

PFAS in Maine:

A Case Study in Environmental Governance

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ABSTRACT

This research describes environmental health governance in response to per- and polyfluoroalkyl substances (PFAS) contamination in Maine. PFAS are a class of 14,700 human-made chemicals that are persistent, ubiquitous, and mobile in the environment, exposure to which is associated with adverse health outcomes. Governance actions that address PFAS contamination are complex, existing between scales of governance, types of governance actions, and across stakeholder groups. Through legislative history research and interviews with stakeholders, I describe Maine's national leadership in widespread testing, broad regulation, and advocacy on farmland contamination.

INTRODUCTION

Governance actions that address per- and polyfluoroalkyl substances (PFAS) contamination are complex and diverse, occurring at different scales of governance (federal, state, and local), including varied types of governance activities (regulatory, legislative, and nonregulatory activities), and involving multiple stakeholder groups. PFAS are a class of approximately 14,700 human-made fluorinated chemicals that are persistent, ubiquitous, and mobile in the environment. Individuals may encounter PFAS through many sources including nonstick coatings in cookware, textiles such as waterproof clothing and upholstery, firefighting foam and protective gear, cosmetic and personal care products, food packaging, and food. Exposure to PFAS is associated with adverse health outcomes including cancers, weakened immune response, hormonal disruption, adverse reproductive outcomes, and liver and kidney diseases (Trowbridge et al. 2020). Because many PFAS are highly water soluble, exposure to PFAS contamination through drinking water is a particular concern (Hu et al. 2016). Major sources of PFAS releases into the environment include industrial facilities that produce or process PFAS; areas where fluorine-containing Class B firefighting foams are stored, used, or released; waste management facilities such as landfills; and wastewater

treatment residuals and areas of sludge production and application.¹

PFAS governance exists within the larger context of complex environmental governance. Environmental governance is broadly defined as “the set of regulatory processes, mechanisms, and organizations through which political actors influence environmental actions and outcomes” (Lemos and Agrawal 2006: 298). Environmental governance increasingly occurs via methods beyond traditional policies and legislation, including international accords, local decision-

making structures, transnational institutions, environmental nongovernmental organizations, business interests, and scientists (Karkkainen 2004). As environmental problems grow increasingly complex, we need to craft environmental governance that combines the roles of state, market, and civil society to adequately address environmental issues (Bulkeley 2005). Indeed, due to their widespread use and extreme resistance to degradation, PFAS regularly cross various spatial, sociopolitical, and temporal scales (Hu et al. 2016). Furthermore, due to the global spread of PFAS, the irreversibility of exposure to PFAS, and the associated biological effects, Cousins et al. (2022) postulate that a new “planetary boundary” for PFAS has been exceeded. Planetary boundaries delineate the limits within which humanity can safely operate with respect to a functioning Earth system; crossing that boundary implies serious consequences for environmental integrity, human health, and remediation costs.

This article presents a case study within the PFAS Project Lab's² broader study of environmental governance. The PFAS Project began by studying overall social and scientific discovery of PFAS, then examined PFAS activism, and is currently studying governance. Eight states were selected for case studies on PFAS governance because it would not be feasible to analyze every piece of PFAS legislation, regulation, and litigation nationwide. States were selected because they are engaged in varying

forms of governance and because they vary in select criteria, including the extent of PFAS contamination; timing of maximum contaminant levels, if created; level of community engagement; level of technical competence in state agencies; and development of innovative types of governance. Maine is one of several select states with a relatively high amount of PFAS governance and is frequently mentioned by activists and legislators across the United States as a model. Furthermore, Maine has been a national leader in other chemical regulation—the state’s past successes in phasing out mercury, arsenic, and flame retardants from household products laid the foundation for its comprehensive response to PFAS.³

Using a qualitative approach that combines legislative history research and an analysis of stakeholder interviews, I describe select examples of key governance actions. I argue that prior chemicals regulation, Maine’s culture and values, certain characteristics of the legislature, the timing of industry lobbying, and collaboration between key players have contributed to the development of interdisciplinary environmental governance across state, federal, and local levels. This paper discusses the benefits and challenges of this multifaceted approach to PFAS governance and suggests that Maine’s approach may be applicable to PFAS governance in other states and to toxics governance more broadly.

Overview of PFAS

While PFAS have been produced since the 1940s, public awareness of their toxicological concerns did not emerge until the early 2000s (Richter et al. 2018). This public awareness was initiated by a class action lawsuit brought against chemical manufacturer DuPont for releasing perfluorooctanoic acid (PFOA)—one of the most widely used and studied PFAS compounds—into drinking water and farmland in West Virginia and the Ohio River Valley (Rich 2016). The settlement required DuPont to fund an independent epidemiological study of residents exposed to PFOA, the results of which expanded scientific and regulatory attention to the greater class of PFAS. In response to the health concerns that this study elucidated, EPA launched its PFOA Stewardship Program in 2006, inviting eight US manufacturers to phase out production and use of PFOA and related long-chain PFAS compounds by 2015 (US EPA 2006). As a result of this non-binding approach, PFOA and perfluorooctane sulfonic acid (PFOS) (the two most widely produced chemicals in the class) are no longer manufactured in the United States; however, they have since been replaced with short-chain

alternative PFAS, which may also adversely affect human health (Hu et al. 2016).

