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REDUCING RELEASES OF PAHS: A COMPARATIVE CASE STUDY OF COAL TAR SEALANT BANS IN THE UNITED STATES

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REDUCING RELEASES OF PAHS:
A COMPARATIVE CASE STUDY OF COAL TAR SEALANT BANS IN THE UNITED STATES

By

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A THESIS

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Abstract

Coal tar based sealants are applied to parking lots, driveways, and playgrounds in order to prevent pavements from deteriorating and cracking. Approximately 85 million gallons of coal tar based sealants are applied annually in the United States. In the mid-2000s scientists discovered that these type of sealants release polycyclic aromatic hydrocarbons (PAHs), which can be harmful to human and ecosystem health. After this discovery, dozens of city, county, and state wide bans of the product were put in place. However, some attempts at statewide bans have failed, while others have succeeded. This research examines the factors explaining the difference. These factors are then evaluated in order to suggest ways to improve decision making in other states, as well as at the federal level. Specifically, a comparative case analysis of four coal tar sealant ban bills (in Washington, Minnesota, Illinois, and Maryland) was performed using documentary research, governance mapping, and interviews. Examples of factors influencing the outcomes of these state-level efforts include the participation (or lack of participation) of the state agency responsible for environmental quality, whether any public outreach has been performed, and the degree to which the costs of PAH contamination is accounted for in the law. This case study also provides insight into how state-level efforts to develop environmental policies can serve as a testing ground for efforts at the national level.

Chapter 1: Introduction

Miles of parking lots, driveways, and playgrounds are sealed each year with a product recently found to be harmful to both humans and ecosystems. Asphalt-paved surfaces, like driveways, are often sprayed or painted with a sealcoat to improve appearances and protect the surface from becoming cracked or damaged. The sealant can be asphalt based or coal tar based, the latter of which can be particularly harmful to both humans and ecosystems. Coal tar sealant has been in use since the 1950s, and surfaces sealed with it are typically re-sprayed every two to four years. It is estimated that 85 million gallons of coal tar based sealants are used annually in the U.S, and this amount of use covers roughly 170 square miles of pavement. Most coal tar based sealants are applied east of the Continental Divide, most likely due to the fact that coal tar distillation plants receive their coal tar from coking facilities, which are usually placed near steel mills and have historically been located in the central and eastern United States (Scoggins, Ennis et al. 2009; Van Metre and Mahler 2010; Mahler, Metre et al. 2012; Williams, Mahler et al. 2013).

When coal is converted into coke, coal tar is produced as a byproduct. This coal tar is then sold as a product, 95% of which is used in the manufacture of electrodes employed in the production of aluminum. The other 5% is used to produce products such as roofing material and pavement sealant. What makes coal tar, and more specifically coal tar sealant, harmful is its ability to release polycyclic aromatic hydrocarbons (PAHs), a class of compounds that are known to include human carcinogens. It is estimated that coal tar sealants contain 20-30% coal tar pitch, which in itself contains roughly 50% or more PAHs (Mahler, Metre et al. 2012; EPA 2012).

Coal tar sealants were first identified as a major PAH emission source in the mid-2000s. Starting in the late 1980s and early 1990s, the Watershed Protection and Environmental Resources Division in Austin, Texas began sediment sampling as part of the EPA's Nationwide Urban Runoff Program and Clean Lakes initiatives. The Clean Lakes Program started in 1972 (under the Federal Water Pollution Control Act), and the Nationwide Urban Runoff Program began in 1978. Because PAHs can be toxic to aquatic organisms, receiving waters were tested for PAHs under these programs. In Austin, high PAH levels were detected in Town Lake, which receives inputs from urbanized creeks. Further studies tested sediments in four urban creeks and identified them as "hot-spots" (areas where concentrations of toxic compounds cause elevated risks) for PAHs, with levels above most literature values found in creeks nationwide. Because PAHs are hydrophobic and tend to attach to sediment, previous studies that tested PAH levels in the water only did not find elevated levels (Texas 2005).

Research using aerial photography, GIS analysis, and historical data suggested a link between nearby coal tar sealed parking lots and the elevated PAH levels in the urban creeks. At the same time, a study by the United States Geological Survey (USGS) detected high levels of PAHs at multiple urban sites nationwide. Upon discovering the research being performed in Austin, the USGS, working with the city and Texas State University, conducted more studies. Specific investigations examined the parking lot sealants themselves, the particulate material from the parking lots, the transport of sediment to tributaries, and the PAH concentration in waters receiving the sediment. These studies confirmed the early investigations that showed coal tar sealants as being a large contributor to PAH levels in the air and sediment (Van Metre, Mahler et al. 2000;

Austin 2005; Mahler, Van Metre et al. 2005). The researchers concluded that PAHs can be released from coal tar sealcoat in numerous ways. Friction from car tires can release particles from the pavement and these particles can then be transported to storm drains and streams during a rain event. Abraded particles can also attach to shoes and be tracked indoors, or be blown offsite by wind. Some PAH particles also evaporate directly from the sealcoat (USGS 2011).

Although coal tar sealants are not the only source of PAHs in urban environments, they are a main contributor of PAHs reaching urban and suburban streams. Other PAH sources include fossil fuel combustion, motor vehicles exhausts, and biomass fires. Humans can be exposed to these PAHs through dermal contact, inhalation, and ingestion (when the particles land on food or objects). PAHs are listed as priority pollutants by the EPA, and chronic exposure to the chemical can cause lung, skin, bladder, and respiratory cancers, along with breathing problems, asthma symptoms, cataracts, and decreased immune functions (Simcik and Offenberg 2006; Lah 2011; EPA 2013; Motorykin, Matzke et al. 2013; Williams, Mahler et al. 2013).

The United States has not set PAH standards for ambient air, partially due to the fact that these compounds are present in complex mixtures, and not all PAHs are equally toxic. PAHs also have the ability to attach to particles and may interact with other chemicals, making it difficult to measure and regulate them. However, a maximum occupational exposure level has been set for PAHs at .2 mg/m^3 for an eight hour workday due to potentially high levels of exposure in some workplaces. A recent study shows that PAH concentrations due to emissions from a freshly coal tar sealed parking lot can be as high as 0.297 mg/m^3, which exceeds the permissible OSHA limit. Another study found that living next to coal tar sealed lots will increase a person’s risk of getting cancer to 1 in 10,000 (Van Metre, Majewski et al. 2012; Williams, Mahler et al. 2013; ATSDR 2014).

PAHs that reach waterbodies can affect organisms such as mussels and other benthic creatures. They can harm aquatic ecosystems by decreasing species richness and abundance. When benthic organisms are exposed to PAHs, they experience problems such as narcosis, inhibited reproduction, and mortality. Coal tar sealant exposure has also been shown to cause reduced growth and increased mortality in amphibians. A study by the USGS has shown that coal tar sealants are the largest source of PAHs loads to numerous urban lakes across the United States (Neilson 1998; Bryer, Elliott et al. 2006; Van Metre and Mahler 2010; Mahler, Metre et al. 2012).

Since 2005, dozens of local and regional coal tar sealant bans have occurred throughout the U.S., but it wasn’t until 2011 that the first statewide ban occurred. Nine statewide bans have been attempted, but only two (Washington and Minnesota) have been successful. Four other ban bills have failed, while three are still in the committee stage. In addition to this, a national ban of the product was attempted in 2013, but is still stuck in committee.

This research explores the reasons why bills to ban coal tar sealants have been successful in some states but not others. Four states have been chosen for evaluation, based on the range of outcomes associated with efforts to ban coal tar sealants at the state level: Washington (which implemented after the first attempt), Minnesota (which successfully passed a bill after several attempts), Illinois (which currently has a bill in committee), and Maryland (which was unsuccessful in passing a statewide bill). Data for these case studies has been collected through interviews with legislators who introduced the bills, and representatives from environmental organizations in the states. Key members of the national effort to ban coal tar sealants, such as representatives from USGS and the Pavement Coating Technology Council, were also interviewed. Documentary research involving reports, tapes of bill hearings, and media such as newspaper and journal articles, was also analyzed in order to develop a collective case study on why coal tar bans have been successfully implemented in some states but not others.

