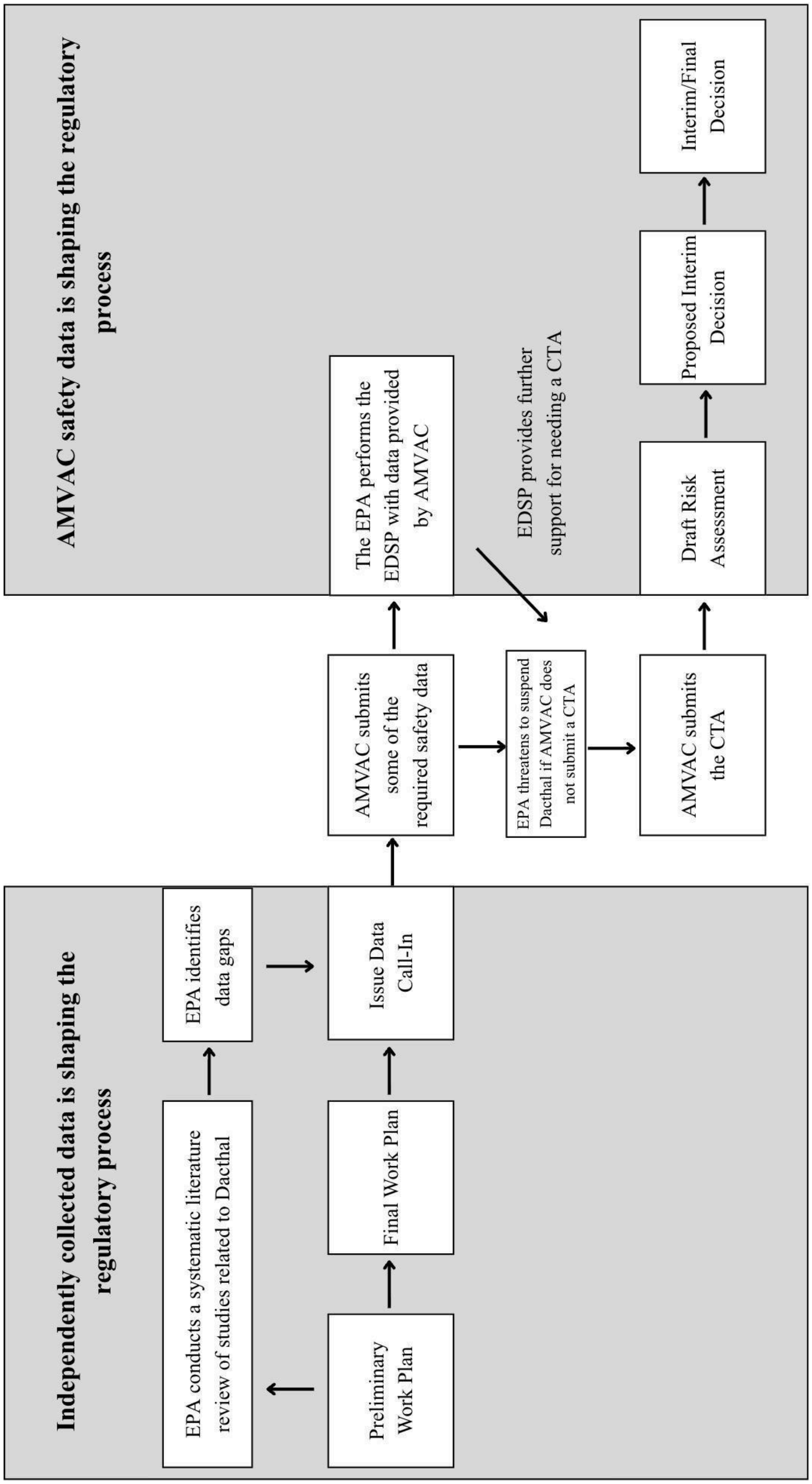
Former Employee L who worked for the EPA during the time period when the EPA was regulating Dacthal noted that while delays in data submission are known to happen during the EPA’s Registration Review Process, the delay that occurred during Dacthal’s Registration Review Process was unusually long.

“In this case, it is a very, very egregious delay. There are other pesticides with delays like this. This isn't the only one. This is the only one for which the delay probably was very problematic, right? Because it was a delay of information that ended up being very crucial to regulating a particular pesticide. So I guess my first point is, there's a lot of slippage in how the laws are implemented, and this is one of multiple examples. (Former Employee L)

According to Former EPA Employee D, who remains connected to the work being done at the EPA through their involvement in the EPN, the EPA's reliance on registrant-sponsored data has increased following the EPA's cancellation of Dacthal.

> *"And now the private researchers who were funded through EPA's grant program… all their money's gone too. Which means that you're fully dependent now, and for the remainder of the Trump administration, on industry generated studies." (Former Employee D)*

Figure 10. Flowchart depicting the EPA's regulation of Dacthal.



DISCUSSION

Summary of key findings

This evaluation of how different sources of scientific evidence shaped the EPA's regulation of the herbicide Dacthal revealed four key findings:

1) Independent studies published through 2024 addressed both human/animal and environmental health hazards of Dacthal, focusing primarily on the accumulation of the herbicide in various organisms and environments.
2) Through 2024, there were no independent studies that addressed the potential thyroid toxicity of Dacthal or the effects of Dacthal on the human or animal endocrine system.
3) The EPA used independently conducted studies to identify gaps in the literature regarding Dacthal's potential health hazards.
4) The final cancellation of Dacthal was based upon safety data supplied by AMVAC.

The goal of this study was to determine the extent to which the EPA's regulation of Dacthal was shaped by safety data provided by AMVAC rather than independently conducted studies that evaluated the potential health hazards of Dacthal. Because the EPA cancelled Dacthal so quickly after receiving safety data from AMVAC in 2023, I hypothesized that the EPA's regulation and eventual cancellation of Dacthal was primarily shaped by industry data provided by AMVAC rather than independently conducted scientific studies. My evaluation of the EPA's regulation of Dacthal supported this hypothesis.

Independent studies located Dacthal residues but rarely linked exposure to health outcomes

Generally, both types of studies focused on the presence of Dacthal residues in the environment or in human/animals rather than the specific health effects of Dacthal. Compared to a pesticide like glyphosate (the active ingredient in Roundup), this lack of data regarding health effects stands out as being somewhat unusual. On PubMed, the phrase “glyphosate AND cancer” pulls 321 results published between 1999 and 2026, including a variety of epidemiological studies exploring potential links between glyphosate exposure and the development of cancer. “chlorpyrifos AND cancer” yields 311 results published between 1989 and 2026 on PubMed. Despite not being classified as a phthalate, searching the phrase “chlorpyrifos AND thyroid” on PubMed yields 60 results published between 1993 and 2026, including titles such as “Short- and Long-Term Effects of Chlorpyrifos on Thyroid Hormone Axis and Brain Development in Xenopus laevis” and “Thyroid-disrupting effects of chlorpyrifos in female Wistar rats.” Conversely, the phrase “Dacthal AND thyroid” retrieves zero results on PubMed.

Dacthal was detected all around the world, in a variety of mediums. As illustrated in Figure 6, Dacthal was primarily detected in the Northern Hemisphere. However, it is important to note that while this review represents a comprehensive list of where Dacthal residues have been detected so far, this does not mean these are the only locations around the world where Dacthal residues are present. Instead, this review represents where the researchers have looked for Dacthal so far.

While Dacthal residues have been detected in a variety of fish species as well as other animals such as Cascades frogs and European eels, no animal study was able to definitively link the presence of Dacthal in animal tissue to adverse health outcomes.

Two studies done on humans reported an association between Dacthal exposure and an increased risk of childhood leukemia; however, similarly to the animal studies, no human study was able to demonstrate that exposure to Dacthal caused any adverse health outcomes.

Taken altogether, the independently conducted studies did not provide any compelling evidence that exposure to Dacthal caused any serious, negative health outcomes. This finding makes sense given the general public perception of Dacthal prior to the pesticide's cancellation in 2024. Prior to Dacthal's cancellation, Dacthal flew under the public's radar as a seemingly harmless, relatively unknown herbicide.

No independent studies addressed the potential thyroid toxicity of Dacthal

When the EPA cancelled Dacthal, the agency stated that this decision was based on "the best available science, which included robust studies demonstrating thyroid toxicity" ("EPA Finalizes Cancellation," 2024). An unexpected finding from this review was that none of the independently conducted studies examined the potential thyroid toxicity of Dacthal. Therefore, the robust studies referenced by the EPA did not come from independent sources.

This is an unexpected finding because Dacthal is known to be a phthalate, and there is a general consensus that many phthalates function as endocrine disrupters. In fact, a 2021 paper written as a collaboration between researchers at Zhejiang University of Technology and Monash University in Melbourne, Australia noted that chronic exposure to phthalates can have numerous adverse health effects towards both the endocrine and reproductive system of pregnant people and adolescents and recommended that more strict regulations be put in place to limit human exposure to these chemicals (Wang & Qian, 2021). More recently, a systematic review published in 2024 by researchers at Portugal's University of Porto reported that exposure to phthalates significantly increases T3 levels and decreases T4 levels in children, indicating that these exposures affect thyroid function as a whole. The review went on to recommend that people avoid making contact with phthalates, particularly through their food sources (Maia &

Vieria-Coelho, 2024). Given the concerns expressed by independent researchers around the world, it is surprising that a reasonably popular herbicide like Dacthal that was known to be a phthalate would not prompt further research into its potential thyroid toxicity, especially considering that we have been aware of the potential endocrine-disrupting effects of phthalates since the early 1990s (Colborn et al., 1993).

During the interview process, multiple former EPA employees explained that independent researchers don't often perform thyroid assays for chemicals like Dacthal due to the high cost of performing these assays. While this is a valid barrier for independent researchers to overcome without adequate funding, the fact that a CTA was not conducted for Dacthal until 2022 is concerning. However, given that the EPA does not operate under an explicit precautionary principle like many European countries do (Tickner et al., 2001), the agency did not violate its normal practice by not banning Dacthal based solely on its potential to disrupt the endocrine system. The precautionary principle allows policymakers to write regulatory policies despite uncertain scientific evidence, as long as the threat of potential adverse health outcomes is high (Bourguignon, 2015). In other words, it can be thought of as a better-safe-than-sorry principle.