Despite the widespread prevalence and many toxic effects of PFAS, federal regulations of them have taken decades to develop due to the enormous size of the chemical class and their use in over 200 distinct categories of products. On April 10, 2024, EPA and the Biden-Harris administration finalized the first national legally enforceable drinking water standards for PFAS. The agency set low maximum contaminant levels of 4 parts per trillion for PFOA and PFOS and 10 parts per trillion for three other widely used PFAS compounds.⁴ The new standards also include maximum contaminant level goals of 0 parts per trillion for PFOA and PFOS, a nonenforceable health-based goal that reflects the research suggesting there is no safe level of exposure to these compounds. In addition to the rule, EPA made nearly \$1 billion in funding available through the Bipartisan Infrastructure Law for states to test and treat public water systems and wells for PFAS (US EPA 2024a).⁵ In the realm of federal legislation, Congress members have sponsored bills related to detection and research, regulatory mandates, clean-up assistance, and responses to military use of PFAS, but few bills have passed both chambers of Congress. In the absence of enforceable federal PFAS standards prior to April 2024, state governments acted to develop drinking water regulations, fund remediation, conduct environmental monitoring, and restrict PFAS in firefighting foams.

PFAS chemicals present an interesting and unique case for studying environmental governance for several reasons. First, the growth in PFAS governance across multiple levels of government and among many stakeholders has been unprecedented. As federal regulations continue to develop, they will intersect with existing state and local governance activities in varying ways. Second, differences in chemistries and use patterns compared to other classes of chemicals have distinguished the regulatory trajectory of PFAS. For example, the persistent, bioaccumulative, and hazardous nature of PFAS makes them ideal for class-based regulations, an approach that did not gain traction with other classes of toxics such as flame retardants (Cordner 2016). Finally, the widespread use of PFAS in popular products, coupled with more local industrial releases, has made contamination both ubiquitous and highly localized (Calafat et al. 2007).⁶

PFAS in Maine

The discovery of widespread PFAS contamination in Maine occurred in 2016 at Stoneridge Dairy Farm in

Arundel, Maine. The neighboring Kennebunk, Kennebunkport, and Wells Water District had participated in the third federal Unregulated Contaminant Monitoring Rule (UMCR 3) (which took place between 2013 and 2015), where PFOS was detected at 50 parts per trillion. Maine Department of Environmental Protection (DEP) subsequently investigated the nearby Stoneridge Dairy Farm, where PFOA and PFOS were detected in milk at concentrations as high as 1,420 parts per trillion, over six times greater than state standards for adulterated milk (Maine PFAS Task Force 2020). PFOA and PFOS were also present in the farm's soil at levels 25 times greater than the state's contaminated soils screening level (Moavenzadeh Ghaznavi et al. 2023). Hay, cow manure, and drinking water were also contaminated with PFAS, leading the farm's owner Fred Stone to shut down his operations and euthanize livestock. The discovery prompted DEP to test municipal sludge, the suspected source of PFAS contamination, which revealed all municipal sludge tested in the state contained PFAS (Treat 2021).

While PFAS contamination is a national issue, the significant public, scientific, and regulatory attention on sludge and agricultural land contaminated with PFAS in Maine distinguishes the state from others that are addressing PFAS. Passed in 1972, the Clean Water Act required wastewater treatment processes to remove organic waste, solids, and pathogens from treatment effluent discharged into surface waters. The solids, known as wastewater sludge, are rich in nutrients and were applied to agricultural fields nationwide beginning in the 1970s. PFAS, persistent organics pollutants, and pharmaceuticals are not removed by current wastewater treatment technologies, but these chemicals are not included in federal regulations on the land application of sludge. Once PFAS-laden sludge is applied to land, the chemicals can easily separate into the soil or water. PFAS are also highly mobile and can continue to move through groundwater to contaminate drinking water (Moavenzadeh Ghaznavi et al. 2023). In fact, DEP collected PFAS data on 2,171 residential drinking water wells across the state, finding that 23 percent had a sum of six PFAS greater than Maine's Interim Drinking Water Standard (Maine DEP 2023).

STUDY DESCRIPTION

This case study uses a mixed-methods approach combining legislative history research and qualitative analysis of interviews with stakeholders. I researched 37 governance actions by Maine related to PFAS drawn

from the PFAS Project Lab Governance Tracker.⁷ To find state actions, the PFAS Project Lab reviewed information collected by Safer States, a network of environmental health organizations, about passed and unpassed legislation, and entered all legislation related to PFAS into a database. Other governance actions in the database were identified via news articles, organizational websites and media, and searches of legislation for keywords such as "PFAS" and "forever chemicals."

Of the 37 governance actions researched, 34 were pieces of legislation introduced in the Maine State Legislature between 2019 and 2023. I tracked the progress of bills through the legislative process and examined bill drafts, committee hearing reports, public testimony, and news articles to ascertain legislative intent. The status of pending legislation was tracked until the adjournment of the 131st legislative session on April 17, 2024. The remaining three governance actions are a lawsuit against PFAS manufacturers brought by the state attorney general and two consumption advisories for freshwater fish and game. For these, I reviewed primary sources, state agency websites, technical documents, and news articles. I also drew ancillary information from the organizational websites of Defend Our Health (an environmental health advocacy organization based in Maine), the University of Maine, and the PFAS Project Lab.