This research contributes to literature pertaining to the changing roles of the federal and state governments in developing environmental policy in the U.S. The coal tar sealant issue represents a case in which actions at the state level have been, and are currently being, taken to resolve the problem. And shows how states can be used as a testing ground for new policies. Before action is taken at the federal level, policy makers can learn from the case studies in the states in order to efficiently develop an effective national policy at the federal level. Analyzing state factors can also help inform other federal level policies, not just those pertaining to the banning of coal tar sealants.

This study is also part of a larger research project on atmospheric surface exchanged pollutants (ASEPs) that started in 2013 and is being conducted by researchers at Michigan Technological University, Massachusetts Institute of Technology, Desert Research Institute, and the University of Massachusetts Boston. ASEPs are pollutants that have three specific characteristics: they are resistant to degradation, they tend to accumulate in organic-rich surface reservoirs, and they are semi-volatile, which causes them to re-emit into the atmosphere. Three ASEPs are being studied under the project: mercury, PCBs, and PAHs. The ASEP project is multidisciplinary and evaluates the cycling, emissions, and governance of mercury, PCBs, and PAHs over time. More information on the project can be found at: http://asep.mtu.edu/ (Perlinger 2013; Perlinger 2015).

This research on the banning of coal tar sealant contributes to the larger project by examining a specific example of communities attempting to reduce PAH emissions and concentrations within their boundaries, and thus the quantity of PAHs in global circulation. The banning of coal tar sealants is an example of a relatively easy and straightforward action that can be taken to achieve the goal of PAH reduction, and yet, success in not guaranteed. From this perspective, this study provides insight into the challenge that will be encountered as communities, organizations, and governments throughout the world learn about ASEPs and attempt to reduce the amount of them being placed into circulation.

Chapter 2: Background

Scientists and researchers have been learning about the effects of PAHs for centuries. There are hundreds of different types of PAHs, and depending on their structure and size they can be carcinogenic, persistent, bioaccumulative, and susceptible to long range transport. Once released, PAHs can also attach to other particles in the air, which can phototransform them into substances much more toxic. Because PAHs are such a vast class of compounds, monitoring and regulating them is difficult. However, knowledge has been gained over the years in regards to compound characteristics, sources, and health and ecosystem effects, making it easier for policy makers to see the importance of enacting policies to reduce their release into the environment.

Coal tar sealants are one source of PAHs, and are an especially important source in urban settings that have more coal tar sealed surfaces. High amounts of PAHs are released from coal tar sealed surfaces upon application, as well as over time through vaporization and particle runoff. PAH particles can reach nearby waterways through runoff, increasing mortality among benthic creatures and disrupting food chains, as well as be inhaled and ingested by humans causing increased cancer risks and other health concerns. Furthermore, the persistence of PAHs can result in the accumulation of these compounds over time.

In order to protect humans and the environment from the harmful effects of coal tar sealants, dozens of bans of the product have been established in the U.S. since 2006. Bans have been passed at the city, county, district, watershed, and state level, which prohibits individuals and companies from applying coal tar coatings to any surface in the area. However, bans were not attempted in all areas of the country, and some bans that were attempted were unsuccessful, suggesting that numerous citizens and ecosystems are still at risk of exposure to PAHs due to releases from nearby driveways, parking lots, and playgrounds.

When analyzing coal tar sealant bans, it is also important to understand how environmental policies have evolved. Environmental regulations in the U.S. have gone from most centralized, in the 1960s and 70s, to more decentralized beginning in the 1980s. Some environmental laws, especially those pertaining to transboundary issues, are best applied at the federal level, while more local issues should be undertaken by the individual states. Banning coal tar sealants is a policy that could one day be applied at the federal level. If such a policy is applied at the federal level, it will be enhanced by studying how it has been applied at the state level.

Polycyclic Aromatic Hydrocarbons

It has long been known that polycyclic aromatic hydrocarbons (PAHs) are harmful to both humans and ecosystems. In fact, the link between PAH exposure and cancer was first made in the 18th century. Over the next two hundred years, laboratory tests confirmed the carcinogenicity of PAHs, and field tests showed their ability to harm aquatic life. Much has also been learned about PAHs in the past couple of decades, including the main sources of the chemical and the main exposure routes. In order to decrease the risk of PAHs to humans and wildlife, national and international laws have been put in place to lower emission and exposure limits.

Two Centuries of Learning about PAH Toxicity

Scientists have known about the detrimental effects of coal tar and PAHs for centuries. In fact, the first recorded link between an occupational exposure to a chemical and cancer was associated with PAHs even before any chemical knowledge of PAHs had been developed. In 1775, the English surgeon Percival Pott reported an increase of scrotal cancer among London chimney sweeps, which he attributed to their exposure of soot and ash (Pott 1775). Throughout the 1850s more reports began linking cancers to oil, tar, and paraffin workers. In 1915, a laboratory study that exposed rats to coal tar showed the rats contracted skin cancer (Yamagiwa and Ichikawa 1918; Fibiger 1927; Fujiki 2014). And in 1933 a specific PAH, benzo(a)pyrene, was isolated from coal tar in the lab and identified as the first chemical carcinogen (Cook, Hewett et al. 1933).

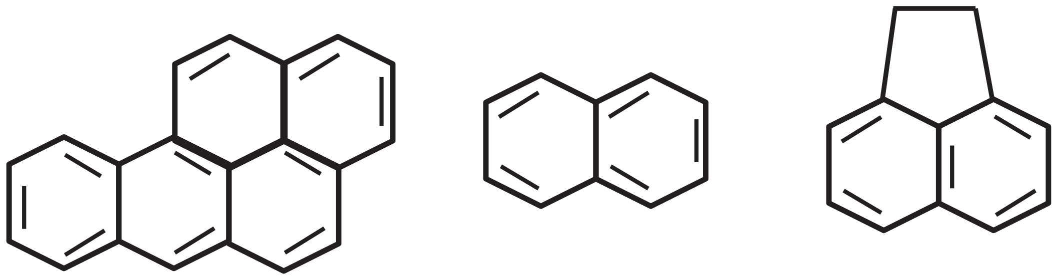
PAHs are organic compounds composed of two or more fused benzene rings, and can be present in gaseous or particulate phases depending on the number of rings present. The chemical structure of benzene was first identified in 1865 by Kekule and Couper, but it wasn't until the 1930s that the chemical structures of numerous PAHs were first discovered (Neilson 1998). Now it is known that there are three classes of PAHs found in the environment. Biogenic PAHs, a minor source, come from living organisms such as plants. Petrogenic PAHs come from geological processes, and are present in oil and some oil products. Pyrogenic PAHs are generated by extremely high temperatures that occur during the processing and combustion of fossil fuels, especially in the coking of coal. In the coking process, coal is exposed to high temperatures and PAHs are formed, but no combustion occurs to destroy them. Instead, the PAHs remain in the coal tar that is a byproduct of the coking process. Pyrogenic PAHs are usually made up of larger benzene rings than those of the other two sources (Anyakora, Coker et al. 2011; Hatheway 2012; Pampanin and Sydnes 2013; Laboratory 2014).

PAHs pose a concern as toxics chemicals because they can be persistent, carcinogenic, mutagenic, hydrophobic, and sometimes bioaccumulative. PBT (Persistent, Bioaccumulative, and Toxic) substances such as PAHs are difficult to remove from the environment, and have the potential to accumulate in plants, animals, and sediment. PAHs are seen as a legacy chemical, because buildup of the pollutant in the environment has occurred for hundreds of years, ever since they've been produced as a byproduct of coal combustion, coking, and other processes. Natural processes, such as forest fires, have also introduced PAHs into the environment. The PBT characteristic of various PAHs began being examined in the early 1900s, when scientists began studying the chemicals in the laboratory (Pashin and Bakhitova 1979; Neilson 1998; EPA 2008; Agency 2012).