The EPA used independently conducted studies to identify gaps in the literature regarding Dacthal's potential health hazards

Early on in the review process, the EPA conducted a systematic review of all studies relevant to the potential health hazards of Dacthal. This systematic review spanned studies published by independent research entities, unpublished studies provided by industry sources, and studies performed by the government. Prior to this study, it was already understood that the EPA often conducts systematic reviews of existing scientific studies to evaluate potential risks pesticides may pose to human health ("Understanding the Science," 2025). Therefore, these findings align with the current understanding of the EPA's regulatory process.

The EPA has also reported that the evidence compiled during these systematic reviews is then analyzed through a Weight of Evidence (WOE) approach to make conclusions regarding the pesticide's safety and how it should be regulated ("Office of Pesticide Programs' Framework," 2016). However, in the case of Dacthal, the EPA determined that there were too many gaps in the data identified through the agency's systematic review (as reported in the EPA's Final Work Plan). This is a fairly common occurrence when the EPA reviews a pesticide's registration status as the EPA acknowledges that scientific knowledge is dynamic and includes the Data Call-In as a formally recognized step in the agency's Registration Review Process ("Registration Review Process," 2025).

It is well-established that gaps in evidence can challenge the formation of evidence-based policy. As discussed in the introduction of this thesis, a lack of epidemiological data challenged the formation of evidence-based policy to regulate DDT, stalling regulatory action for years (Jasanoff, 1994; Murphy, 2017). In the case of DDT, an additional factor that contributed to DDT's registrant (Montrose Chemical Company) successfully stalling the regulatory process was the company's strong lobbying efforts. In contrast, in 2024, AMVAC agreed to voluntarily pull Dacthal from the market, despite publicly disagreeing with the EPA's conclusions that Dacthal causes thyroid toxicity based on the CTA the company submitted ("American Vanguard Withdraws Dacthal Registration," 2024). AMVAC's decision to voluntarily cancel Dacthal production followed a year of poor financial performance at the company ("American Vanguard to end global production," 2024).

To overcome these data gaps, and as a direct outcome of the EPA's systematic review, the EPA issued a Data Call-In. In the Data Call-In document, the EPA requested 49 studies from AMVAC. This process is illustrated in Figure 10.

Interviews with former EPA employees revealed that the EPA often turns to the pesticide's registrant to fill these data gaps because of the high cost of performing the required studies and a lack of funding for independent researchers to perform these studies.

The systematic review was conducted in 2011. Based upon the contents of the EPA docket, this was the only systematic review that the EPA conducted for Dacthal. Because these studies were only used prior to the Data Call-In (officially published to the EPA docket in 2013), the 26 studies published after the issuance of this Data Call-In could not and did not play a significant role in shaping the EPA's regulation of Dacthal.

The final cancellation of Dacthal was based upon safety data supplied by AMVAC

Beginning in 2015, AMVAC submitted multiple studies to the EPA that assessed Dacthal's potential health hazards, as illustrated in Figure 9. These studies included 11 EDSP Tier 1 assays for Dacthal and 24 studies assessing Dacthal's potential toxicity to organisms such as algae and freshwater invertebrates. However, the EPA declared that this data was insufficient to evaluate Dacthal's potential health hazards. As mentioned by the former EPA employees, requesting additional data from a pesticide's registrant is not unheard of at the EPA, but it is less common for the data submission process to last as long as it did in this case.

In 2023, AMVAC submitted a Comparative Thyroid Assay for Dacthal which the EPA cited in its Draft Risk Assessment as having revealed potential health risks for people exposed to Dacthal. The CTA was referenced again in the EPA's Proposed Interim Decision for Dacthal in which the agency specifically acknowledged the CTA as being influential in the agency's decision to cancel Dacthal. Therefore, the AMVAC-supplied CTA played a significant role in shaping the EPA's regulation of Dacthal, indicating that the EPA's decision to ban Dacthal was largely based upon the results of one industry-supplied study.

This is not the first time the results of a single study have greatly influenced the EPA's regulation of a pesticide. As discussed in the introduction of this thesis, in the 1970s, the herbicide 2,4,5-T (an active ingredient used in Agent Orange) was cancelled on the basis of a single independent study that found a correlation between spraying 2,4,5-T and increased rates of miscarriage. Dow Chemical, the producer of 2,4,5-T, heavily criticized the EPA for cancelling the herbicide without sufficient evidence. Ecologist Dave Goulson commented on an ongoing pattern he perceives in the regulation of pesticides in which the pesticide industry acts in favor of its own interests by constantly challenging emerging evidence of pesticides harming human health and/or the environment in order to continue selling those pesticides for as long as it is financially beneficial (Goulson, 2020). Because AMVAC resisted submitting the CTA results to the EPA until the EPA suspended Dacthal's registration, Goulson's observation becomes relevant once again in the case of Dacthal. In this case, AMVAC acted in favor of its own interests by withholding evidence of Dacthal being a threat to human health in order to continue selling Dacthal.

The fact that industry-supplied data was so influential in the EPA's regulation of Dacthal aligns with previous research regarding how different sources of data have shaped the EPA's regulation of Roundup. In the case of Roundup, it has been found that industry-collected data is often preferred by regulators to independently conducted studies (Novotny, 2022). This finding has contributed to controversy surrounding the regulation of Roundup because the producers of

Roundup have been implicated in research misconduct, which sought to hide the true relationship between exposure to Roundup and one's likelihood of developing non-Hodgkin's lymphoma (Glenna & Bruce, 2021).

Why this work matters

Despite existing literature expressing concerns about the EPA relying on industry data to regulate pesticides (Glenna & Bruce, 2021; Bruce et al., 2023), this research demonstrates that the EPA is still relying on industry-supplied data to regulate pesticides. The findings presented in this thesis reveal that industry-supplied safety data played a significant role in the EPA's cancellation of Dacthal and that a lack of funding for independent researchers to evaluate the potential health hazards of Dacthal contributed to the EPA's reliance on industry data.

In the case of Dacthal, relying on industry-supplied data ultimately worked in society's favor because AMVAC eventually agreed to pull Dacthal from the market. However, AMVAC was able to extend this regulatory process for years while the EPA waited for data that the agency could not seem to obtain from any other independent sources. As lawsuits begin to pile up from plaintiffs who are now alleging adverse health outcomes following exposure to Dacthal earlier in their lives (King, 2026), concerns over how long it took for the EPA to ban Dacthal become more pressing. In other words: if the EPA had reason to suspect that Dacthal might cause adverse health effects (particularly by disrupting the endocrine system), why does the EPA allow pesticide companies like AMVAC to stall this process for such an incredibly long time?

This thesis highlights a critical weakness within the EPA's Registration Review Process for pesticides. If the agency is going to continue to rely on industry-supplied data to regulate pesticides, the agency must enforce strict submission deadlines. Or, perhaps, follow the

European Union's lead and adopt a Precautionary Principle that allows the agency to make regulatory decisions despite gaps in scientific evidence. Many of the pesticides banned in Europe, such as paraquat, chlorpyrifos, and atrazine, remain registered for use in America (Donley, 2019; "Chlorpyrifos," 2020; "Atrazine," 2025). For the sake of public health, waiting ten years for a single industry-sponsored study to determine the safety of a pesticide must remain unusual, and, if possible, a thing of the past.

Limitations

The research presented in this study is not without limitations. The systematic review of the independently conducted scientific studies that evaluate Dacthal's potential health risks was only conducted across two search engines: PubMed and Web of Science. This was partially due to a lack of access to search engines like Scopus through my institution and a lack of time to review the results pulled by a search engine like Google Scholar which tends to yield a much larger quantity of results compared to other search engines. Additionally, concerns about the replicability of Google Scholar searches made using this search engine a less desirable choice.

My analysis of the EPA's regulation of Dacthal is limited because I only had access to information that was made publicly available through EPA docket EPA-HQ-OPP-2011-0374. This means I had to rely on information that the EPA willingly chose to make public. I therefore had to trust that this information is an accurate reflection of the EPA's actions during the agency's regulation of Dacthal. I was also restricted to information that was written down for the public record, meaning that I was unable to witness any informal conversations that might have occurred between employees regarding this process. This limits my understanding of how unspoken rules, informal practices, and hidden norms might have influenced the EPA's regulation of Dacthal. In order to overcome this limitation, I interviewed five former EPA employees and asked them about their perception of how cultural norms at the EPA might influence the agency's regulatory process. Collectively, the former employees suggested that internal, non-public, cultural norms can influence EPA regulatory practices. Additionally, the majority of the former employees I interviewed did not work directly with Dacthal and left the EPA years before the agency began to review Dacthal's registration. Therefore, they could often only speak more broadly about the process of regulating pesticides in general.

Finally, I was unable to interview current EPA employees or EPA employees that worked at the agency in 2024 when Dacthal was finally cancelled. This means that many of the responses I recorded during these interviews refer to historical practices at the EPA and might not be the most up-to-date reflection of current EPA practices.

Future research directions

To extend this research further, future studies could either deepen or broaden this analysis. Deepening this analysis would include conducting interviews with current EPA employees (or former EPA employees who worked at the agency through 2024) in order to gain a more detailed account of how different sources of scientific evidence shaped the EPA's regulation of Dacthal beyond what is already available in the public record. Broadening this analysis would include evaluating how different sources of scientific evidence shaped the EPA's regulation of other pesticides (either cancelled or currently in-use). At the time of writing this review, there was no research regarding the role of scientific evidence in the EPA's regulation of Dacthal. Without a standardized framework to guide the use of scientific evidence in EPA policymaking, the role of scientific evidence in the EPA's regulation of pesticides demands further review on a case-by-case basis.

CONCLUSION

This evaluation of how different sources of scientific evidence shaped the EPA's regulation of the herbicide Dacthal revealed that the final cancellation of Dacthal was based upon safety data supplied by AMVAC. Somewhat unusually (compared to the literature available for pesticides like glyphosate and chlorpyrifos), the independent studies regarding Dacthal focused primarily on the detection of Dacthal in various organisms and environments rather than the specific health effects of this herbicide. Former EPA employees cited a lack of funding as being an important reason why there were no independent studies that addressed the potential thyroid toxicity of Dacthal or the effects of Dacthal on the human or animal endocrine system. Because the EPA relied on AMVAC to supply safety data rather than independent sources, AMVAC was able to stall the agency's regulatory process for years. Therefore, this thesis highlights a critical weakness within the EPA's Registration Review Process for pesticides and points to a need for stricter enforcement of submission deadlines, especially if the agency is going to continue to rely on industry-sponsored data going forward.