I completed five interviews between January and March 2024. Interviewees were recruited based on their highly visible public involvement in governance, such as sponsoring multiple PFAS bills or engaging in policy advocacy. Interviewees were contacted via email and interviews took place over Zoom for 40 to 60 minutes. I interviewed two policy advocates at Defend Our Health; one environmental lawyer/former legislator; one current legislator; and one representative of the Maine Center for Disease Control (Maine CDC) (who wished to be quoted anonymously). Interviews were digitally recorded, transcribed, and de-identified. In each interview, I drew questions from a semistructured, collaborative interview guide developed by the PFAS Project Lab and tailored to the individual's background and work. The questions focused on understanding the factors leading to the development of PFAS governance in Maine and whether or to what extent multiple stakeholders engage with different forms and scales of governance ([Appendix](#)).⁸ Interviews were then coded for similar themes. The involvement of human participants in this research was reviewed and approved by the Northeastern University Institutional Review Board (#21-10-09).

EXAMPLES OF GOVERNANCE

Reducing PFAS in Food Packaging (2019)

Maine's LR 1184 (Act to Protect the Environment and Public Health by Further Reducing Toxic Chemicals in Packaging) has incorporated regulatory research from Washington state and thus presents an example of interstate PFAS governance. The statute prohibits the intentional use of PFAS in a food package or a packaging component of food package, contingent on whether DEP has determined a safer alternative is readily available at a comparable cost (32 MRSA §§1731-1747). The legislation was signed into law on June 13, 2019, and was meant to take effect January 1, 2022, or two years after DEP determines a safer alternative is available, whichever date was later. Importantly, this legislation addressed the lack of updated federal regulation regarding chemicals of concern in food packaging (Defend Our Health 2019).

Since the bill became law, the Maine DEP has referred to the Washington State Department of Ecology's investigation of safer alternatives, as their food packaging restrictions law is similar. The Department of Ecology studied alternative products used to hold and serve freshly prepared food and defined a safer alternative as "an alternative material or chemical that both meets improved hazard and exposure considerations and can be practicably and economically substituted for the original chemical" (Washington DOE 2021: 10). Based on these findings, Maine DEP concluded that four of the ten food packaging applications reviewed have alternatives to PFAS in line with Maine's standards for safer alternatives. However, due to differences in Maine and Washington's regional markets, DEP has not made a final determination on the sales prohibition.⁹ Thus, because DEP has not confirmed the availability of safer alternatives, this law has not yet taken effect. Despite this delay, the law is notable for several reasons. First, it was the first PFAS-related law to pass with a definition of PFAS inclusive of the entire chemical class, setting the precedent for future PFAS restrictions. In addition, the ban on PFAS in food packaging has propelled research into safer alternatives to PFAS, potentially affecting interstate commerce and pushing other states to reconsider their food packaging safety laws.

Maine PFAS Task Force (2019–2020)

The Maine PFAS Task Force brought together the perspectives of multiple stakeholders to influence legislation and is thus an integral form of multistakeholder and intrastate governance. The task force was established in

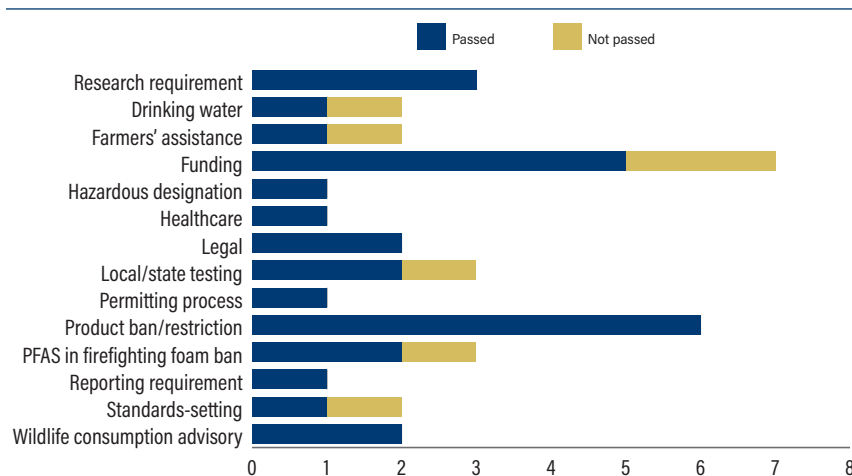
2019 via executive order by Governor Mills to review the extent of PFAS contamination in Maine and recommend ways to protect Maine residents from exposure to PFAS. Governor Mills saw that it was necessary for states to take the lead and address the risks and issues PFAS pose in light of EPA's lack of timely action (Office of the Governor 2019). Indeed, Maine was among the first five states to establish a task force on PFAS.¹⁰ The task force was comprised of representatives from DEP, Maine CDC, and the Department of Agriculture, Conservation and Forestry (DACF); Maine Public Health Association; the pulp and paper industry; public drinking water professionals; sludge and residuals management professionals; the Department of Defense; and Defend Our Health (Maine PFAS Task Force 2020).