However, not all PAHs have the same characteristics. PAHs with four or more benzene rings (such as fluoranthene, pyrene, and benzo[a]pyrene) are considered to be high weight molecular PAHs (HPAHs). HPAHs are more resistant to oxidation, biodegradation, vaporization, and solubility, therefore making them more likely to bioaccumulate and persist in the environment. HPAHs are more susceptible to phototransformation, which can produce compounds that are more toxic. Several HPAHs are known to be carcinogenic. PAHs made up of two or three benzene rings (such as naphthalene, fluorene, and anthracene) are considered to be low weight molecular PAHS (LPAHs). LPAHs are more acutely toxic to aquatic life, since they are more readily dissolved in water. Other characteristics such as the makeup of the core ring structures (which can be can be entirely composed of benzene rings, but doesn't have to be), and the presence of the molecular side groups surrounding the core ring structure, play a role in how a certain PAH behaves in the environment (Environment 2010). For visual representation of a few of these PAH structures, see Figure 2.1.

Figure 2.1: Examples of PAHs & Their Characteristics

Benzo[a]pyrene   Naphthalene   Acenaphthene



Characteristics

- High weight
- Resistant to oxidation, biodegradation, vaporization, and solubility
- Tendency for bioaccumulation and persistence
- Carcinogenic*

Characteristics:

- Low weight
- Toxic to aquatic life
- Possible carcinogenic*

Characteristics:

- Low weight
- Toxic to aquatic life
- Possible carcinogenic*
- Core ring not entirely composed of benzene rings

Figure 2.1: Three different PAH compounds and their characteristics. Characteristics may also correspond to other PAH compounds of the same structure.
*Based on International Agency for Research on Cancer (IARC) classifications

Along with these properties, PAHs also have the ability to travel long distances in the environment. PAHs, typically those with three to four rings, are semi-volatile and have the ability to partition between gaseous and particulate phases. PAHs can deposit on surface waters and soils for long periods of time, but then be re-evaporated into the atmosphere. PAHs are also strongly associated with soot or black carbon that is released during fossil fuel combustion (Friedman and Selin 2012; Keyte, Harrison et al. 2013).

Recent studies are also showing that PAHs can react with particles and sunlight once emitted, which can alter the behavior of the chemicals, or transform them into new toxics. Once in the atmosphere, PAHs can react with other pollutants such as ozone, hydroxyl radical, sulfur dioxide, and nitrogen dioxides, upon reacting with these chemicals, PAHs can become more toxic. Some PAHs have been shown to have half-lives of just hours to days in the atmosphere due to these chemical transformations. Some PAHs can absorb UV light, however, which also changes how the chemicals will behave. The compound 9,10-anthraquinone, for example, is formed when the PAH anthracene undergoes photo-induced oxidation (a transformation that occurs when a chemical is exposed light). 9,10-anthraquinone is more toxic then its parent compound, anthracene. The chemicals formed when PAHs are altered in the environment are difficult to monitor, and further research needs to be done to explore their sources and concentrations (Killin, Simonich et al. 2004; Byeong-Kyu and Van Tuan 2010; Friedman and Selin 2012; Keyte, Harrison et al. 2013; Friedman, Pierce et al. 2014; Mahler, Van Metre et al. 2014).

According to a 2009 the European Monitoring and Evaluation Programme (EMEP) report, the source of PAH pollution (specifically from benzo[a]pyrene) can vary greatly from country to country. For example, the report found that transboundary PAH pollution was responsible for almost 100% of the PAH contamination in Monaco, but only about 5% of it for Spain. The size of the country, differing meteorological conditions, and the amount of domestic emissions are given as factors for the varying amounts of transboundary PAH pollution present (EMEP 2009). Similarly, a study performed at a Canadian high arctic station found that most PAH contamination came from East Asia, Northern Europe, and North America. Although PAH levels have declined in developed countries over the past few decades, they are increasing in developing countries. Therefore, although worldwide PAH emissions have changed very little, controlling them is a global issue as some countries continue to have increases in releases (Zhang and Tao 2009; Wang, Tao et al. 2010).

Sources

PAH sources, as well as our understanding of their sources through monitoring, has changed drastically over the past two hundred years. Two hundred years ago, the largest source of PAHs in the Northern Hemisphere was attributed to biomass burning. The last century of industrial development changed the largest PAH source to fossil fuel combustion, which has increased PAH emissions to 50 times higher compared to the pre-industrial period (Kawamura, Suzuki et al. 1994; Maliszewska-Kordybach 1999).

During the past decade, agencies and scientists have attempted to learn more about PAH sources and emissions based on individual reporting, monitoring, and modeling. However, due to uncertainties in these methods, the largest emission source and the amount of nationwide emissions of PAHs in the U.S. is debated. Emission uncertainties arise because of differing PAH emission factors, which can vary by sector, season, and emission control devices. Discrepancies in PAH releases also arise due to the fact that not all sources are considered.

The National Emissions Inventory (NEI), set up through the EPA, provides emission estimate data for criteria and hazardous air pollutants. Emission inventory data is updated every three years, and is available from 2002 onward. The data is obtained by estimates provided by state, local, and tribal air agencies, and is supplemented with EPA data. PAHs fall under the polycyclic organic matter (POM) compounds category in this inventory, which is made up of all organic compounds having more than one benzene ring and a boiling point of 212^{o} F or greater. According to this inventory, the largest U.S. PAH emission source in 2011 comes from prescribed and un-prescribed fires (EPA 2014).

However, the data provided by the EPA does not agree with emission studies conducted by individual researchers. In 2008, researchers Yanxu Zhang and Shu Tao developed a worldwide PAH emission database for the year 2004. In their study, Zhang and Tao calculated the emission of the 16 PAHs that the EPA has listed as priority pollutants. Results showed that the U.S. emitted 32 Gg/yr (giga grams per year) of the 16 PAHs, with consumer product use (which includes personal care items like medicated shampoos, sealants, and coatings) being the largest emitting sector (at 35.1%), followed by traffic oil combustion (at 23%). Wildfires are one of the smallest emission sources, contributing only 3.3% of total PAHs (Zhang and Tao 2009). These results differ from research conducted by Huizhong Shen et. al. Shen calculated worldwide emissions of the same 16 PAHs using a fuel combustion inventory (PKU-FUEL-2007) and an emission factor database to determine emission rates from 1960 to 2008. According to their research, the U.S. produced only 8.5 Gg/yr of the 16 PAHs in 2008, with the largest source being indoor firewood burning (57.7%), followed by motor vehicles (17.6%). However, some sources such as consumer products, were not taken into account for this study (Shen, Huang et al. 2013).

Assessing PAH concentrations in waterways and determining the source of those PAHs is also challenging because many methods can be utilized. In order to assess PAH levels in water, analysis can be performed on both sediment and water samples. Because PAHs are hydrophobic, they often sink to the bottom of waterbodies and mix with sediment. Tissue samples of aquatic species can also be used to determine environmental contamination of PAHs. In order to assess PAH levels using this method, factors such as relative uptake rates, biotransformation, and excretion characteristics of the organism have to be taken into account. Fish and other invertebrates biotransform PAHs; therefore the amount of PAHs in their tissues cannot be used to represent the contamination level of the water. However, other aquatic organisms, such as mussels, do accumulate PAHs in their tissues, so are often used as indicators. A study by Pampanin and Sydnes found the main sources of PAH contamination for coastal zones are sewage, runoff from roads, the smelting industry, and oil spills; while offshore sources include oil seeps, spills, and water discharge from offshore oil drilling (Pampanin and Sydnes 2013).

Despite discrepancies in the literature, PAH sources have become easier to identify in the past decade because of the use of forensic analysis. PAHs have the ability to degrade, evaporate, and combine with other chemicals in the environment, sometimes making it difficult to find their origins. However, forensic analysis can be performed on PAHs in the air and water to determine their original sources. In order to do this, scientists analyze the PAH fingerprint of a contaminated site (that is, which PAHs and related compounds are present). PAHs usually occur in a mixture of 10-30 different compounds. The mixtures of compounds are identified (using a gas chromatograph mass spectrometer) and compared to potential source mixtures (Ahrens, Depree et al. 2007, Stogiannidis and Laane 2015).

Human and Ecosystem Health

Between 1920 and 1960 laboratory studies confirmed the carcinogenic effects of numerous PAHs (Haddow and Robinson 1937; Bailey and Dungal 1958; Malling and

H.Y. 1970). It is now known that long term exposure to PAHs not only increases the chances of cancers, but also cataracts, kidney and liver damage, breathing problems, skin inflammation, and decreasing immune functions. Recent laboratory tests also show that ingestion of BaP during pregnancy can result in birth defects and decreased weight in offspring (Lah 2011).