REFERENCES

"About EPA's Science Advisory Organizations." Environmental Protection Agency. (2025). https://www.epa.gov/aboutepa/about-epas-science-advisory-organizations

"About EPN." Environmental Protection Network. (2026). https://www.environmentalprotectionnetwork.org/about/about-epn/

Administrative Procedures Act. 5 U.S.C. (1946).

Alavanja M. C. (2009). Introduction: pesticides use and exposure extensive worldwide. *Reviews on environmental health*, *24*(4), 303–309. https://doi.org/10.1515/reveh.2009.24.4.303

Alford, R. R., & Friedland, R. (1985). The pluralist perspective on the bureaucratic state. In Powers of Theory: Capitalism, the State, and Democracy *Cambridge University Press* (pp 112–135). https://www.cambridge.org/core/books/powers-of-theory/pluralist-perspective-on-the-bureaucratic-state/A6ED3ED57DCF4EE33FEF16DEEF746F9E

"American Vanguard to end global production of Dacthal weedkiller after EPA ban." Agriculture Dive. (2024). https://www.agriculturedive.com/news/american-vanguard-ends-dacthal-dcpa-production-weedkiller-epa-ban/725115/

"American Vanguard Withdraws Dacthal Registration." American Vanguard. (2024). https://www.amvac.com/news/american-vanguard-withdraws-dacthal-registration

"Assessment of Dimethyl Tetrachloroterephthalate (DCPA) (PC: 078701) Use, Usage, and Benefits." Environmental Protection Agency. (2023).

"Atrazine." Environmental Protection Agency. (2025). https://www.epa.gov/ingredients-used-pesticide-products/atrazine

Baron, J. (2018). A brief history of evidence-based policy. *The ANNALS of the American Academy of Political and Social Science*, *678*(1), 40-50. https://doi.org/10.1177/0002716218763128

Beach, D. & Pedersen, R. B. (2013). Process Tracing Methods. *The University of Michigan Press*.

Bennett, A., & Checkel, J. T. (2014). Process tracing: From philosophical roots to best practices. *Cambridge University Press*.

Bosso, C. (1987). Pesticides and Politics. *University of Pittsburgh Press.*

Bourguignon, D. (2015). The Precautionary Principle: Definitions, applications, and governance. *European Parliamentary Research Service*. https://www.europarl.europa.eu/thinktank/en/document/EPRS_IDA(2015)573876

Bruce, A. B., Borlu, Y., & Glenna, L. L. (2023). Assessing the scientific support for US EPA pesticide regulatory policy governing active and inert ingredients. *Journal of Environmental Studies and Sciences, 13(1),* 1-13. https://doi.org/10.1007/s13412-022-00788-4

Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. Oncology nursing forum, 41(5), 545–547. https://doi.org/10.1188/14.ONF.545-547

"Chlorpyrifos & Chlorpyrifos-Methyl." European Commission. (2020). https://food.ec.europa.eu/plants/pesticides/approval-active-substances-safeners-and-synergists/renewal-approval/chlorpyrifos-chlorpyrifos-methyl_en

Colborn, T., vom Saal, F. S., & Soto, A. M. (1993). Developmental effects of endocrine-disrupting chemicals in wildlife and humans. *Environmental health perspectives*, *101*(5), 378–384. https://doi.org/10.1289/ehp.93101378

Collier, D. (2011). Understanding process tracing. PS: political science & politics, 44(4), 823-830. doi:10.1017/S1049096511001429

Cropper, M. L., Evans, W. N., Berardi, S. J., Ducla-Soares, M. M., Portney, P. R. (1992). The Determinants of Pesticide Regulation: A Statistical Analysis of EPA Decision Making. *Journal of Political Economy, 100(1), 175-197.* https://doi.org/10.1086/261812

Dalglish, S. L., Khalid, H., & McMahon, S. A. (2020). Document analysis in health policy research: the READ approach. *Health policy and planning*, *35*(10), 1424-1431. https://doi.org/10.1093/heapol/czaa064

Davis, F. R. (2014). Banned: A History of Pesticides and the Science of Toxicology. *Yale University Press*.

"DDT Regulatory History: A Brief Survey (to 1975)." EPA. (1975). https://www.epa.gov/archive/epa/aboutepa/ddt-regulatory-history-brief-survey-1975.html

Donley, N. (2019). The USA lags behind other agricultural nations in banning harmful pesticides. *Environmental Health 18, Article Number: 44*. https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0488-0#:~:text=Of%20those%20134%2C%2097%20have,market%20or%20cancel%20its%20approval.

Dunlap, T. (1981). DDT: Scientists, Citizens, and Public Policy. *Princeton Legacy Library*.

"Endocrine Disrupters." Environmental Protection Agency. (2026). https://www.niehs.nih.gov/health/topics/agents/endocrine

"Endocrine Disrupter Screening Program Timeline." Environmental Protection Agency. (2026). https://www.epa.gov/endocrine-disruption/endocrine-disruptor-screening-program-timeline

"EPA Announces Selection of Members to the Science Advisory Board and the Clean Air Scientific Advisory Committee." Environmental Protection Agency. (2024). https://www.epa.gov/newsreleases/epa-announces-selection-members-science-advisory-board-and-clean-air-scientific

"EPA Issues Emergency Order to Stop Use of Pesticide Dacthal to Address Serious Health Risk." Environmental Protection Agency. (2024). https://www.epa.gov/newsreleases/epa-issues-emergency-order-stop-use-pesticide-dacthal-address-serious-health-risk-4

"EPA Science Advisory Board." FACADATABASE. ([n.d.]). https://www.facadatabase.gov/FACA/s/meeting-members-advisory-reports?recordId=a10t0000001gzq9AAA

Exposure Assessment Tools by Chemical Classes - Pesticides. Environmental Protection Agency. (2025). https://www.epa.gov/expobox/exposure-assessment-tools-chemical-classes-pesticides#:~:text=EPA%20currently%20regulates%20thousands%20of%20pesticide%20active,derived%2C%20or%20the%20sites%20at%20which%20they

"Federal Insecticide, Fungicide, and Rodenticide Act." Congress. (2012). https://www.agriculture.senate.gov/imo/media/doc/FIFRA.pdf

FIFRA Scientific Advisory Panel (SAP) Basic Information. Environmental Protection Agency. (2025). https://www.epa.gov/sap/fifra-scientific-advisory-panel-sap-basic-information

Glenna, L., & Bruce, A. (2021). Suborning science for profit: Monsanto, glyphosate, and private science research misconduct. *Research Policy*, *50*(7), 104290. https://doi.org/10.1016/j.respol.2021.104290

Glyphosate - Response to Comments Usage and Benefits - Final. Environmental Protection Agency. (2019). https://www.epa.gov/sites/default/files/2019-04/documents/glyphosate-response-comments-usage-benefits-final.pdf#:~:text=About%20280%20million%20pounds%20of%20glyphosate%20are,large%20majority%20of%20growers%20find%20it%20useful

Goulson, D. (2020). Pesticides, corporate irresponsibility, and the fate of our planet. *One Earth*, *2*(4), 302-305. https://doi.org/10.1016/j.oneear.2020.03.004

"Guidelines for Ecological Risk Assessment." Environmental Protection Agency. (1998). https://nepis.epa.gov/Exe/ZyNET.exe/30004XFR.txt?ZyActionD=ZyDocument&Client=EPA&Index=1995%20Thru%201999&Docs=&Query=Ecological%20Risk%20Assessment%20Pesticides%20Technical%20Overview%20&Time=&EndTime=&SearchMethod=2&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C95THRU99%5CTXT%5C00000003%5C30004XFR.txt&User=ANONYMOUS&Password=anonymous&SortMethod=-%7Ch&MaximumDocuments=15&FuzzyDegree=0&ImageQuality=r85g16/r85g16/x150y150g16/i500&Display=hpfr&DefSeekPage=&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1

"Health Effects Support Document for Dacthal Degradates: Tetrachloroterephthalic Acid (TPA) and Monomethyl Tetrachloroterephthalic Acid (MTP)." EPA. (2008). www.epa.gov/safewater/ccl/pdf/DacthalDegradates:TPAandMTP.pdf

Howlett, M., McConnell, A., & Perl, A. (2017). Moving policy theory forward: Connecting multiple stream and advocacy coalition frameworks to policy cycle models of analysis. *Australian Journal of Public Administration*, *76*(1), 65-79. https://doi.org/10.1111/1467-8500.12191

"In Brief: How does the thyroid gland work?" National Library of Medicine. (2024). https://www.ncbi.nlm.nih.gov/books/NBK279388/

"Introduction to Embracing Collaboration." Environmental Protection Agency. (2025). https://www.epa.gov/organon/introduction-embracing-collaboration

Jasanoff, S. (1994). The Fifth Branch: Science Advisers as Policymakers. *Harvard University Press*.