In its summary, the task force report identified what the state should prioritize, namely, "providing safe drinking water; protecting the food supply; identifying and investigating PFAS contaminants in the environment; identifying and reducing uses of PFAS; managing waste and waste residuals responsibly; improving public education about PFAS; promoting federal action; and funding for state agencies to investigate, respond to and reduce exposure of Maine citizens to PFAS" (Maine PFAS Task Force 2020: 2). In addition to the recommendations, the report provided information on PFAS uses, described human exposure concerns, and summarized data from the environmental, drinking water, and agricultural testing that had been conducted by state agencies. The report's recommendations were subsequently incorporated into the 17 pieces of PFAS legislation introduced in Maine's following legislative session in 2021 and 2022. The task force and its final report served to inform legislators and other stakeholders on a complicated, pressing issue and provide tools for action.

Governance actions addressing PFAS in Maine span 14 topic areas (Figure 1) and involve numerous state agencies. Only through effective intrastate coordination between proactive state agencies and actors has PFAS governance been successful. A Maine CDC representative (2024, personal communication) described the utility of monthly interagency meetings between representatives from Maine CDC, DEP, DACF, and the Department of Inland Fisheries and Wildlife:

We have a monthly talk and we update each other on what's going on. So we'll update on our data that we're receiving. Toxicologists will bring up anything that is new on their end. They're mostly doing a lot of studies and going over the

FIGURE 1: **Summary of the Quantity and Breadth of PFAS Governance Actions, 2019–2023**



research. And then our DEP colleagues are doing all of the private well testing.... So yes, it's great to get updated on not just PFAS and drinking water, but what the state is doing as a whole.

Sarah Woodbury, vice president of programs and policy at Defend Our Health (personal communication, 2024), also described how Maine's interagency collaboration is a strength:

I do think it's important because [PFAS] is such a widespread issue that it doesn't just fall under DEP. It doesn't just fall under DEP or DACF, because PFAS contamination is so prevalent across the US and the world that you need all hands-on deck to deal with the issue. Maine's been pretty good about interagency partnerships.... They work really well together. And I do think that is a model for other states. I think it behooves people to share information and bring as many experts in as they can.

The PFAS Fund (2022)

In 2022, the Fund to Address PFAS Contamination (also called the PFAS Fund) appropriated \$60 million to support farmers whose land and water are contaminated with PFAS. The funds could be used for many purposes including monitoring the health of farmers and their families, buying and selling contaminated agricultural land, and conducting research and long-term monitoring of contaminated sites (7 MRS §320-K). The fund established an interdisciplinary advisory committee that has worked to include the perspectives of other stakeholders as it organizes and plans for funding, making the PFAS Fund a compelling example of multistakeholder governance. The

15-member advisory committee consists of two state senators; two state representatives, the commissioners of DACF, DEP, and CDC; the dean of the Maine Agricultural and Forest Experiment Station at the University of Maine; an expert in agricultural finance; an expert in public health; and five farmers.¹¹ The advisory committee also formed subcommittees to address specific issues—namely, financial and business support, land transfers, research, and health—with membership and input from stakeholders beyond the advisory committee (PFAS Fund Advisory Committee 2023). Finally, the advisory committee held a public hearing

and solicited public comments on its draft PFAS Fund implementation plan in 2023 to inform the final eligibility criteria, administrative procedures, and programs for the PFAS Fund, which opened to applications in March 2024 (Maine DCF 2024).

Ban on the Land Application of Sludge (2022)

In light of the agricultural issues stemming from the land application of PFAS-laden sludge, in 2022 Maine became the first state to ban the practice (38 MRS §1304). This ban diverted wastewater sludge generated in the state to landfills and illuminates how PFAS governance can create environmental justice concerns. There are several drawbacks to landfilling sludge. First, the liners underneath landfills meant to contain leachate (polluted liquid that has filtered through solids) can become permeable with time and release contaminants like PFAS into the surrounding groundwater and air. Indeed, analyses of leachate produced by Juniper Ridge Landfill in Maine between December 2021 and October 2022 showed increasing concentrations of PFAS in this 10-month period (Moavenzadeh Ghaznavi et al. 2023). Furthermore, landfill capacity is finite. Landfilled sludge must either be dried to reduce volume—an energy-intensive process—or be coupled with bulky materials to stabilize it, which requires more space (US EPA 2024b). Shortages of bulky materials and public opposition to expanding Juniper Ridge Landfill reveal the limitations of managing sludge via landfills in the long term (Maine BGS 2024).

This imperfect solution to reducing agricultural PFAS contamination has shifted the burden of pollution

to landfills, sparking environmental justice concerns for the Native Nations in Maine. The Penobscot Nation is located along the Penobscot River, into which leachate from landfills is regularly discharged. Landfill leachate is treated before being discharged into water bodies, but current treatment systems in Maine fail to remove PFAS. Tests show leachate contains 20 times more PFAS than is allowed by the state in drinking water (Miller 2022). Furthermore, of the more than 400 closed municipal landfills in Maine, 72 are in the Penobscot River Watershed. DEP has found PFAS when sampling monitoring wells at these sites, but the extent of PFAS pollution in the Penobscot River and broader watershed ecosystem remains unknown due to lack of comprehensive testing (Schauffler 2022a).