According to the United States Agency for Toxic Substances and Disease Registry (ATSDR), a low level of exposure to PAHs through air, water, soil, and food occurs regularly for most people. The main exposures to PAHs from inhalation is due to tobacco smoke, wood smoke, and ambient air. For non-smokers in non-occupational settings, 70% of their PAH exposure occurs through food intake. Relatively high exposure rates due to food intake was first discovered in the 1950s, when scientists studied PAH levels in Icelandic smoked foods (Bailey and Dungal 1958). PAHs can also end up on food when particles from the air are deposited on it. Dermal exposure and exposure from water are also possible. A comprehensive study in 1992 that estimated exposure sources for a typical male in North America found that the mean daily intake of PAHs (of non-smokers) is 3.12 μg/day, with 96.2% coming from food, 1.6% from air, 0.2% from water, and 0.4% from soil. According to the EPA, harmful effects are unlikely to occur with PAH exposures below the following: 0.3 mg of anthracene, 0.06 mg of acenaphthene, 0.04 mg of fluoranthene, 0.04 mg of fluorene, and 0.03 mg of pyrene per kilogram (kg) of your body weight (Menzie 1992; ATSDR 1995; ATSDR 2013).

Although all people are exposed to PAHs on a daily basis due to their presence in ambient air, exposure levels can be increased due to personal circumstances, such as living location, smoking, and workplace conditions. In addition, urban air tends to have higher concentrations of PAHs than rural air. In one study, background levels for 17 PAHs were measured to be between 0.02 ng/m^3 for rural areas, and 0.15 -19.3 ng/m^3 in urban areas. Given indoor and outdoor concentrations, the average inhalation intake of just on type of PAH, BaP, ranges from 0.15 to 32 ng/day. Occupational exposures, and exposure to smokers, can be much higher. Smoking just one cigarette can result in an intake of 20-40 ng of BaP, and those who live in a smoking environment take in roughly 4–62 ng of PAHs daily. Workers in certain fields such as aluminum smelting, coke oven plant workers, and truck, bus, and taxi drivers are also exposed to PAH levels many times higher than the average person. Exposure to higher concentrations of PAHs can increase the chances of getting cancer in one's lifetime. Based on epidemiological data from coke-oven workers, excess lifetime cancer risk based on exposure to BaP is 100 per 1,000,000 at 1.2 ng/m^3, 10 per 1,000,000 at 0.12 ng/m^3, and 1 per 1,000,000 at 0.012 ng/m^3 (WHO 2000; Choi, Harrison et al. 2010; ATSDR 2013).

PAH risks to terrestrial and aquatic life vary due to the ability of different organisms to metabolize the chemical. In general, PAHs exhibit moderate to acute toxicity to birds and aquatic life. Exposure to PAHs can result in tumors, adverse reproduction effects, and a decrease in species richness and abundance. When benthic organisms are exposed to PAHs they experience problems such as narcosis, inhibited reproduction, and mortality, which can disrupt whole food chains (Neilson 1998, Mahler, Metre et al. 2012). Bioaccumulation is also an issue for mollusk species, and PAH concentrations in these organisms can be much higher than the concentrations of the chemical in their environment. Specific case studies have also shown PAH exposure is lethal to newt larvae, can cause deformities in amphibians and carcinogenic effects in

Brown bullhead catfish and English sole (Fernandez and I'Haridon 1994, Bryer, Elliott et al. 2006, Lah 2011, Perrin 2014).

Agencies, Laws, and Regulations

There are hundreds of different types of PAHs, but the subset being monitored depends on then specific agency or regulation. The Environmental Protection Agency (EPA), for example, has listed 16 PAHs as priority pollutants, 7 of which are carcinogenic. On the other hand, the Agency for Toxic Substances and Disease Registry (ATSDR), a health advisory agency founded in 1985 by the United States Department of Health and Human Services, lumps together 17 PAHs for analysis. The 17 PAHs classified under ATSDR are: acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorine, indeno[1,2,3-c,d]pyrene, phenanthrene, and pyrene. The EPA's list is similar, but includes naphthalene and omits benzo[e]pyrene and benzo[j]fluoranthene. The ATSDR chose these 17 PAHs because there is more known about them, they are thought to be more harmful than other PAHs, and there is a greater chance for human exposure for these certain types. These specific PAHs are also present at the highest concentrations in superfund sites that are listed on EPA's National Priority List (NPL). The NPL is made up of over 1,400 hazardous waste sites that have been identified for cleanup by the EPA. PAH contamination has been found in over 600 of these sites.

PAHs have also been placed on the Substance Priority List (SPL), which is a list of chemicals developed by the EPA and ATSDR as required by the Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA). PAHs as an entire class are listed at number nine on the list, while specific PAHs, like benzo(a)pyrene (BaP) are also listed. BaP is the most commonly monitored and regulated PAH because of its carcinogenic properties, strong correlation with the presence of other PAHs, and its high concentrations at many NPL sites (ATSDR 1995; EPA 2008; Friesen, Demers et al. 2008; Rubailoa and Oberenkob 2008).

Atmospheric concentrations of thirteen PAHs are monitored under the Integrated Atmospheric Deposition Network (IADN). The IADN was formed by the U.S. and Canada under the Great Lakes Water Quality Agreement in 1990. Under this network, chemical concentrations are measured at five master stations (located in rural areas), and ten satellite stations throughout the Great Lakes. The IADN takes the measured concentrations from the stations and combines them with physical parameters (such as meteorological data) to give information about dry and wet depositions, and gas absorption and volatilization rates for the measured chemicals. Thirteen PAHs are measured under this network, and concentration trends have remained constant according to the 2005 IADN Results Report. The report also states that PAH concentrations tend to increase with increasing population; therefore higher amounts have been reported at the more urban stations, such as Chicago (IADN 2008).

Numerous national laws exist in the U.S. with the goals of protecting clean air, water, and land, and PAHs are often regulated directly or indirectly by these laws. PAH exposure limits are set for occupational settings and for levels in drinking water. The Occupational Safety and Health Administration's (OSHA) permissible exposure level (PEL) of PAHs (based on an 8 hour work day) is 0.2 mg/m^3, which is measured as the benzene-soluble fraction of coal tar pitch volatiles. The concentrations of PAHs at coking facilities is limited to 0.15 mg/m^3 under OSHA. PAHs in drinking water are regulated under the 1974 Safe Drinking Water Act. Under this act, seven carcinogenic PAHs have set maximum contaminant levels (MCL). The MCL for BaP, the most carcinogenic regulated PAH, is 0.2 ppb (ATSDR 2008).

National laws such as the Clean Air Act, Resource Conservation Recovery Act, Toxic Substance Control Act and the Clean Water Act also have resulted in the monitoring of PAHs and, in some cases, set discharge limits. In general, because PAHs are considered hazardous air pollutants (HAPs) by the EPA, their emissions are monitored and facilities that release them must control their discharges through best available control technologies. Material containing PAHs, such as commercial waste products and spill residues, must also be disposed of properly in order to reduce further contamination.

For a more specific list of national regulations and emission guidelines one can visit The Agency for Toxic Substances and Disease Registry's toxic profile on PAHs (ATSDR 1995). PAH levels have decreased in the U.S., partly due to these laws and partly due to energy shifts. Specifically, emission declines have been credited to the use of catalytic converters (which are used to comply with Clean Air Act emission standards), a reduction in coal burning (as the U.S. moved towards oil and natural gas energy sources), and reduced open burning and improved pollution control combustion technologies (Baek, Field et al. 1991).

However, the U.S. is still learning how to protect humans and the environment from PAH contamination. The Resource Conservation and Recovery Act (RCRA), for example, stopped regulating coal tar as a waste in the 1990s because it can be recycled into coal tar sealant and other products. Since coal tar containing products are seen as recycled items, they are exempt under the act. Products made from coal tar, like coal tar sealants, could be regulated under the Toxics Substance Control Act (TSCA), but are not. PAH levels are also not monitored or regulated in foodstuff under the U.S. Food and Drug Administration. The Delaney Clause, under the Federal Food Drug and Cosmetic Act, does prohibit the use of carcinogenic substances to be used in foods, and PAHs are regulated under the Delaney Clause to some degree (for example, their use in color additives) but no standards have been established for PAH levels in all foods. Finally, although PAHs are monitored under the Clean Air Act, no standards have been created for them in ambient air concentrations (EPA 1992; FDA 2007; ASTDR 2014).