Jasanoff, S. (1992). Science, Politics, and the Renegotiation of Expertise at EPA. *Osiris*, *7*, 194-217. https://www.jstor.org/stable/301772

Kano, H., & Hayashi, T. I. (2021). A framework for implementing evidence in policymaking: perspectives and phases of evidence evaluation in the science-policy interaction. *Environmental Science & Policy*, *116*, 86-95. https://doi.org/10.1016/j.envsci.2020.09.001

King, R. (2026). Dacthal Lawsuit – February 2026 Update. *King Law*. https://www.robertkinglawfirm.com/personal-injury/dacthal-lawsuit/

Luken, R. A. (1985). The emerging role of benefit-cost analysis in the regulatory process at EPA. *Environmental Health Perspectives 62*. https://doi.org/10.1289/ehp.8562373

MacIntyre, A. (1987). Why Pesticides Received Extensive Use in America: A Political Economy of Agricultural Pest Management to 1970. *Natural Resources Journal. Volume 27, Number 3*. https://www.jstor.org/stable/24882995

Maia, A., & Vieira-Coelho, M. A. (2024). The impact of exposure to phthalates in thyroid function of children and adolescents: a systematic review. *European journal of pediatrics*, *184*(1), 111. https://doi.org/10.1007/s00431-024-05939-z

McGarity, T. O. (1991). The Internal Structure of EPA Rulemaking. Law and Contemporary Problems, 54(4), 57–111. https://doi.org/10.2307/1191874

Murphy, M. K. (2018). Scientific argument without a scientific consensus: Rachel Carson's rhetorical strategies in the *Silent Spring* debates. *Argumentation and Advocacy*, *55*(3), 194–210. https://doi.org/10.1080/00028533.2018.1429065

Novotny E. (2022). Glyphosate, Roundup and the Failures of Regulatory Assessment. *Toxics*, *10*(6), 321. https://doi.org/10.3390/toxics10060321

Nownes, A. J. (1991). Interest groups and the regulation of pesticides: Congress, coalitions, and closure. *Policy Sciences*. https://link.springer.com/article/10.1007/BF00146462

Occupational Safety and Health Act of 1970, Pub. L. No. 91–596, 29 U.S.C. §§ 651–678 (1970).

"Office of Pesticide Programs' Framework for Incorporating Human Epidemiologic & Incident Data in Risk Assessments for Pesticides." Office of Pesticide Programs US Environmental Protection Agency. (2016). https://www3.epa.gov/pesticides/EPA-HQ-OPP-2008-0316-DRAFT-0075.pdf

Oreskes, N. (2004). Science and public policy: what's proof got to do with it?. *Environmental science & policy*, *7*(5), 369-383. doi:10.1016/j.envsci.2004.06.002

"Organization Chart/Current Headquarters Leadership for EPA Pesticide Programs." Environmental Protection Agency. (2025). https://www.epa.gov/pesticide-contacts/organization-chartcurrent-headquarters-leadership-epa-pesticide-programs

Patton M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. Health services research, 34(5 Pt 2), 1189–1208. https://pmc.ncbi.nlm.nih.gov/articles/PMC1089059/

Paroske, M. (2009). Deliberating International Science Policy Controversies: Uncertainty and AIDS in South Africa. *Quarterly Journal of Speech*, *95*(2), 148–170. https://doi.org/10.1080/00335630902842053

"Pesticide Cancellation Under EPA's Own Initiative." EPA. (October 24, 2024). https://www.epa.gov/pesticide-tolerances/pesticide-cancellation-under-epas-own-initiative#:~:text=In%20order%20to%20initiate%20cancellation,and%20Cosmetic%20Act%20(FFDCA).

Pimentel, D. (1996). Green revolution agriculture and chemical hazards. *Science of the total environment*, *188*, S86-S98. https://doi.org/10.1016/0048-9697(96)05280-1.

Ray, D. (2010). 13.26 - Organochlorine and Pyrethroid Insecticides. *Comprehensive Toxicology Volume 13*. https://www.sciencedirect.com/science/article/pii/B9780080468846013270?ref=pdf_download&fr=RR-2&rr=917330ef49671f30

"Registration Review Process." Environmental Protection Agency. (2025). https://www.epa.gov/pesticide-reevaluation/registration-review-process

“Restricted Use Products (RUP) Report.” EPA. (January 28, 2025). https://www.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report

Sabatier, P.A. An advocacy coalition framework of policy change and the role of policy-oriented learning therein. *Policy Sci* 21, 129–168 (1988). https://doi.org/10.1007/BF00136406

Scott, T. A., Kim, S., & Wood, L. (2025). The Drivers of Science Referenced in US EPA Regulatory Impact Analyses: Open Access, Professional Popularity, and Agency Involvement. Regulation & Governance. https://doi.org/10.1111/rego.70026

Sellers, C., Kohl, E., Sullivan, M., Gehrke, G., Varner, J., Chambers, M., & the Environmental Data and Governance Initiative. (2025). History of Risk Assessments of the Organophosphate Pesticide Chlorpyrifos at the US Environmental Protection Agency, 1980–2024. American Journal of Public Health, 0(0) ahead of print. https://doi.org/10.2105/AJPH.2025.308073

Shwed, U., & Bearman, P. S. (2010). The temporal structure of scientific consensus formation. *American sociological review*, *75*(6), 817-840. DOI: 10.1177/0003122410388488

Stoddard, K. (2020). *Farmers' Perceptions of the Health Risks of Roundup* (Master's thesis, Idaho State University). https://colorado.idm.oclc.org/login?url=https://www.proquest.com/dissertations-theses/farmers-perceptions-health-risks-roundup/docview/2854824432/se-2?accountid=14503

Suazo, I., Saracostti, M., & Chaple-Gil, A. M. (2025). Scientific Evidence and Public Policy: A Systematic Review of Barriers and Enablers for Evidence-Informed Decision-Making Authors. *Frontiers in Communication*, *10*, 1632305. https://doi.org/10.3389/fcomm.2025.1632305

Sunstein, C. R. (2002). Risk and Reason: Safety, Law, and the Environment. *Cambridge University Press*.

Ticker, J., Raffensberger, C., Myers, N. (2001). The Precautionary Principle in Action: A Handbook. https://calepa.ca.gov/wp-content/uploads/2016/10/EnvJustice-Documents-2003yr-Appendices-AppendixI.pdf#:~:text=In%20the%20United%20States%2C%20the%20precautionary%20principle,and%20biological%20integrity%20of%20the%20Nation's%20waters.%22

"The Downfall of the "Secret Science" Rule, and What It Means for Biden's Environmental Agenda." Environmental and Energy Law Program Harvard Law School. (2021). https://eelp.law.harvard.edu/final-secret-science-rule/

Toxic Substances Control Act, Pub. L. No. 94-469, 90 Stat. 2003 (1976).

Understanding the Science Behind EPA's Pesticide Decisions. United States Environmental Protection Agency. (2025). https://www.epa.gov/pesticide-registration/understanding-science-behind-epas-pesticide-decisions#:~:text=The%20EPA%20regulates%20pesticides%20to,health%20when%20evaluating%20pesticide%20products

Wargo, J. (1996). Our Children's Toxic Legacy: How Science and Law Fail to Protect Us from Pesticides. *Yale University Press*.

Wagner, W. (2023). The Consensus Rule: Lessons From the Regulatory World. Villanova Law Review, 67(5). https://digitalcommons.law.villanova.edu/vlr/vol67/iss5/6

Wang, Y., & Qian, H. (2021). Phthalates and Their Impacts on Human Health. Healthcare (Basel, Switzerland), 9(5), 603. https://doi.org/10.3390/healthcare9050603

"What is a Pesticide?" EPA. (February 13, 2025). https://www.epa.gov/minimum-risk-pesticides/what-pesticide

"World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100." United Nations. (2017). https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100#:~:text=Calendar,World%20population%20projected%20to%20reach%209.8%20billion%20in%202050%2C%20and,Nations%20report%20being%20launched%20today

Yen, J. & Esworthy, R. Pesticide Law: A Summary of the Statutes. (2012). *Congressional Research Service*. https://crsreports.congress.gov/product/pdf/RL/RL31921/19

APPENDIX

Figure A1. **Docket Codebook**

Code name: Independent Studies (INDSTU)
Definition: This code captures content that describes scientific studies published by scientists not employed by American Vanguard Corporation (AMVAC). This code captures instances in which independently conducted data is used to inform the regulation of Dacthal.
Inclusion Criteria: Apply this code when documents reference studies published by scientists who are not employed by AMVAC during the regulation of Dacthal.
Exclusion Criteria: Do not apply this code when AMVAC safety data is referenced during the regulation of Dacthal. Do not apply when the source of the data cannot be determined.

Code name: Safety Data (SAFDAT)
Definition: This code captures content that describes data generated by AMVAC about the potential human and environmental hazards associated with Dacthal exposure. This code identifies AMVAC's own assessments of its product Dacthal.
Inclusion Criteria: Apply this code when documents reference AMVAC-generated data that evaluates the safety of Dacthal. Include safety reports, risk assessments, and toxicity studies generated by AMVAC.
Exclusion Criteria: Do not apply this code when documents reference data collected by independent sources (scientists not employed by AMVAC). Do not apply this code when AMVAC-generated data is referenced but that data does not evaluate the safety of Dacthal (e.g., marketing of Dacthal or production of Dacthal). Do not apply when the source of the data cannot be determined.

Code name: Data on Related Substances (RELATED)
Definition: This code captures content that references scientific studies evaluating the health effects of chemicals *other than* Dacthal, where those chemicals are similar to Dachal (chemically or functionally). This code captures instances in which related evidence is used to inform decisions about Dacthal's regulation.
Inclusion Criteria: Apply this code when regulatory documents reference studies that evaluate the safety of substances that are distinct from but comparable to Dacthal. Include instances where studies are used to infer potential health effects of Dacthal.
Exclusion Criteria: Do not apply this code when the referenced study evaluates Dacthal, specifically. Do not apply this code when the referenced study evaluates chemicals that are unrelated to Dacthal (structurally, functionally, etc.). Do not apply this code when the study does not evaluate safety (e.g., study evaluates efficacy on target organisms).

Figure A2. **Former EPA Employee Interview Guide**

The purpose of this study is to create a more nuanced understanding of modern EPA pesticide regulation by exploring the role of scientific consensus regarding the health risks of pesticide exposure in shaping EPA regulatory policy, using the regulation and eventual cancellation of the pesticide Dacthal as a case study. We expect that you will be in this research study for approximately 30 minutes today and that a total of approximately 5 – 20 people will participate in the study. Your participation in this study is entirely voluntary. You may withdraw from participating in this study at any point, even after consenting to participate.

Your participation will consist of a 30-minute virtual interview. I will ask you questions about your level of involvement in the regulation and cancellation of Dacthal, your views on the role of outside scientific studies in the EPA's regulation of pesticides, and your views on the role of scientific certainty and consensus in the EPA's regulation of pesticides. Should you consent to it, the interview will be audio-recorded, and you may skip any questions you do not want to answer.

Your participation will consist of answering a series of open-ended interview questions. The interview will begin shortly after the verbal consent process.