PFAS contamination in the Penobscot River has implications for subsistence fishing, hunting, and gathering traditions for tribal communities in Maine. In 2021, the US Agency for Toxic Substances and Disease Registry evaluated the public health effects of exposure to contaminants in the Penobscot River by sampling fish tissue and aquatic plants. The agency reported that sea-run fish contained PFAS, mercury, and dioxins—specifically, PFOS was found in four fish species at levels that could cause adverse health effects (ATSDR 2021). Jan Paul, the Penobscot Nation’s water resources technician, said she avoids eating duck, fish, and other traditional Wabanaki foods after spending decades monitoring pollution in the watershed. Paul and the Penobscot Nation’s water resources program manager Dan Kusnierz are working to help “tribal members navigate the risks of contaminated fish and riverine plants,” food sources that are essential to the Penobscot cultural identity (Schauffler 2022a). PFAS contamination has been characterized as “another legacy of harm from colonization” by Darren Ranco, a Penobscot Nation member and professor at the University of Maine and leaves tribal members struggling to sustain a livable home and traditional ways of life (Schauffler 2022a).

Several initiatives are underway to address the implications of PFAS pollution for the Penobscot Nation. One provision of the “Act to Investigate PFAS Contamination of Land and Groundwater,” passed in 2021, required DEP to evaluate leachate collected and managed by solid waste landfills for PFAS contamination (38 MRSA §1310-B-1). DEP has since recommended treatment technologies to reduce PFAS concentrations in leachate to below the Maine Interim Drinking Water Standard of 20 ng/l (Brower 2024). The Penobscot Nation supported the ban on land application of sludge, but also advocated for legislation to test and treat leachate to prevent it from

becoming another source of PFAS pollution (Schauffler 2022b). Maine Resolves 2022, Ch. 172 was subsequently passed as an emergency resolution to require a study on the methods of treating leachate collected at state-owned landfills to reduce the concentration of PFAS. The state has since authored a report that reviews sources and volumes of leachate collected at landfills and summarizes the available and best treatment technologies (Sevee & Maher Engineers 2023). The report was submitted to the legislature in January 2023 and may inform the development of laws on leachate in the next legislative session.

Relief for Farmers Hit with PFAS Act (2023)

As a key example of state-federal governance, Senator Collins and Senator King, who represent Maine in the US Congress, have sponsored a bill supporting farmers that was modeled after existing farmer assistance funds in Maine. The Relief for Farmers Hit with PFAS Act would create grants for states to provide financial assistance to affected farmers, expand monitoring and testing, remediate PFAS, and help farmers relocate (Collins 2023a). Senator Collins urged the US Department of Agriculture to step up and provide support to farmers across the nation, as the scope of agricultural contamination is not limited to Maine. The proposed bipartisan, bicameral legislation has been characterized as a unified approach to remediating PFAS issues and was co-sponsored by the entire Maine delegation in Congress as well as senators from New Hampshire, who are highly involved in PFAS policy due to military and industrial contamination in the state, and New Mexico, another site of major farm contamination (S.747—Relief for Farmers Hit with PFAS Act). The act was commended by Maine Farmland Trust and Maine Organic Farmers and Gardeners Association (MOFGA), nonprofit organizations that have jointly established a farmers assistance grant program in Maine.¹² In fact, state Representative Bill Pluecker also works as a public policy organizer at MOFGA and was brought on specifically to build support for the act (Pluecker, personal communication 2024). Hence, the connections between state and federal legislation regarding funding for farms is a key example of state-federal PFAS governance.

DEVELOPMENT OF GOVERNANCE IN MAINE

Prior Chemicals Regulation

Maine’s history of social movement advocacy and environmental policies addressing mercury and dioxin pollution helped pave the way for PFAS

governance. While the nation's largest industrial firms never took hold in Maine, paper and textile manufacturing have held a large presence in the state and have dammed and significantly polluted the Kennebec, Penobscot, and Androscoggin Rivers. As early as 1929, grassroots protesters had organized against industrial pollution in response to typhoid outbreaks along the watersheds where paper manufacturers disposed of waste. These polluted watersheds fostered a coalition between merchants and community organizations who were linked by their shared uses of the river. In the 1950s, statewide organizations focused on environmental conservation were formed, including Citizens for Conservation and Pollution Control and the Natural Resources Council of Maine. These groups campaigned throughout the latter decades of the 20th century against mercury and dioxins, persistent bioaccumulative substances released by pulp and paper manufacturers that activists found particularly difficult to challenge because they were byproducts of production. These battles against entrenched local industries enabled state-level environmental advocacy to become professionalized and activists to become skilled in policy negotiation with state and industry, all while developing a strong understanding of the relationship between environmental issues and the economy (Altman 2008).

PFAS legislation in Maine is preceded by earlier progressive chemicals regulation by the state. In the early 2000s, Maine was among the first states to regulate dioxin and mercury stemming from household, medical, commercial, and industrial waste streams (Altman 2008), in addition to arsenic-treated wood used in outdoor structures (38 MRS § 1682). In 2004, Maine was also the first state to ban brominated flame retardants used in household products such as televisions, computers, and furniture (Cordner 2016). The legislature required industry to inform the public about chemical hazards present in consumer products, and, where an alternative is feasible, ban flame retardants and arsenic from certain goods (38 MRS § 1609). Current PFAS legislation has mirrored this approach by, for example, restricting PFAS from food packaging where an alternative is feasible (32 MRSA §§1731-1747).