The European Union, in comparison, is more stringent in terms of their PAH regulations. The European Commission regulates BaP in foodstuff and in the ambient air. Numerous food regulations exist which set maximum levels of BaP concentrations. For example, the maximum level of BaP in oils and fats is 2 μg/kg. Ambient air regulations are set up under the European Commission's Air Quality Standards. A concentration of 1 ng/m^3 has been set for BaP over the averaging period of one year (Commission 2005; Commission 2011).

At the international level, PAHs are governed under the Convention on Long-Range Transboundary Air Pollution (CLRTAP). The U.S. signed the convention when it was first introduced in 1979, and ratified it when it entered into force in 1983. According to the 1998 POPs protocol of the convention, parties must decrease their PAH emissions from a chosen reference year between 1985 and 1995. Although the U.S. never set a specific goal or reference year for PAH reduction under the convention. Emission data submitted to the convention shows that PAH emissions in the U.S. have gone from 15,642 Mg/yr in 1990, to 519 Mg/yr in 2011. (UNECE 1979; UNECE 1998; UNECE 2014).

To help meet the overall goals of CLRTAP, the U.S. worked with Canada and developed the Air Quality Agreement, the Great Lakes Binational Toxics Strategy, the Commission for Environmental Cooperation (along with Mexico), and the Border Air Quality Strategy. However, the only program that directly governs and monitors PAHs is the Great Lakes Binational Toxics Strategy (GLBTS), which was set up in accordance with the Great Lakes Water Quality Agreement. This strategy calls for the virtual elimination of persistent toxics in the Great Lakes basin. As a group, PAHs are listed as a Level II substance, which means that only one country (in this case Canada) identifies the pollutant as persistent, with the potential for bioaccumulation and toxicity. Unless Level II substances are bumped to Level I, both countries simply encourage their stakeholders to practice pollution prevention activities in order to reduce pollution by the contaminant (EPA and EC 2012).

Coal Tar Sealants

It has been widely known since 2005 that coal tar sealants are a large source of PAH contamination, especially in urban settings. Throughout the mid-2000s, numerous studies were conducted in Austin, Texas, in cooperation with the USGS and Texas State University (Austin 2005). Once these studies were complete, many more investigations were performed both by the USGS and independent scientists, which consistently showed the adverse effects of coal tar based sealants to both humans and ecosystems. As an alternative to coal tar sealants, asphalt based emulsion can be used which is comparable in price and quality.

Studies in Austin, Texas

The first investigation carried out by the research team in Austin, Texas, dealt with the characteristics of parking lot sealants. An estimated 660,000 gallons of pavement sealant are applied annually in the area of Austin, Texas. These sealants must be reapplied every two to three years because of wear. There are two types of sealant used in the area, one which contains up to 35% coal tar, and the other which is an asphalt based emulsion. Studies were performed for both the asphalt and coal tar based sealants, as raw and applied products.

By studying both raw and applied sealant products, scientists found the coal tar based sealants contained much higher PAH levels. Chemical analysis of the raw products showed that the median concentration of PAHs for the asphalt based sealant was 50 ppm, while the concentration for the coal tar based product was over 50,000 ppm. The chemical profiles for both, however, were similar, with two PAHs (phenanthrene and fluoranthene) dominating the compositions. It was also discovered that the stated amount of coal tar in a sealant product should not be used as an indicator for PAH concentrations. The study found that coal tar sealant products sometimes varied greatly between batches, and the manufacturing process did not produce a consistent product. As a result, the material safety data sheet (MSDS) for sealants, which states the range of coal tar concentrations in the product, is not always accurate. To test asphalt and coal tar sealant levels from applied products, park lot scrapings were taken and analyzed. The PAH profiles for both sealant types, as with the raw product, were similar in composition. PAH levels were lower for the applied products than the pre-applied raw product, but the parking lot with the coal tar based sealant had substantially higher PAH concentrations than the ones with the asphalt based sealant.

The next study focused on the particulates from parking lots by taking dry samples and by looking at PAH levels during simulated rainfall events. To start, particulate parking lot samples were collected from the most down-slope point on numerous parking lots in order to identify the potential PAH sources going into nearby waterways. The USGS then simulated rainfall runoff on four different types of parking lots (coal-tar sealed, asphalt sealed, concrete, and unsealed), and collected sediment from the lots. In addition, the tests were performed on lots that were in use and lots in which no cars or traffic were ever on. The chemical analysis of these particulate samples indicated that PAH levels were generally higher on the in-use parking lots, as opposed to the test lots, showing that additional PAHs may be coming from tires or oil. However, the PAH profile between both the in-use and test lots did not change much (with fluoranthene and phenanthrene having the highest peaks), showing that the sealants made up a large portion of the PAH contamination, or that the makeup of the traffic sources were similar to that of the sealants. In general, for the in-use parking lots, PAH levels were highest for coal tar based sealant lot, followed by asphalt based, unsealed, and concrete.

A third investigation evaluated the actual transport of PAHs from a source to a waterway. For this study, the site of Barton Springs Pool was chosen because it is home to the endangered Barton Springs salamander and is near a potential PAH source (the parking lot of an apartment complex which is sealed with coal tar based sealant).

Chemical analysis of sediment from the parking lot to the water site showed that PAH concentrations decrease from the source to the waterway. This decrease was attributed to degradation, transformation, and dilution (as the PAHs because mixed with different particulate matter).

Sediment sampling comparing upstream and downstream sites near parking lots were also conducted in this study. Seven creek sites were chosen, which evaluated PAH concentrations from the same creek both upstream and downstream from a coal tar sealed parking lot. Five of these sites showed a significant difference in PAH levels, between the upstream portion of the creek and the downstream portion, with the downstream portion being higher. For example, the upstream PAH concentrations for the Barton stream were less than 5 ppm, while the downstream concentrations were roughly 33 ppm. Since the parking lots made up just a tiny fraction of the entire watershed, this was a surprising result, and indicates that parking lots sealed with coal tar sealant can be large contributors to PAH levels in nearby creeks and waterways.

Another study reviewed the impacts PAH contamination had on receiving waters. At this time, the PAH fingerprint for pavement sealants was unknown, so information was gathered on the amount and location of PAH contamination near waterways. Sediment samples for numerous sites were collected and PAH concentrations evaluated. The results showed the amount of PAHs in an area are related to the amount of sealed parking lots in the watershed, with PAH concentrations increasing as the amount of sealed parking lots increases.

PAH concentrations in sites were also sampled and compared to a probable effect concentration (PEC), the concentration in which direct exposure is likely to cause an adverse effect (which is 22.8 mg/kg). Sites with levels above the PEC were shown to be concentrated in urban watersheds. USGS reports have shown increasing PAH concentrations over time in the primary receiving water body for the area, Town Lake. This indicates that the ongoing transport of PAHs from parking lots sediment and other sources continues to be a problem (Austin 2005).

Additional Studies

Over the last decade, numerous additional studies showed the effect that coal tar based sealants have on PAH air emissions and concentrations in sediment and water. Studies evaluating particles from parking lot runoff and dust above parking lots have showed increased amounts of PAHs from lots sealed with a coal tar emulsion. In a 2005 study, Mahler et al. determined that particles from coal tar based parking lot runoff have a mean concentration of 3,500 mg/kg of PAHs, which is 65 times higher than the concentrations from that of an asphalt based parking lot (Mahler, Van Metre et al. 2005). In 2009, Van Metre et al. evaluated parking lot dust from nine cities in the U.S. (six central and eastern cities, and three western cities). The coal tar sealed parking lots in the central and eastern U.S. had a median PAH concentration of 2,200 mg/kg, while the asphalt sealed lots from the west had a median concentration of 2.1 mg/kg (Van Metre, Mahler et al. 2009). In a later study, Mahler et al. found higher concentrations of PAHs from parking lot dust. This study quantified PAH concentrations in dust from both coal tar sealed lots and those with other surface types (asphalt based, concreate, and unsealed), as well as the concentrations of PAHs in settled house dust from apartments on the lots. Results showed a median PAH concentration of 4,760 mg/kg from coal tar sealed parking lot dust, which was 530 times higher than the concentrations from the other parking lot types. The house dust concentrations, from apartments with coal tar sealed lots, were 25 times higher than the dust from apartments on other types of parking lots, with median PAH concentrations of 129 mg/kg, and 5.1 mg/kg respectively (Mahler, Van Metre et al. 2010).