To protect your privacy, all of the information you provide today will be de-identified, meaning that your name and any other personal identifying information will be separated from your responses. Following the transcription of your responses, the transcribed responses will be stored under a unique participant code that will not include any personal identifying information such as your name or role/title in the EPA. The information from this research may be published for scientific purposes; however, your identity will not be given out. The audio files of your interview will be deleted after transcription is completed. If you choose not to consent to an audio recording, your responses will be transcribed during the interview process and de-identified immediately following the completion of the interview.

All the responses you share will be stored securely on a password-protected device that is only accessible to key personnel in this study.

If you have questions about the research, you can contact the Principal Investigator, Dr. Karen Bailey, at karen.bailey@colorado.edu.

If you have concerns or complaints about the research you can contact the CU Boulder IRB at (303) 735-3702 or irbadmin@colorado.edu.

Do you consent to participate in this study?

Is it alright if I record a voice memo of this interview? Your name will not be included in it. If you are alright with it, I will begin recording after we go over a little bit of background information.

Questions for EPA Employees

What year did you begin working for the EPA? How has your role in the EPA changed since then?

Would you please describe the general process of cancelling a pesticide? Additionally, could you describe the role you play in this process?

To your knowledge, who are the major stakeholders involved in the EPA's regulation of pesticides?

What role do you perceive scientists having in the EPA's regulation of pesticides, and to what extent do you think scientists are a key stakeholder in the EPA's regulation of pesticides?

How familiar are you with the pesticide Dacthal? It is also sometimes referred to as DCPA.

To what extent were you involved in the process of regulating Dacthal during your time at the EPA?

Would you describe your perception of the level of involvement of the Scientific Advisory Panel in the EPA's regulation of pesticides?
Based on your experience as an EPA employee, how do you perceive the role of outside studies in informing the EPA's regulation of pesticides?

I've pulled a quote from a 2024 EPA press release titled "EPA Finalizes Cancellation of the Pesticide Dacthal."
"Today, Oct. 22, the U.S. Environmental Protection Agency is announcing the cancellation of all products containing the pesticide dimethyl tetrachloroterephthalate (DCPA or Dacthal) under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). In making this decision, EPA relied on the best available science, which included robust studies demonstrating thyroid toxicity."
Based on your experience as an EPA employee, to what extent were these "robust studies" provided by AMVAC (the company that manufactured Dacthal)? To what extent were they provided by outside organizations?

Based on your experience as an EPA employee, to what extent does having a greater (or more "robust") number of scientific studies suggesting that a pesticide is hazardous to humans and/or the environment make a more compelling case to reevaluate the pesticide's safety or ban it?

As an EPA employee, to what extent do you look for a specific level of scientific certainty when evaluating evidence that a pesticide is potentially hazardous to humans and/or the environment?

Based on your perception, what systems or philosophies inform this threshold/level?

Based on your experience at the EPA, to what extent do you believe a lack of scientific certainty regarding the safety of a pesticide affects the EPA's regulation of that pesticide?

I understand that the EPA sometimes performs its own assessments to evaluate the safety of various chemicals and pesticides. For example, the EPA performed its own assessment to evaluate the safety of Dacthal based on data submitted by the company AMVAC. How do you perceive the role of outside studies in informing the EPA's own scientific assessments of chemical/pesticide safety?

Figure A3. **List of the studies included in the systematic review of the independently conducted scientific studies that evaluate Dacthal's potential health risks.**

Arinaitwe, K., Kiremire, B. T., Muir, D. C., Fellin, P., Li, H., Teixeira, C., & Mubiru, D. N. (2016). Legacy and currently used pesticides in the atmospheric environment of Lake Victoria, East Africa. *Science of the Total Environment*, *543*, 9-18. https://doi.org/10.1016/j.scitotenv.2015.10.146

Barr, D. B., Ananth, C. V., Yan, X., Lashley, S., Smulian, J. C., Ledoux, T. A., ... & Robson, M. G. (2010). Pesticide concentrations in maternal and umbilical cord sera and their relation to birth outcomes in a population of pregnant women and newborns in New Jersey. *Science of the total environment*, *408*(4), 790-795. https://doi.org/10.1016/j.scitotenv.2009.10.007

Barnhoorn, I., & Van Dyk, C. (2020). The first report of selected herbicides and fungicides in water and fish from a highly utilized and polluted freshwater urban impoundment. *Environmental Science and Pollution Research*, *27*(26), 33393-33398. https://link.springer.com/article/10.1007/s11356-020-09930-7

Bhoi, R., Mahananda, M. R., & Pradhan, A. (2022). Human health risk assessment of pesticides used for rice cultivation in an agricultural pockets of Eastern India. *Environmental Quality Management*, *32*(2), 61-72. https://onlinelibrary.wiley.com/doi/full/10.1002/tqem.21908

Bradford, D. F., Heithmar, E. M., Tallent-Halsell, N. G., Momplaisir, G. M., Rosal, C. G., Varner, K. E., ... & Riddick, L. A. (2010). Temporal patterns and sources of atmospherically deposited pesticides in alpine lakes of the Sierra Nevada, California, USA. *Environmental science & technology*, *44*(12), 4609-4614. https://pubs.acs.org/doi/full/10.1021/es100758a

Bradman, A., Whitaker, D., Quiros, L., Castorina, R., Henn, B. C., Nishioka, M., ... & Eskenazi, B. (2007). Pesticides and their metabolites in the homes and urine of farmworker children living in the Salinas Valley, CA. *Journal of exposure science & environmental epidemiology*, *17*(4), 331-349. https://www.nature.com/articles/7500507

Chen, C., Li, T., Zou, W., Chen, S., Zhang, K., & Ma, L. (2020). Spatial distribution and sources of organochlorine pesticides in surface waters of Shanghai, China. *SN Applied Sciences*, *2*(10), 1739. https://link.springer.com/article/10.1007/s42452-020-03507-2

Chu, S., Henny, C. J., Kaiser, J. L., Drouillard, K. G., Haffner, G. D., & Letcher, R. J. (2007). Dacthal and chlorophenoxy herbicides and chlorothalonil fungicide in eggs of osprey (Pandion haliaetus) from the Duwamish–Lake Washington–Puget Sound area of Washington state, USA. *Environmental Pollution*, *145*(1), 374-381. https://doi.org/10.1016/j.envpol.2005.12.058

Daly, G. L., Lei, Y. D., Teixeira, C., Muir, D. C., Castillo, L. E., & Wania, F. (2007). Accumulation of current-use pesticides in neotropical montane forests. *Environmental science & technology*, *41*(4), 1118-1123. https://pubs.acs.org/doi/full/10.1021/es0622709

Daly, G. L., Lei, Y. D., Teixeira, C., Muir, D. C., & Wania, F. (2007). Pesticides in western Canadian mountain air and soil. *Environmental Science & Technology*, *41*(17), 6020-6025. https://pubs.acs.org/doi/full/10.1021/es070848o

Davidson, C., Stanley, K., & Simonich, S. M. (2012). Contaminant residues and declines of the Cascades frog (Rana cascadae) in the California Cascades, USA. *Environmental Toxicology and Chemistry*, *31*(8), 1895-1902. https://doi.org/10.1002/etc.1902

Eisenberg, M., & Topping, J. J. (1985). Organochlorine residues in finfish from Maryland waters 1976–1980. *Journal of Environmental Science & Health Part B*, *20*(6), 729-742. https://doi.org/10.1080/03601238509372506

Foreman, W. T., Majewski, M. S., Goolsby, D. A., Wiebe, F. W., & Coupe, R. H. (2000). Pesticides in the atmosphere of the Mississippi River Valley, part II—air. *Science of the total environment*, *248*(2-3), 213-226. https://doi.org/10.1016/S0048-9697(99)00544-6

Gao, Y., Zheng, H., Xia, Y., Chen, M., Meng, X. Z., & Cai, M. (2019). Spatial distributions and seasonal changes of current‐use pesticides from the North Pacific to the Arctic Oceans. *Journal of Geophysical Research: Atmospheres*, *124*(16), 9716-9729. https://doi.org/10.1029/2018JD030186

Garrison, V. H., Majewski, M. S., Foreman, W. T., Genualdi, S. A., Mohammed, A., & Simonich, S. M. (2014). Persistent organic contaminants in Saharan dust air masses in West Africa, Cape Verde and the eastern Caribbean. *Science of the Total Environment*, *468*, 530-543. https://doi.org/10.1016/j.scitotenv.2013.08.076

Gilbert, M., & Lisk, D. J. (1978). Residues of dacthal herbicide in carrots. *Bulletin of Environmental Contamination and Toxicology*, *20*(1), 180-183. https://link.springer.com/article/10.1007/BF01683506

Gunier, R. B., Ward, M. H., Airola, M., Bell, E. M., Colt, J., Nishioka, M., Buffler, P. A., Reynolds, P., Rull, R. P., Hertz, A., Metayer, C., & Nuckols, J. R. (2011). Determinants of agricultural pesticide concentrations in carpet dust. *Environmental health perspectives*, *119*(7), 970–976. https://doi.org/10.1289/ehp.1002532

Gutenmann, W. H., & Lisk, D. J. (1966). Metabolism of Daconil and Dacthal pesticides in lactating cows. https://www.cabidigitallibrary.org/doi/full/10.5555/19670401556

Hageman, K. J., Simonich, S. L., Campbell, D. H., Wilson, G. R., & Landers, D. H. (2006). Atmospheric deposition of current-use and historic-use pesticides in snow at national parks in the western United States. *Environmental Science & Technology*, *40*(10), 3174-3180. https://pubs.acs.org/doi/full/10.1021/es060157c

Hageman, K. J., Hafner, W. D., Campbell, D. H., Jaffe, D. A., Landers, D. H., & Simonich, S. L. M. (2010). Variability in pesticide deposition and source contributions to snowpack in western US national parks. *Environmental science & technology*, *44*(12), 4452-4458. https://pubs.acs.org/doi/full/10.1021/es100290q

Harley, K. G., Parra, K. L., Camacho, J., Bradman, A., Nolan, J. E., Lessard, C., ... & Gunier, R. B. (2019). Determinants of pesticide concentrations in silicone wristbands worn by Latina adolescent girls in a California farmworker community: The COSECHA youth participatory action study. *Science of the total environment*, *652*, 1022-1029. https://doi.org/10.1016/j.scitotenv.2018.10.276