Mainers' Values

As its history and leadership in environmental policy suggests, Mainers take pride in the state's tradition of environmental activism and preservation of natural resources. Farming is also an important part of Maine's culture as a

rural state. These values, coupled with extensive testing of soil and water contaminated by PFAS, is one reason why much legislative action and public attention has been centered around farmland contamination. Adam Nordell, farmer and environmental health advocate, underscored the importance of Maine's rural sustenance traditions (Nordell, personal communication, 2024):

There's a very strong tradition of home gardening, self-sustenance, [and] putting out food. That again, crosses a lot of cultural boundaries. The old timers who've been here for generations are very actively trying to feed themselves off their own land, as are people who've moved from away like myself and maybe have more of a progressive bent or a different worldview. So, when the state of Maine tells people, "you need to landfill your venison," there are plenty of people who rely on wild harvested venison as a significant part of their yearly protein and their food budget. It was very scary and confusing for a lot of people.

Nordell is referring to Maine's "Do Not Eat" consumption advisory for wild deer and turkey harvested in the Fairfield area, issued by the Department of Inland Fisheries and Wildlife (DIFW) in 2021. In 2021 DIFW began investigating PFAS levels in wildlife in the greater Fairfield area and found high levels of PFOS in deer in areas known to have high PFOS soil and surface water levels.¹³ Furthermore, Sharon Anglin Treat, environmental attorney and former legislator, described the tradition of environmental stewardship in Maine (Treat, personal communication, 2024):

And there's a history there too. I mean, [former US Senators from Maine] Muskie and Mitchell sponsored the Clean Water Act and Clean Air Act, and there's this history of environmental activism and a pride in that that I think is an important part of the state's image of itself. It's a tourist state so clean water, air, these are things that [Maine] markets. Something like PFAS, that's really a stain on that image of the state. It potentially has consequences beyond just the clean environment, but also affects the economy and questions whether this is a place that people want to come visit or move to.

Moreover, farmland contamination is particularly concerning in a rural state that prides itself on environmental protection. According to Nordell (personal communication, 2024):

Contaminating farmland is a uniquely bad idea. If you have a waste product and you're not sure where to put it, farmland is a uniquely bad place to put it because of course, we all depend on the health of farm soils and the health of crops grown on farms to nourish ourselves and our families.

Industry and Lobbying

The chemical manufacturing industry, one of the loudest opponents of legislation restricting PFAS, does not have a strong presence in Maine. So the state's early PFAS legislation passed without significant industry pushback. Woodbury noted (personal communication, 2024):

You've got this little state of 1.3 million people over in the corner in New England. The industry knew that these bills were happening, but they weren't necessarily as concerned. There's no real industry here—there's no 3M factory or Chemours factory. I mean, we have industry, but it's not the same.

Interviewees drew comparisons to larger states like California, where legislation is met with more opposition because laws in California have a bigger impact on commerce within and between states. This is not to say there has been no opposition: certain sectors of the agricultural industry, municipal wastewater treatment plants, Casella Waste Systems (a waste management company) and IDEXX (a veterinary technology company) have pushed back against legislation that affects these sectors in Maine. Corporations and lobbyists have increasingly opposed Maine's 2021 law phasing out nonessential uses of PFAS in products. (Pluecker, personal communication, 2024; Woodbury, personal communication, 2024). The law previously required manufacturers of consumer products to disclose their use of PFAS to the state by 2025. However, due to budget constraints, legislators amended the law in April 2024 to revise the requirement and delay the effective dates of certain sales bans, maintaining the law's protective intent while enabling the state to properly implement it (Salter and Woodbury 2024).

Industry has also attempted to challenge how PFAS are defined in Maine's laws. Nearly all legislation in Maine restricting PFAS—beginning with the state's initial action restricting PFAS in food packaging—have defined the chemicals as substances that include “any member of the class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom” (32 MRSA §§1731-1747). This class-based approach is critical: the toxicological and epidemiological risks associated with PFAS exposure suggest the entire chemical class should be regulated to avoid adverse human and environmental effects (Kwiatkowski et al. 2020). However, chemical companies have a history of circumventing class-based regulatory approaches, going so far as to intentionally weaken the federal Toxic Substances Control Act to render it unable

to address chemical classes known to pose health and environmental risks (Richter et al. 2021). In light of these regulatory challenges at the federal level, it is noteworthy that the Maine Legislature has opted to legislate PFAS under an inclusive class definition of the chemicals. As previously noted, this was in part possible because of the lack of industry pushback when PFAS were initially legislated in Maine:

We had an attempt to overturn [the class definition recently], which failed in the committee unanimously. It was voted down by even some of the more conservative Republicans. The definition fight, because it's in so much of our statute now, is a harder lift for industry to try to overturn it. I think they missed their window here in Maine to really do something with that definition because it's all over our statutes now. (Woodbury, personal communication, 2024)

Five years after Maine's first use of the class definition, the topic remains salient to the work of legislators who are addressing PFAS, as the class definition has increasingly garnered opposition from industry and the executive branch of government:

[The class definition] will continue to be the biggest hottest thing that we'll be fighting to preserve in Maine in the coming years. The executive branch, that's the Department of Environmental Protection as well as Agriculture, Conservation and Forestry, definitely would prefer to follow EPA's definition of two fully fluorinated carbon molecules, and we're fighting against that. Certainly when you have the EPA plus the regulators within the executive branch plus industry all pushing to limit the scope of our regulations, it's a big, hard fight. (Pluecker, personal communication, 2024)

Characteristics of the Legislature

Maine's citizen legislature and sparse population may contribute to the legislature's prioritization of PFAS issues. Moen and Palmer (2002) note the legislature's part-time sessions and modest compensation are the attributes of a citizen legislature, in comparison to more professionalized legislatures in other states. Indeed, Treat described how she was able to run for office because she did not need to be wealthy or a career politician to work in the legislature, particularly the House. Furthermore, House districts represent small populations of on average 9,000 people, so it is possible for state representatives to get to know their constituents well by visiting many of the homes they represent. The close relationship flows the other way as well: citizens frequently call their legislators' home or office numbers to voice their concerns (Treat,

personal communication, 2024). In these ways, the legislature is tuned into citizen concerns and is thus able to closely represent concerns about PFAS contamination.