Different methods have been conducted to understand the rate at which PAHs are emitted from coal tar based sealcoat, and thus understand the total PAH emissions to the environmental annually from the product. A study by Sroggins et al. employed a photographic study, in which photos were digitally analyzed over time to determine how much wear occurred. The results showed that coal tar based sealcoat wears off at a rate of about 4.7% a year from driving areas, and 1.4% a year from parking areas, with the overall annual sealcoat loss rate 2.4%. This sealcoat loss results in a delivery of 0.51 g of PAHs per m^2 of parking lot annually to the environment (Scoggins, Ennis et al. 2009). A study by Van Metre et al. showed much higher concentrations of PAHs to the environment on an annual basis. The study quantified volatilization rates for PAHs above coal tar sealed parking lots for one year. It was found that PAH concentration in the gas phase (at 0.03 m above the pavement, 1.6 hours after application), was 297,000 ng/m^{-3}. The first 16 days after application, it was estimated that 25-50% of the PAHs in the sealcoat were released to the atmosphere (roughly speaking, about 8 g/m^2). By combining these results with the estimated amount of coal tar sealants used in the U.S., the study concluded that annual PAH emissions from coal tar sealed surfaces averages ~1,000 Mg annually, making it a larger PAH emission source than vehicles (Van Metre, Majewski et al. 2012).

Laboratory and field studies have been conducted to explore the harmful effects of PAH contamination from coal tar sealants on animals and ecosystems. When exposed to PAHs in the lab, amphibians experienced stunted growth, decreased righting ability (the capability to get back onto its feet after being laid upside down), decreased liver enzymes, and mortality. One study looking at African clawed frogs exposed the amphibians to a range of PAH concentrations that are regularly seen in streams in the city of Austin, Texas (levels of 3, 30, and 300 ppm from coal tar sealant flakes). Frogs exposed to the highest amount of PAHs died after the sixth day and those exposed to the medium amount of PAHs experienced stunted growth and slower development by the fourteenth day (Bryer, Elliott et al. 2006). Another study, looking at adult newts, did not notice an increase in mortality due to an increase in exposure. However, the study did notice that those exposed to coal tar based sealant had increased chance of liver damage and were less able to right themselves after being laid on their backs (Bommarito, Sparling et al. 2010).

Field studies have also shown detrimental effects to wildlife due to exposure of PAHs from coal tar sealants. One study looked at five streams in Austin, Texas and performed biological surveys and collected sediment samples in both upstream and downstream areas. PAH concentrations from the downstream locations were higher in most cases, and analysis of organisms at the sites showed a decrease in species richness and abundance (Scoggins, McClintock et al. 2007). Another field study applied dried coal tar sealant flake to an outdoor site, and introduced sediment-dwelling benthic macroinvertebrates. At the end of 24 days, the high treatment group (those exposed to the highest amount of PAHs) experienced lower species abundance and diversity than the other treatment groups (Bryer, Scoggins et al. 2010).

People can be exposed to PAHs from coal tar based sealants through numerous pathways, including ingestion of sealant particles (when they fall on food or objects), skin contact, and inhalation from wind-blown particles or volatized gas particles. A USGS study was conducted in order to estimate the human health risks associated with PAHs from pavement surfaces. The study evaluated the concentration of seven carcinogenic PAHs from soils near paved surfaces (both asphalt and coal tar sealed), and in house dust from residences near the paved surfaces. The study found that the average PAH dose for someone living adjacent to a coal tar sealed pavement was 38 times higher than someone living adjacent to an asphalt surface. About one half of the PAH dose occurs during childhood (0-6 years of age), and about 84% of that is due to ingestion of soil. On average, a person who lives adjacent to a coal tar sealed parking lot (either their entire life, or the first 6 years), will have an excess lifetime cancer risk greater than 1 in 10,000. The EPA deems that excess cancer risks greater than 1 in 10,000 is large enough that some sort of remediation should be undertaken (Williams, Mahler et al. 2013).

Although numerous papers have been produced since 2005 that identify coal tar sealants as a PAH source, three studies funded by the Pavement Coatings Technology Council have been published that challenge this claim. These studies use different forensics techniques to show that coal tar sealants are not a major PAH source. In a 2012 study, a suite of potential PAH sources were compared to one another. Researchers found that PAH profiles for coal tar sealants are similar to other sources. The study states that coal tar sealants could be a potential PAH source in some areas, but conclude that it is not possible to differentiate one source of PAHs from another (O'Reilly, Pietari et al. 2012).

Two additional articles published in 2014 and 2015, claim that coal tar sealant is not a major PAH source. Both articles discredit the receptor modeling technique the USGS used in their studies and state that a multiple-lines-of-evidence approach should have been used. This approach employs various forensic modeling methods and compares the results against one another. The researchers in the 2014 study used the multiple-lines-of-evidence approach and considered numerous potential PAH sources in their study. They found that coal tar sealants have a similar PAH profile to other sources, so it cannot be said with certainty that they are a large PAH source (O'Reilly, Pietari et al. 2014; O'Reilly, Ahn et al. 2015).

Coal Tar Sealants Vs. Asphalt Based Sealants

Coal tar based sealcoats are made up of roughly 50% water, 20% clay, and 30% refined coal tar. Coal tar is a byproduct, produced when coal is stripped of its volatile component to make coke, which is then used in steel manufacturing. The volatile components are then captured and cooled, forming a substance known as coal tar. Coal tar based sealants are resistant to damage from ultraviolet light, gas, motor oil, kerosene, fat, grease, salt, and chemicals. Upon application, coal tar sealants will emit strong fumes and can cause skin irritation. Once the coal tar is dry, it forms a hard layer over the asphalt, which protects the asphalt from deterioration. Coal tar sealants can last two to four years before needing to be reapplied. The price of coal tar based sealants are location dependent, with costs usually being higher in the west where there is less manufacturing of coal tar. However, generally speaking, prices of coal tar sealant have gone up in recent years as the availability of coal tar in the U.S. has decreased (Dubey 2006; Heydorn 2007; Dubey 2011; Walters 2011).

Asphalt based sealcoats are the primary alternative to coal tar based sealants.

Asphalt based sealcoats have been in use since the 1980s, and are continually being improved. These types of sealants are made up of an asphalt emulsion, which is asphalt cement mixed with water. Some believe that an asphalt sealcoat can better protect asphalt surfaces because it is made up of the same base element and is more compatible with the underlying pavement. In the past, asphalt sealants did not last as long as coal tar based sealants because they are not, by themselves, resistant to gas, motor oil, kerosene, fat, and grease. However, if the asphalt based sealants are mixed with additives such as sand and water, they can be made to perform just as well, if not better, than coal tar based sealants. Generally speaking, asphalt based sealants are dependent on the price of oil, and have decreased in price in the last five years. Asphalt based sealants are also price comparable with coal tar based sealants in many parts of the country (Dubey 2006; Heydorn 2007; Walters 2011; Ennis 2015 (d)).

When comparing coal tar based sealants and asphalt based sealants, the main difference is the PAH content and releases from the products. Asphalt based sealants typically contain about 50 mg/kg of PAHs, whereas coal tar based sealants contain roughly 70,000 mg/kg of PAHs (Austin 2005; Mahler 2005). Both products are comparable in quality and, according to one manufacturer, both perform well if they manufactured, mixed, and applied appropriately (Walters 2011). There is little price difference between the two products, especially if a full cost-benefit analysis is performed that accounts for the potential costs of human and ecosystem health issues. In addition, most sealant appliers in the U.S. offer both products, and the same equipment is used for both application (Neal 2011). However, coal tar sealants have been in use longer, and may be preferred by consumers for this reason. At the same time, asphalt based sealcoats are continuing to be improved upon, making them even more competitive and, in some cases, better than coal tar based sealants in terms of price and quality. Since many companies offer both products, the switch to strictly providing asphalt sealers would not be difficult, if this is what consumers, or policy, demanded (Heydorn 2007; Walters 2011; Ennis 2015 (d)).