Hinck, J. E., Schmitt, C. J., Chojnacki, K. A., & Tillitt, D. E. (2009). Environmental contaminants in freshwater fish and their risk to piscivorous wildlife based on a national monitoring program. *Environmental monitoring and assessment*, *152*(1), 469-494. https://link.springer.com/article/10.1007/s10661-008-0331-5

Hinck, J. E., Schmitt, C. J., Ellersieck, M. R., & Tillitt, D. E. (2008). Relations between and among contaminant concentrations and biomarkers in black bass (Micropterus spp.) and common carp (Cyprinus carpio) from large US rivers, 1995–2004. *Journal of Environmental Monitoring*, *10*(12), 1499-1518. https://pubs.rsc.org/en/content/articlehtml/2008/em/b811011e

Hinck, J. E., Blazer, V. S., Denslow, N. D., Echols, K. R., Gale, R. W., Wieser, C., ... & Tillitt, D. E. (2008). Chemical contaminants, health indicators, and reproductive biomarker responses in fish from rivers in the Southeastern United States. *Science of the Total Environment*, *390*(2-3), 538-557. https://doi.org/10.1016/j.scitotenv.2007.10.026

Hinck, J. E., Blazer, V. S., Denslow, N. D., Echols, K. R., Gross, T. S., May, T. W., ... & Tillitt, D. E. (2007). Chemical contaminants, health indicators, and reproductive biomarker responses in fish from the Colorado River and its tributaries. *Science of the Total Environment*, *378*(3), 376-402. https://doi.org/10.1016/j.scitotenv.2007.02.032

Hoferkamp, L., Hermanson, M. H., & Muir, D. C. (2010). Current use pesticides in Arctic media; 2000–2007. *Science of the Total Environment*, *408*(15), 2985-2994. https://doi.org/10.1016/j.scitotenv.2009.11.038

James, R. R., & Hites, R. A. (1999). Chlorothalonil and dacthal in Great Lakes air and precipitation samples. *Journal of Great Lakes Research*, *25*(2), 406-411. https://doi.org/10.1016/S0380-1330(99)70750-1

Jantunen, L. M., Wong, F., Gawor, A., Kylin, H., Helm, P. A., Stern, G. A., ... & Bidleman, T. F. (2015). 20 years of air–water gas exchange observations for pesticides in the Western Arctic Ocean. *Environmental Science & Technology*, *49*(23), 13844-13852. https://pubs.acs.org/doi/full/10.1021/acs.est.5b01303

Klopman, G., Fercu, D., & Rosenkranz, H. S. (1996). The carcinogenic potential of dacthal and its metabolites. *Environmental toxicology and chemistry*, *15*(2), 80-84. https://doi.org/10.1002/etc.5620150202

LeBlanc, L. A., & Kuivila, K. M. (2008). Occurrence, distribution and transport of pesticides into the Salton Sea Basin, California, 2001–2002. *Hydrobiologia*, *604*(1), 151-172. https://link.springer.com/article/10.1007/s10750-008-9316-1

Madrigal, J. M., Gunier, R. B., Jones, R. R., Flory, A., Metayer, C., Nuckols, J. R., & Ward, M. H. (2024). Residential proximity to agricultural herbicide and fungicide applications and dust levels in homes of California children. *Environment international*, *192*, 109024. https://doi.org/10.1016/j.envint.2024.109024

Majewski, M. S., Foreman, W. T., & Goolsby, D. A. (2000). Pesticides in the atmosphere of the Mississippi River Valley, part I—rain. *Science of the total environment*, *248*(2-3), 201-212. https://doi.org/10.1016/S0048-9697(99)00543-4

Martínez-Gómez, C., Fernández, B., Barcala, E., García-Aparicio, V., Jumilla, E., Gea-Pacheco, Á., & León, V. M. (2023). The impact of chemical pollution on the European eel (Anguilla anguilla) from a Mediterranean hypersaline coastal lagoon. *Environmental Science and Pollution Research*, *30*(33), 80106-80122. https://link.springer.com/article/10.1007/s11356-023-27871-9

Mast, M. A., Foreman, W. T., & Skaates, S. V. (2007). Current-use pesticides and organochlorine compounds in precipitation and lake sediment from two high-elevation national parks in the Western United States. *Archives of environmental contamination and toxicology*, *52*(3), 294-305. https://link.springer.com/article/10.1007/s00244-006-0096-1

Mast, M. A., Alvarez, D. A., & Zaugg, S. D. (2012). Deposition and accumulation of airborne organic contaminants in Yosemite National Park, California. *Environmental Toxicology and Chemistry*, *31*(3), 524-533. *Environmental Toxicology and Chemistry*, Volume 31, Issue 3, 1 March 2012, Pages 524–533, https://doi.org/10.1002/etc.1727

Morris, A. D., Muir, D. C., Solomon, K. R., Letcher, R. J., McKinney, M. A., Fisk, A. T., ... & Duric, M. (2016). Current‐use pesticides in seawater and their bioaccumulation in polar bear–ringed seal food chains of the Canadian Arctic. *Environmental toxicology and chemistry*, *35*(7), 1695-1707. https://doi.org/10.1002/etc.3427

Morris, A. D., Muir, D. C., Solomon, K. R., Teixeira, C., Duric, M., & Wang, X. (2014). Trophodynamics of current use pesticides and ecological relationships in the Bathurst region vegetation‐caribou‐wolf food chain of the Canadian Arctic. *Environmental toxicology and chemistry*, *33*(9), 1956-1966. https://doi.org/10.1002/etc.2634

Oliva, J., Melgar, B., Paya, P., Cámara, M. Á., & Barba, A. (2009). Effect of the organic and mineral fertilization on the persistence of chlorthal-dimethyl in soil under laboratory conditions. https://www.cabidigitallibrary.org/doi/full/10.5555/20093287088

Primbs, T., Wilson, G., Schmedding, D., Higginbotham, C., & Simonich, S. M. (2008). Influence of Asian and Western United States agricultural areas and fires on the atmospheric transport of pesticides in the Western United States. *Environmental science & technology*, *42*(17), 6519-6525. https://pubs.acs.org/doi/full/10.1021/es800511x

Pućko, M., Stern, G. A., Burt, A. E., Jantunen, L. M., Bidleman, T. F., Macdonald, R. W., ... & Rysgaard, S. (2017). Current use pesticide and legacy organochlorine pesticide dynamics at the ocean-sea ice-atmosphere interface in resolute passage, Canadian Arctic, during winter-summer transition. *Science of the Total Environment*, *580*, 1460-1469. https://doi.org/10.1016/j.scitotenv.2016.12.122

Pućko, M., Stern, G. A., Macdonald, R. W., Jantunen, L. M., Bidleman, T. F., Wong, F., ... & Rysgaard, S. (2015). The delivery of organic contaminants to the Arctic food web: Why sea ice matters. *Science of the Total Environment*, *506*, 444-452. https://doi.org/10.1016/j.scitotenv.2014.11.040

Quirós-Alcalá, L., Bradman, A., Nishioka, M., Harnly, M. E., Hubbard, A., McKone, T. E., ... & Eskenazi, B. (2011). Pesticides in house dust from urban and farmworker households in California: an observational measurement study. *Environmental Health*, *10*(1), 19. http://www.ehjournal.net/content/10/1/19

Rawn, D. F., & Muir, D. C. (1999). Sources of chlorpyrifos and dacthal to a small Canadian prairie watershed. *Environmental science & technology*, *33*(19), 3317-3323. https://pubs.acs.org/doi/full/10.1021/es990290n

Rostad, C. E., Pereira, W. E., & Leiker, T. J. (1994). Distribution and transport of selected anthropogenic organic compounds on Mississippi River suspended sediment (USA), May/June 1988. *Journal of contaminant hydrology*, *16*(2), 175-199. https://doi.org/10.1016/0169-7722(94)90051-5

Rostad, C. E., Pereira, W. E., & Leiker, T. J. (1999). Distribution and transport of selected anthropogenic lipophilic organic compounds associated with Mississippi River suspended sediment, 1989–1990. *Archives of environmental contamination and toxicology*, *36*(3), 248-255. https://link.springer.com/article/10.1007/s002449900468

Ruggirello, R. M., Hermanson, M. H., Isaksson, E., Teixeira, C., Forsström, S., Muir, D. C., ... & Meijer, H. A. (2010). Current use and legacy pesticide deposition to ice caps on Svalbard, Norway. *Journal of Geophysical Research: Atmospheres*, *115*(D18). https://doi.org/10.1029/2010JD014005

Schmitt, C. J., Zajicek, J. L., & Peterman, P. H. (1990). National contaminant biomonitoring program: residues of organochlorine chemicals in US freshwater fish, 1976–1984.