Maine's public funding system for candidates running for state offices may be another reason why the legislature prioritizes environmental issues. The Maine Clean Elections Act was passed in 1996 by citizen initiative and established a publicly financed campaign financing option for candidates running for governor, senator, or representative (21-A MRS §§1121-1128). Qualification for public funds is determined by collecting \$5 donations from voters in their district (the minimum number of required donations varies for House, Senate, and gubernatorial candidates); agreeing not to raise or spend any private money; and limiting overall spending to the amount received from the Maine Clean Election Fund.¹⁴ Treat claims this is a good governance approach: "it keeps [candidates] from taking money from lobbyists and makes state representatives more likely to be responsive to the public because they are not beholden to companies who have made large donations to [their] campaigns" (Treat, personal communication, 2024). Indeed, a 2007 report on the Maine Clean Elections Act confirmed the legislature has fewer ties to private interests because of this campaign financing option (Maine CGEEP 2007).

Partisan Influences

Toxics issues, particularly those concerning farmland contamination, have garnered bipartisan support among legislators. Treat noted that conservative legislators, who might otherwise oppose environmental regulations, were interested in and responsive to PFAS contamination issues because they were "happening in their neighborhoods." Treat (personal communication, 2024) further elaborated on the nature of bipartisan interest in environmental issues:

There's been a strong history [in Maine] of interest in environmental issues and not having it be a Democratic issue only. I think that may have changed somewhat, but even today there's some strong Republican voices in the legislature pushing on the PFAS issues and other issues....I think Democrats have a stronger record overall, but it's not so polarized that it's limited to one party or another. I think that's a real positive thing.

The way legislation has been framed is also an important factor: Pluecker (personal communication, 2024) spoke about this:

When we're talking about supporting farmers and we're able to frame it in that way, then we can get bipartisan support. Even like I mentioned, [Maine] Farm Bureau was opposing us, but if we can really make it clear that it's about supporting farmers, not about making life harder for farmers, then we can get bipartisan support....[On the other hand] when we're talking about regulation, so if we're talking about banning sludge spreading, or if we're talking about banning products with PFAS in them, that's when it becomes a much more partisan issue and it's harder to pull Republican support at that point.

Additionally, the election of the current Governor Janet Mills in 2019 came shortly after the discovery of PFAS contamination on Stoneridge Farm. The change in administration after the conservative Governor Paul LePage's tenure brought more funding and staff to state agencies like DEP, the establishment of a PFAS task force, and overall greater legislative and regulatory attention on PFAS. Woodbury (personal communication, 2024) emphasized the importance of leadership in government:

LePage [the preceding governor] was more focused on business than the public health of communities and really did not like any sort of government oversight. [LePage] worked really hard to tear down the agencies, not just DEP, but all of them. And so having somebody in the governor's office that does care about a functioning government, does think that government is there to help people and not as a hindrance, I think really makes a difference. Now, is Governor Mills perfect on this stuff? No, she has not been as supportive as we would like, particularly on the products ban stuff. But overall, it's a massive improvement from LePage in that particular instance.

Key Players

Affected farmers, residents, policy advocates, journalists, and legislators make up the broad coalition of key players who have been instrumental to the development of PFAS governance in Maine. Farmer Fred Stone was widely featured in the press when PFAS contamination was discovered on his farm, bringing the issue of agricultural PFAS contamination to both local and national attention (Perkins 2022). Despite the alarming levels of PFAS found in the farm's milk and soil in 2016, the state initially downplayed the severity of the crisis and attempted to frame it as a narrow issue that was Stone's fault (Woodbury, personal communication, 2024). Stone faced \$500,000 in debt because of the contamination and loss of business and was devastated that his occupation and identity as a third-generation dairy farmer were periled (Valdmanis and Schneyer 2019). Defend Our Health, an

environmental health advocacy organization, played a crucial role at this time by working with Stone to elevate the issue of PFAS contamination and call attention to the fact that many other sites were likely contaminated also. Nordell (personal communication, 2024) commented:

The state very much tried to portray the problem as unique to [Stoneridge] farm. And Fred had participated in the land application [of sludge] program. He was the one who held the contract, and he had custom-applied for other farms who held sludge licenses. [Fred] knew that there was nothing unique about his farm other than that he was in the spotlight now that the contamination had been identified at his farm. He was very, very courageous and has continued to speak out at great personal cost and help the public understand the issue. And really as a result of Fred and [his wife] Laura's efforts to help people understand what's at stake for farmers and for the food supply, Defend Our Health got involved.