Coal Tar Sealant Bans

In the period since the link between elevated PAH levels and coal tar sealants was made, numerous bans on the use of coal tar sealant have been established throughout the U.S. The first ban was passed in 2006, in Austin, Texas, shortly after the discovery of elevated PAH levels in local waterways. The first statewide ban occurred in 2011 in the state of Washington. Many areas across the U.S. have also attempted to implement bans during the past decade, but not all have been successful.

Proposed, Successful, and Unsuccessful Bills

To date, over 35 coal tar sealant bans have been put in place in the U.S. These bans occur at the state, regional, and local levels, as well as at the level of specific institutions and government buildings. Roughly 17.5 million citizens in the U.S. are currently living in areas covered by a coal tar sealant ban. Numerous hardware stores have also banned the product from their shelves nationwide, including Home Depot, Lowes, and ACE. Some applicator and supplier companies have also agreed to stop offering coal tar sealants as a paving option (Agency 2014). According to a blog by Tom Ennis, an Environmental Resource Manager for the City of Austin, bans include:

- State bans: Washington, Minnesota
- County bans: Dane, Wisconsin; Montgomery County, MD; Washington, D.C., and Suffolk, NY
- Watershed Bans: Anacostia Watershed
- States with city/town/university bans in them: 13 (Texas, Wisconsin, New York, Massachusetts, District of Columbia, Michigan, North Carolina, South Carolina, California, Kansas, Illinois, Maryland, and Missouri)
- Institutions with bans: 7 (Including: University of Michigan, University of Illinois- Springfield, San Diego Unified School District)

Figure 2.2 shows where bills to ban coal tar sealants have been successful, unsuccessful, and proposed at the statewide level, as well as successful bills at the county and town/city wide level. For more information on statewide bills to ban the product, see Table 2.1 for successful bills, and Table 2.2 for unsuccessful bills. Although numerous bills to ban the product may have been attempted in a state, the table only lists the most current bills. A national ban was also attempted (H.R. 1625: Coal Tar Sealants Reduction Act) in 2013, but did not pass.

Figure 2.2: Statewide, Countywide, City/Town Wide Bill Bans

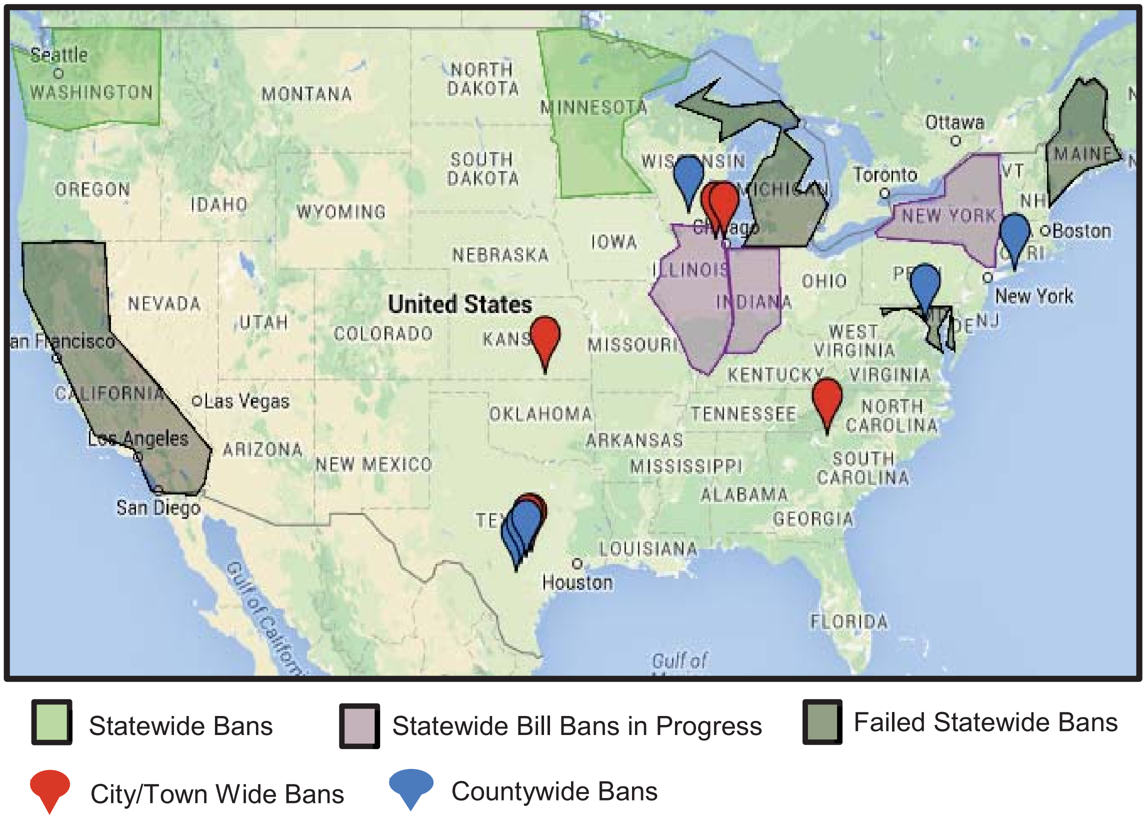


Figure 2.2: Coal tar sealant restriction bills. Bill bans up to date as of December 2014. Map does not include bans at institutions or government restriction bans. Ban information courtesy of Minnesota Pollution Control Agency.

Table 2.1: Successful Coal Tar Sealant Bills

Table 2.1: Bills which were successfully passed at the state level to restrict the use and sale of coal tar sealants. Bill information from www.govtrack.us, and state government websites

State	Bill Name	Last Decision	Last Action	Summary
WA	HB 1721. Preventing storm water pollution from coal tar sealants	7/22/2011	Enacted	No sale of coal tar sealer after January 1, 2012 No application after July 1, 2013
MN	SF 1423. Coal tar bill	5/23/2013	Added to CHAPTER 137 (Enacted)	No sale and use of coal tar sealants, by January 1, 2014

Table 2.2: Unsuccessful Coal Tar Sealant Bills

Table 2.2: Bills which were unsuccessfully passed at the state level to restrict the use and sale of coal tar sealants. Bill information from www.govtrack.us, and state government websites. Information up to date as of May 2015.

State	Bill Name	Last Decision	Last Action	Summary
CA	AB 1704. Coal tar pavement sealants	2/15/2012	Died in Committee	Prohibits the selling or applying of coal tar pavement sealant products
MD	HB 369. Coal Tar Pavement Products - Prohibition	2/27/2012	Unfavorable Report by Environmental Matters - Withdrawn	Prohibits the application of coal tar sealant to any surface
MI	HB 4074. Coal tar-based products for pavement; prohibit use and sale of	1/23/2013	Bill Printed and Filed (never voted on)	A bill to amend "Natural resources and environmental protection act" Prohibits use and sale of coal tar sealant products
IN	HB 1115. Ban on sale or use of coal tar pavement products	1/8/2015	Referred to Committee on Environmental Affairs	Prohibits the sale and application to pavement of a coal tar sealant except for research
NY	S02595A/A00418, Prohibits the sale and use of pavement products containing coal tar	2/11/2015	Amended and recommitted to Environmental Conservation Committee, and printed	An act to amend the environmental conservation law, in relation to prohibiting coal tar in pavement products
IL	HB 2401. Coal Tar Ban	3/27/2015	Re-referred to Rules Committee	Amends the Environmental Protection Act. No person may sell or use coal tar sealant on any surface
ME	LD 1208. An Act Concerning Pavement Sealing Products	5/27/2015	Failed	Prohibits the sale and use of coal tar sealant products

Evaluation of the Austin, Texas Ban

After the ban in Austin, Texas, in 2006, two studies were conducted to assess the effect of the ban on reducing PAH concentrations. The first study collected and compared PAH concentrations in 2005, prior to the ban, and again in 2008. Results showed no net change in PAH levels in sediments from Austin streams. The researchers expected PAH concentrations to decrease, if coal tar sealant was indeed a major PAH source. However, the authors also state that two years may be an insufficient amount of time to understand the full effects of the ban and called for further monitoring to determine if PAH concentrations would decrease as a result of the banning (DeMott, Gauthier et al. 2010).