Archives of Environmental Contamination and Toxicology, *19*(5), 748-781. https://link.springer.com/article/10.1007/BF01183992

Schmitt, C. J., Zajicek, J. L., & Ribick, M. A. (1985). National pesticide monitoring program: residues of organochlorine chemicals in freshwater fish, 1980–81. *Archives of Environmental Contamination and Toxicology*, *14*(2), 225-260. https://link.springer.com/article/10.1007/BF01055615

Schmitt, C. J., Zajicek, J. L., May, T. W., & Cowman, D. F. (1999). Organochlorine residues and elemental contaminants in US freshwater fish, 1976-1986: National Contaminant Biomonitoring Program. *Reviews of Environmental Contamination and Toxicology: Continuation of Residue Reviews*, 43-104. https://link.springer.com/chapter/10.1007/978-1-4612-1528-8_2

Spataro, F., Patrolecco, L., Ademollo, N., Præbel, K., Rauseo, J., Pescatore, T., & Corsolini, S. (2021). Multiple exposure of the Boreogadus saida from bessel fjord (NE Greenland) to legacy and emerging pollutants. *Chemosphere*, *279*, 130477. https://doi.org/10.1016/j.chemosphere.2021.130477

Su, F. C., Goutman, S. A., Chernyak, S., Mukherjee, B., Callaghan, B. C., Batterman, S., & Feldman, E. L. (2016). Association of environmental toxins with amyotrophic lateral sclerosis. *JAMA neurology*, *73*(7), 803-811. https://jamanetwork.com/journals/jamaneurology/fullarticle/2519875

Sweet, R. D., Warholic, D. T., Senesac, A. F., Gutenmann, W. H., & Lisk, D. J. (1988). Residues of dacthal and metabolites in field-treated Chinese cabbage. *Bulletin of environmental contamination and toxicology*, *41*(5), 642–644. https://doi.org/10.1007/BF02021012

Tate, C. M., & Heiny, J. S. (1996). Organochlorine compounds in bed sediment and fish tissue in the South Platte River Basin, USA, 1992–1993. *Archives of Environmental Contamination and Toxicology*, *30*(1), 62-78. https://link.springer.com/article/10.1007/BF00211330

Vogel, J. R., Majewski, M. S., & Capel, P. D. (2008). Pesticides in rain in four agricultural watersheds in the United States. *Journal of environmental Quality*, *37*(3), 1101-1115. https://doi.org/10.2134/jeq2007.0079

Waldron, A. C. (1973). Herbicide residues on strawberries: the effects of combinations of dacthal and sesone. https://www.cabidigitallibrary.org/doi/full/10.5555/19742304705

Weldon, R. H., Barr, D. B., Trujillo, C., Bradman, A., Holland, N., & Eskenazi, B. (2011). A pilot study of pesticides and PCBs in the breast milk of women residing in urban and agricultural communities of California. *Journal of environmental monitoring*, *13*(11), 3136-3144. https://pubs.rsc.org/en/content/articlehtml/2011/go/c1em10469a

Wheeler, D. C., Rustom, S., Carli, M., Whitehead, T. P., Ward, M. H., & Metayer, C. (2021). Assessment of grouped weighted quantile sum regression for modeling chemical mixtures and cancer risk. *International journal of environmental research and public health*, *18*(2), 504. https://doi.org/10.3390/ijerph18020504

Wheeler, D. C., Rustom, S., Carli, M., Whitehead, T. P., Ward, M. H., & Metayer, C. (2021). Bayesian group index regression for modeling chemical mixtures and cancer risk. *International journal of environmental research and public health*, *18*(7), 3486. https://doi.org/10.3390/ijerph18073486

Wu, X., Davie-Martin, C. L., Steinlin, C., Hageman, K. J., Cullen, N. J., & Bogdal, C. (2017). Understanding and predicting the fate of semivolatile organic pesticides in a glacier-fed lake using a multimedia chemical fate model. *Environmental science & technology*, *51*(20), 11752-11760. https://pubs.acs.org/doi/full/10.1021/acs.est.7b03483

Yan, X., Lashley, S., Smulian, J. C., Ananth, C. V., Barr, D. B., Ledoux, T. A., ... & Robson, M. G. (2009). Pesticide concentrations in matrices collected in the perinatal period in a population of pregnant women and newborns in New Jersey, USA. *Human and Ecological Risk Assessment*, *15*(5), 948-967. https://doi.org/10.1080/10807030903153089

Yao, Y., Harner, T., Ma, J., Tuduri, L., & Blanchard, P. (2007). Sources and occurrence of dacthal in the Canadian atmosphere. *Environmental science & technology*, *41*(3), 688-694. https://pubs.acs.org/doi/full/10.1021/es061725r

Zhang, X., Meyer, T., Muir, D. C., Teixeira, C., Wang, X., & Wania, F. (2013). Atmospheric deposition of current use pesticides in the Arctic: Snow core records from the Devon Island Ice Cap, Nunavut, Canada. *Environmental Science: Processes & Impacts*, *15*(12), 2304-2311. https://pubs.rsc.org/en/content/articlehtml/2013/em/c3em00433c

Zhong, G., Xie, Z., Möller, A., Halsall, C., Caba, A., Sturm, R., ... & Ebinghaus, R. (2012). Currently used pesticides, hexachlorobenzene and hexachlorocyclohexanes in the air and seawater of the German Bight (North Sea). *Environmental Chemistry*, *9*(4), 405-414. https://doi.org/10.1071/EN12065

Zhong, G., Tang, J., Xie, Z., Möller, A., Zhao, Z., Sturm, R., ... & Ebinghaus, R. (2014). Selected current‐use and historic‐use pesticides in air and seawater of the Bohai and Yellow Seas, China. *Journal of Geophysical Research: Atmospheres*, *119*(2), 1073-1086. https://doi.org/10.1002/2013JD020951

Zhong, G., Tang, J., Xie, Z., Mi, W., Chen, Y., Möller, A., ... & Ebinghaus, R. (2015). Selected current-use pesticides (CUPs) in coastal and offshore sediments of Bohai and Yellow seas. *Environmental Science and Pollution Research*, *22*(3), 1653-1661. https://link.springer.com/article/10.1007/s11356-014-2648-7

Zhong, G., Xie, Z., Cai, M., Möller, A., Sturm, R., Tang, J., ... & Ebinghaus, R. (2012). Distribution and air–sea exchange of current-use pesticides (CUPs) from East Asia to the high Arctic Ocean. *Environmental science & technology*, *46*(1), 259-267. https://pubs.acs.org/doi/full/10.1021/es202655k

***Figure A4.* List of the documents included in the systematic review of EPA Docket EPA-HQ-OPP-2011-0374 (listed in the order they were posted to the docket).**

May 27, 2011 - DCPA. (Chlorthal Dimethyl). Human Health Assessment Scoping Document in Support of Registration Review. *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0004

DCPA Summary Document Registration Review: Initial Docket June 2011. *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0002

Registration Review: Pesticide Dockets Opened for Review and Comment and Other Docket Actions. *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0001

January 20, 2011 - BEAD Chemical Profile for Registration Review: DCPA (078701). *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0005

August 18, 2010 - DCPA-Chlorthal-dimethyl (078701), Screening Level Usage Analysis (SLUA). *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0006

May 31, 2011 - Registration Review – Preliminary Problem Formulation for the Ecological Risk Assessment of Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA). *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0003

December 1, 2010 - Appendix A: Food/Feed & Non-Food/Non-Feed Uses [of DCPA] Considered in Registration Review Work Planning. *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0007

11/20/2011 DCPA Final Work Plan Registration Review. *Environmental Protection Agency*. (2011). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0008

DCPA Generic Data Call In (GDCI-078701-1140). *Environmental Protection Agency*. (2013). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0009

DCPA Weight of Evidence Analysis (WOE). *Environmental Protection Agency*. (2015). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0010

DCPA Data Evaluation Records (DERs) for EDSP Tier 1 Assays. *Environmental Protection Agency*. (2015). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0011

DCPA: HED Review of the Comparative Thyroid Assay Range-Finding Study and Thyroid Hormone Methods Data November 16, 2017 DP Barcode D444017, TXR No. 0057666. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0045

Data Evaluation Report on the Acute Toxicity of Dacthal Technical to Algae, Anabaena flos-aquae MRID No. 49307507. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0030

Data Evaluation Record on the Chronic Toxicity of Dacthal (DCPA) to Freshwater Invertebrates - Daphia Magna MRID No. 49307510. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0019

Data Evaluation Record Chronic Sediment Hyalella azteca Toxicity Test (Following EPA Test Method 100.4, draft guideline 850.1770) MRID No. 49865801. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0031

Data Evaluation Report on the Acute Toxicity of Dacthal of 2,3,5,6-Tetrachloroterephthalic acid (degradate of DCPA) to Fresh Water Invertebrates - Daphnia magna MRID No.

51235101. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0035

Data Evaluation Report on the Acute Toxicity of Dacthal to Algae, Navicula pelliculosa MRID No. 49307508. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0029

DCPA: HED Review of the Revised Comparative Thyroid Toxicity Study Protocol April 16, 2015 DP Barcode D424915 TXR No. 0054026. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0044

Data Evaluation Record 850.1025 - Acute EC50 Test with an Estuarine/Marine Mollusk Shell Deposition Study MRID No. 49500701. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0015

Data Evaluation Report on the Acute Toxicity of Dacthal W-75 [ai: chlorthal-dimethyl (Dacthal)] to Green Algae, Pseudokirchneriella subcapitata (formerly Selenastrum capricornutum) MRID No. 51499402. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0028

Data Evaluation Record MYSID Life Cycle Test OCSPP 850.1350 MRID No. 49307512. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0022

Data Evaluation Record on the Acute Toxicity of Tetrachloroterephthalic Acid (TPA) (Metabolite of DCPA) to Freshwater Invertebrates – Daphnia magna MRID No. 49307519. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0033

Data Evaluation Record on the Toxicity of TPA, a metabolite of DCPA, to Terrestrial Vascular Plants: Seedling Emergence MRID No. 51235102. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0036

DCPA: HED Review of the Comparative Thyroid Toxicity Study Protocols November 19, 2013 DP Barcode D413170, TXR No. 0056835. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0041

Data Evaluation Report on the Acute Toxicity of Tetrachloroterephthalic Acid (degradate of DCPA) to Algae Pseudokirchneriella subcapitata (formerly Selenastrum capricornutum) MRID No. 5149401. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0037

Summary of the Submitted Information and Data still Considered Outstanding for DCPA and/or TPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0039

DCPA (Dacthal): HED Response to Comments on the Residue Chemistry Requirement 860.1900 (Field Accumulation in Rotational Crops) of the Generic Data Call In (GDCI-078701-1140) February 17, 2015 DP Barcode D423450. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0043

Protocol Review for an Updated Range-Finding Comparative Thyroid Assay for Dimethyl Tetrachloroterephthalate (DCPA) March 9, 2020; DP Barcode D456384 TXR No. 0057999. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0046

Suspension of Registration of Pesticide Product (EPA Registration Number 5481- 495) for Failure to Comply with the Data Call-In (GDCI-078701-1140, issued January 31, 2013). *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0052

DCPA (Dacthal): HED Response to Comments on the Residue Chemistry Requirements of the Generic Data Call In (GDCI-078701-1140) October 23, 2013 DP Barcode D413176, D413177, D413195, D413202, D413218. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0042

Data Evaluation Record Acute LC50 Test with an Estuarine/Marine Shrimp 850.1035 MRID No. 49307505. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0016