Defend Our Health's PFAS advocacy, which began in 2018, coincided with the change in governorship and increased legislative and regulatory attention toward PFAS in Maine in 2019. During 2019 and 2020, Mike Belliveau, then executive director at Defend Our Health, served on Maine's PFAS Task Force, which recommended the state expand water testing, investigate PFAS-contaminated sites, and phase out existing uses of PFAS to prevent future pollution (Maine PFAS Task Force 2020). As a testament to the collaborative nature of PFAS governance, Belliveau's advocacy has extended beyond Maine. In 2021 Belliveau was invited to speak at a Massachusetts Inter-agency PFAS Task Force meeting, where he strongly recommended Massachusetts adopt a class-based approach to PFAS legislation and emphasized the need to maintain an inventory of products containing PFAS for states to reference.¹⁵ Sarah Woodbury regularly testifies at bill hearings at the state house and advocates for health-protective legislation. Several other nonprofit environmental and public health advocacy groups across Maine bring together people affected by PFAS contamination and influence PFAS legislation. These include Maine Organic Farmers and Gardeners' Association, Maine Conservation Voters, and Maine Farmland Trust. Indeed, Pluecker (personal communication, 2024) noted that these advocacy organizations have played a key role by involving affected residents in testifying for legislation and supporting increased governance.

CONCLUSION

The absence of federal standards regulating PFAS has resulted in a decentralized and varied governance response by states wherein Maine has emerged as a national leader. This case study has examined how prior chemicals regulation, Maine's culture and values, characteristics of the legislature, the timing of industry lobbying, and collaboration between key players have contributed to the development of PFAS governance in Maine. Interviewees agreed that Maine's class-inclusive definition of PFAS and the funding it has allocated for affected farmers are notable strengths of the state's approach. Advocacy by lawmakers, residents, and organizations like Defend Our Health and MOFGA has translated to the numerous laws addressing PFAS, and state agencies have effectively coordinated to execute these laws.

Despite these strengths, Maine faces challenges in its PFAS governance and has room for improvement. Interviewees shared concerns about the welfare of Indigenous communities, whose cultural traditions are burdened by PFAS contamination (Treat, personal communication, 2024; Woodbury, personal communication, 2024). As landfills in Maine reach capacity, landfilling sludge may no longer be a viable method of waste management. While Maine exemplified leadership by being the first state to phase out PFAS in all consumer products, delays in the law's implementation have been less than ideal. State agencies will need to integrate new and forthcoming federal standards into regulation and monitoring efforts. The US EPA's recently finalized maximum contaminant levels for PFAS in drinking water are lower than Maine's drinking water standards and thus must be worked into the state's existing framework for testing and remediation. Moreover, Nordell (personal communication, 2024) would like to see more resources dedicated toward understanding the health consequences of exposure to PFAS:

I hope that the research community puts significant focus on mitigating the health risks of PFAS. That's been like the most enduring frustration since learning of our exposure... Let's get these chemicals out of our bodies. Let's get these chemicals out of our kids' bodies, and let's find ways to mitigate the known health impacts. I don't want my family and my friends to get cancer and to suffer through cancer treatment if we don't have to. I'd love to see that get more attention. I know it's a challenging topic and making headway will be hard, but hopefully we can make some headway there.

In sum, this case study of PFAS governance in Maine may offer evidence and guidance for regulatory approaches in other states and environmental health issues. Future case studies on state PFAS governance will offer comparative analyses and can strengthen the case for an interdisciplinary approach that leverages multiple scales of governance.

NOTES

- 1 Information about various PFAS from <https://comptox.epa.gov/dashboard/chemical-lists/PFASSTRUCT>. Information on PFAS uses and products from the Interstate Technology Regulatory Council, "2.5 PFAS Uses and Products," <https://pfas-1.itrcweb.org/2-5-pfas-uses/>. Information about sources of PFAS releases to the environment from the Interstate Technology Regulatory Council, "2.6 PFAS Releases to the Environment," <https://pfas-1.itrcweb.org/2-6-pfas-releases-to-the-environment/>.
- 2 The lab is affiliated with Northeastern University and Whitman College.
- 3 From Safer States, <https://www.saferstates.org/states-in-the-lead/maine/>
- 4 perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (GenX),
- 5 Beyond drinking water rules, EPA is also undergoing the rulemaking process for hazardous substance designations and monitoring rules for PFAS analytes, among other actions (EPA 2024a).
- 6 PFAS Sites and Community Resources Map, PFAS Project Lab, <https://pfasproject.com/pfas-sites-and-community-resources/>
- 7 The PFAS Governance Tracker, PFAS Project Lab, <https://governance.pfasproject.com/>
- 8 Appendix is available at <https://digitalcommons.library.umaine.edu/mpr/vol34/iss1/3/>.
- 9 Maine Toxics in Food Packaging Program, Maine DEP, <https://www.maine.gov/dep/safechem/packaging/index.html>
- 10 The PFAS Governance Tracker, PFAS Project Lab, <https://governance.pfasproject.com/>
- 11 <https://www.maine.gov/dacf/ag/pfas/pfas-fund.shtml#meetings>
- 12 <https://www.mofga.org/pfas-emergency-relief-fund/>
- 13 <https://www.maine.gov/ifw/hunting-trapping/hunting/laws-rules/pfas-related-consumption-advisory.html>
- 14 <https://www.mainelections.org/cleanelections>

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