Data Evaluation Report on the Acute Toxicity of Dachal Technical to Algae, Skeletonema costatum MRID No. 49307504. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0027

Data Evaluation Record Life-Cycle Sediment Chironomus dilutus Toxicity Test (Following EPA Test Method 100.5; 850.1760, in prep) MRID No. 49865802. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0032

Study Plan review for a range-finding and comparative thyroid assay for dimethyl tetrachloroterephthalate (DCPA) September 17, 2019 DP Barcode D420813, TXR No. 0057935. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0047

DCPA: Response to Waiver Request for the Chronic Sediment Toxicity Study with Leptocheirus plumulosus June 27, 2016 DP Barcode D432677. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0050

DCPA HED Response to (12 month) Comments on the Residue Chemistry Requirements of the Generic Data Call-In (GDCI-0798701-1140). *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0040

DCPA (Chlorthal-dimethyl): Review of Study Protocols for Determining Chronic Toxicity to Sediment-Dwelling Estuarine/Marine and Freshwater Organisms, March 20, 2014 DP Barcode D413319, D413320, D413321. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0048

Transmittal of Data Evaluation Records (DER) for DCPA and TPA Response to Registrant's Data Waiver Requests for Environmental Fate Studies for TPA February 7, 2017 DP Barcode D413733, D413736, D420875, D420877, D420903. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0051

Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA): Response to Registrant's Waiver Requests of Environmental Fate Data for DCPA and Its Degradate Tetrachlorophthalic Acid (TPA). *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0014

Data Evaluation Report on the Acute Toxicity of Dacthal (DCPA) to Freshwater Invertebrates - Daphnia sp MRID No. 49307514. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0020

Data Evaluation Report on the Acute Toxicity of Dachal Technical to Aquatic Vascular Plants (Lemna gibba G3) MRID No. 49307509. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0026

Notification of Outstanding Data Requirements, and Anticipated Registration Review Schedule for DCPA, 10/16/20. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0013

Pesticide Product Registration: Dimethyl Tetrachloroterephthalate; Suspension. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0012

Data Evaluation Record on the Acute Toxicity of Dachal (DCPA) to Terrestrial Vascular Plants: Vegetative Vigor MRID No. 49307506. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0025

Data Evaluation Report on the Acute Toxicity of Dacthal (DCPA) to Fish (Cyprinodon variiegatus) MRID No. 49307511. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0017

Response to Data Waiver Requests for Ecological Effects Related Data for Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA) and Its Degradate Tetrachlorophthalic Acid (TPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0038

Data Evaluation Report on the Acute Toxicity of Dacthal W-75 (ai: Dacthal) to Rainbow Trout Oncorhynchus mykiss MRID No. 51398105. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0018

Data Evaluation Report on the Chronic Toxicity of Chlorthal-dimethyl (DCPA) to Freshwater Invertebrates - Daphnia magna MRID No. 51398104. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0021

Data Evaluation Record on the Acute Oral Toxicity of DCPA (Chlorthal Dimethyl) to Zebra Finch (Taeiopygia guttata) MRID No. 49477601. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0023

Data Evaluation Record on the Acute Toxicity of Dacthal (DCPA) to Terrestrial Vascular Plants: Seedling Emergence MRID No. 49307513. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0024

Data Evaluation Report on the Acute Toxicity of Dacthal of Tetrachloroterephthalic Acid (TPA) (Metabolite of DCPA to Fish Oncorhynchus mykiss MRID No. 49307518. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0034

Response to registrant's data waiver requests for environmental fate and ecological effects related data for the parent DCPA and degradate TPA, March 21, 2014 DP Barcode D413324, D413329, D413333, D413344, D413353, D413364, D413365, D413369, D413377, D413379, D413381, D413382, D413390, D413392, D413393, D413399. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0049

Dimethyl 2,3,5,6-tetrachloroterephthalate, (Dacthal or DCPA) and its degradate Tetrachlorophthalic Acid (TPA): Transmittal of Data Evaluation Records (DERs) for 23 Ecotoxicity Studies. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0055

DCPA; Review of Ecological Effects Data Submissions required in GDCI-078701-1140. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0054

DCPA. A Review of the Existing Thyroid Toxicity Data and Residual Uncertainty Related to the Lack of a Definitive Comparative Thyroid Assay. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0053

Hearings: Objections to Notice of Intent to Suspend Dimethyl Tetrachloroterephthalate Technical Registration. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0056

DCPA. Review of a Protocol for an Oral (Gavage) Comparative Thyroid Assay (CTA), with a Lactational Exposure Assessment in Sprague Dawley Rats. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0057

DCPA, Diuron, and Fluometuron Meeting Notes: Webinar Hosted by Weed Science Society of America (WSSA) on Pesticide Registration Review, DCPA, Diuron, and Fluometuron June 15, 2022. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0058

Reason for Filing – Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0070

Objection to EPA Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0059

American Farm Bureau Federation AFBF DCPA NOITS Letter. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0061

Stakeholder Input from Southern Crop Production Association on the Notice of Intent to Suspend the Herbicide DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0062

Meeting Between EPA and AMVAC Concerning Comparative Thyroid Assay Data. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0066

Reason for Filing - Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0068

Reason for Filing - Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0072

Reason for filing – Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0063

Objection to Intention to Suspend Herbicide DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0075

Objection to Intention to Suspend Herbicide DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0076

Reason for Filing - Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0064

Arizona Farm Bureau Federation (AZFB) DCPA NOITS Letter. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0065

Reason for Filing - Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0060

Reason for Filing – Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0071

Objection to EPA Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0073

Objection to EPA Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0077

Reason for Filing - Objection to the Intent to Suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0067

With this Letter our Organization Voices Strong Support to Avoid the Suspension of DCPA. The Active Ingredient in Dacthal Flowable herbicide in the United States. (Dacthal Technical is EPA Registration Number 5481‑495 and Dachtal Flowable is EPA Registration Number 5481‑487). *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0069

Reason for filing – Objection to the intent to suspend DCPA. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0074

Thain Farms DCPA NOITS Letter. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0078

Hearing: Intent to Suspend Dimethyl Tetrachloroterephthalate Technical Registration; Rescheduled. *Environmental Protection Agency*. (2022). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0079

DCPA Data Evaluation Record of a submitted definitive study to fulfill the Comparative Thyroid Assay study requirement MRID No. 51957801. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0080

Companion Document to the Occupational and Residential Exposure Assessment for the Registration Review of DCPA.. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0082

Adult Spray Drift Calculator D467110. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0083

DCPA. Occupational and Residential Exposure Assessment for the Registration Review of DCPA. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0081

Assessment of Dimethyl Tetrachloroterephthalate (DCPA) (PC: 078701) Use, Usage, and Benefits. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0088

USEPA-OPP-HED ExpoSAC Policy 3 Occupational Pesticide Re-entry Exposure Calculator March 2021 D467110. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0086

Residential-Sops-Lawns-Turf-Cancer D467110. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0085

USEPA-OPP-HED Occupational Handler Exposure May 2021 D467110. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0087

Children Spray Drift Calculator D467110. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0084

Pesticide Registration Review: Dimethyl Tetrachloroterephthalate; Draft Occupational and Residential Risk Assessment. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0089

DCPA AMVAC ORE Assessment meeting notes 20230601. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0093

20230718 Earthjustice Comments on DCPA OREA. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0103

DCPA Final Order of Suspension Letter. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0104

Administrative Settlement Agreement Between U.S. Environmental Protection Agency Office of Pesticide Programs And AMVAC Chemical Corporation. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0105

DCPA AMVAC meeting notes 20230925. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0106

DCPA CDPR meeting notes 20231011. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0107

DCPA Written Notice of Suspension Lifted 20231102. *Environmental Protection Agency*. (2023). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0108

DCPA AMVAC Meeting Notes 20231108. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0109

DCPA CDPR Meeting Notes 20240222. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0111

DCPA AMVAC Meeting Notes 20240213. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0110

AMVAC Response DCPA sent 20240221. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0113

EPA's response to AMVAC's DCPA risk mitigation proposal signed 20240327. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0112

EPA-OPP Information and Inquiry Dacthal (DCPA) Use on Brassica and Cole Crops 20240308. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0114

EPA Response to AMVAC Proposed DCPA Product Label 20240502. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0116

DCPA Revised Occupational and Residential Exposure Assessment for the Registration Review of DCPA to Reflect Proposed Mitigation 20240502. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0117

DCPA CDPR Meeting Notes 20240412. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0115

DCPA Study Review of Dacthal DCPA Assessment of the Differential in Leaf Foliage Surface Area within Transplanted Versus Mature Agricultural Fields 20240502. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0118

DCPA AMVAC Meeting Notes 20240506. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0119

Emergency Order: Suspending the Registrations of All Pesticide Products Containing Dimethyl Tetrachloroterephthalate. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0120

Request to Voluntarily Cancel Pesticide Registration: Dimethyl Tetrachloroterephthalate. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0121

DCPA AMVAC Meeting Notes 20240819. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0125

Dimethyl 2,3,5,6-Tetrachloroterephthalate (DCPA): Drinking Water Assessment in Support of Registration Review 20230417. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0122

DCPA. Summary of Hazard Updates to DCPA Metabolite Tetrachloroterephthalic acid (TPA) 20240812. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0123

DCPA Emergency Order of Suspension Transmittal Email to AMVAC 20240806. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0126

DCPA. Chronic (Food and Drinking Water) and Cancer Dietary (Food and Drinking Water) Exposure and Risk Assessment for Registration Review Risk Assessment 20240819. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0124

Pesticide Product Registration: Dimethyl Tetrachloroterephthalate; Final Cancellation Order. *Environmental Protection Agency*. (2024). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0130

AMVAC DCPA Recall Program Summary 20241219. *Environmental Protection Agency*. (2025). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0131

DCPA Registration Review Case Closure Case Number 0270 20250708. *Environmental Protection Agency*. (2025). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0132

DCPA AMVAC Meeting Notes 20240903-20241219. *Environmental Protection Agency*. (2025). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0133

Pesticide Registration Review: Decisions and Case Closures for Several Pesticides. *Environmental Protection Agency*. (2025). https://www.regulations.gov/document/EPA-HQ-OPP-2011-0374-0134