A later study conducted by the USGS showed a decrease in PAH concentrations due to the coal tar sealant ban in Austin. The study analyzed PAH levels in sediment from Lady Bird Lake in Austin, which is the main receiving water body in the city for urban runoff. Sediment cores were taken and concentrations for EPA's 16 Priority Pollutant PAHs were analyzed for the past sixteen years. Samples taken from the lower part of the lake had a mean PAH concentration of 7,980 µg kg from the years 1998-2005, and a mean concentration of 4,500 µg kg from the years 2006-2014, representing a 44% decrease. From 2012 to 2014 alone, the decline in PAHs was roughly 58%. The decrease of PAHs since 2006 reverses a forty year trend of increases of the chemical in the lake (from 1959-1998). Although PAH concentrations are decreasing, source-receptor modeling shows that coal tar sealants are still the largest PAH source to the lake. This indicates that PAH concentrations will continue to decrease in the coming years, as coal tar sealed surfaces continue to be depleted and phased out (Van Metre and Mahler 2014).

The Broader Policy Context

Environmental policy making in the U.S. has evolved greatly over the past fifty years, with the role of the states becoming larger in recent decades. At the national level, relatively little has changed in terms of environmental regulations since the 1980s, and political gridlock in recent years has made decision making even more difficult. Some states, therefore have taken it upon themselves to develop their own policies on certain issues. For example, environmental laws concerning air quality standards are more sophisticated in the state of California than elsewhere. Using states as a testing ground for policies has advantages over immediately developing national policies. When a policy is first introduced at the state level, many issues are debated and fleshed out. In addition, many issues that might not have been anticipated initially, become resolved, especially as more and more states beginning implementing a similar law. Therefore, at the federal level, policy makers now have the opportunity to learn from what happens in the states before constructing national policies.

Brief History of Environmental Policy in the U.S.

Before the 1970s, states were seen as unable to make serious environmental policies themselves. Specifically, they were seen as "racing to the bottom," and desired to implement as few regulatory measures as possible. In response to this, environmental laws were adopted at the national level, to ensure that states would do their parts to protect the environment, in areas such as air and water pollution. During the 1970s, all the major environmental laws and regulations that now define the federal environmental regime were passed. These laws include the Safe Drinking Water Act, the Toxic

Substance Control Act, the Resource Conservation and Recovery Act, the Clean Air Act, and the Clean Water Act (Rosenbaum 2013; Vig and Kraft 2013).

Federal leadership in environmental policy, however, declined with the Reagan administration. Bipartisan support for environmental causes ended, as other issues such as economic relief and energy independence became top issues. Environmental issues continued to receive little attention in the Ford, Bush, and Clinton administrations. In George W. Bush's administration (2001-2009) efforts to address environmental concerns became even more difficult, as energy production became his top priority. Environmentalists hoped that president Obama would be able to end the bipartisan fight over environmental problems, but were ultimately let down by the overall lack of action (Rosenbaum 2013).

In the meantime, states began playing a larger role in the development of environmental regulations. States are now seen to be "racing to the top", as new innovations and stricter regulations are being explored at the state, instead of the federal level. States are now being proactive in addressing environmental concerns. They are also taking on more responsibility for enforcing existing laws. As a whole, states now issue over 90% of environmental permits, complete over 90% of all environmental enforcement actions, and collect almost 95% of all the environmental data used by the federal government.

Improving Federal Policies

Because of the gridlock at the federal level, many now believe that environmental regulations are best developed and enforced for the state level. The environmental think tank, Resources for the Future, pointed this out in a 2001 report by stating: "A basic tenet of much current thinking about environmental policy is the desirability of decentralization" (Davies, Hersh et al. 2001). This sentiment is echoed by political scientists Klyza and Sousa who confirm that states have more flexibility when it comes to implementing policies, and have a better chance to enhance policy innovations (Klyza and Sousa 2007; Vig and Kraft 2013).

However, there is growing concern about how evenly environmental policies are actually adopted at the state level. While some states may "race to the top" in terms of environmental regulations and innovation, others may do as little as possible when it comes to environmental policies. The "race to the bottom" approach becomes especially attractive to states during times of recession, which was shown from 2011-2012 when states such as Wisconsin delayed or reversed policies in order to promote their goal of economic development. Because of this dynamic, it is clear that federal action still has a place in environmental regulation (Vig and Kraft 2013).

At the same time, states can serve as a proving ground for new policies and approaches, allowing efforts at the federal level to be informed by what happens at the state level. In order to develop national policies that are efficient and effective, policy makers at the national level can learn from what worked at the state level, both in terms of the decision-making process and in terms of policy design. Evaluating how policies are formulated at the state level gives policy makers an idea on how an issue may play out at the national level. In the case of coal tar sealants, efforts to pass a ban at the national level can be informed by what happened at the state level by examining the factors which were debated in each state case study. At a more general level, this study will also contribute to how states can serve as a testing ground in the development of environmental policies.

Chapter 3: Research Question and Methodology

How and why bills to prevent coal tar sealant bans were passed, or not passed, was explored using a collective case study analysis. This case study method requires that one first analyze the individual cases and then compare them to one another. Data for each case study came from governance mapping, documentary research, and interviews. The focus of each case study is on the portion of the policy process associated with problem identification, agenda setting, and policy adoption.

Research Question

The main question this study explores is: Why were coal tar sealant ban bills successfully passed in some states but not others? In order to answer this question, four states have been selected for analysis, based on their varying degree of success in passing coal tar sealant bills. The states are: Washington (which implemented a ban after the first attempt), Minnesota (which successfully passed a bill after several attempts), Illinois (which currently has a bill in committee), and Maryland (which was unsuccessful in passing a statewide bill). The factors that influenced the introduction of these bills, and the factors that either helped or hindered bans from passing was first examined. Then, to identify the similarities and differences, a comparison of the four cases also was conducted. These results can then be used to provide insight into the idea that states policies can be used as a guide to improve federal policy implementation.

Methodology

Collective Case Study

Collective case studies, also known as multiple case studies, allow researchers to analyze cases individually, as well as in groups. Although several cases are presented collectively, each case narrative is also expressed with its own unique characteristics. When using a collective case study method, each case is analyzed the same way, such as the replication of an experiment, so that results can be compared and contrasted across cases. Collective case studies can be seen as more valuable than single case studies because it allows the researcher to test a theory amongst several situations, and it allows for generalizations to be made (Robson 2002; Yin 2003; Baxter and Jack 2008).

There are multiple characteristics of methods associated with case studies. To begin with, a study can be qualitative (in which observations are made to identify patterns, with no numerical support) or quantitative (in which numerical evidence is used to support a claim). Second, a study can be descriptive, explorative, or confirmative. Descriptive studies are used to explain a certain phenomenon. Explorative studies are used in order to gain knowledge about a certain occurrence. And confirmative studies are utilized when a hypothesis has already been made, and a study is conducted to confirm or deny the hypothesis. Finally, unique to multiple case studies, cases are chosen based on literal replication, or theoretical replication. Literal replication cases are chosen when cases are similar, and the expected results are similar as well. When cases are different, theoretical replication is chosen, which is based on the assumption that cases will produce contradictory results (Stake 1995; Yin 2003; Shkedi 2005; Johnson and Christensen

2008).

For this study, a qualitative, explorative approach is being used. Interviews with key players and documentary research about coal tar sealant bans was collected and analyzed. However, no statistical analysis was performed. The main purpose of this study is to gain a better understanding about a specific phenomenon, the efforts to ban coal tar sealant. On one hand, this study involves an issue that one might expect to be resolved in a similar manner in all cases, with a ban either succeeding or failing in each case. However, that is not what happened, and the goal here is to explain the reasons why. The states which were chosen to analyze were picked because they involve a range of outcomes and therefore are likely to provide insight into the coal tar sealant case as a whole. The coal tar sealant case studies at the state level can also be used to inform a federal policy on the matter.

The Policy Process

The policy process is the general cycle that starts with an issue first coming to be seen as a problem and ends with the problem being perceived as resolved. In the simplest of terms, the policy process can be visualized as consisting of six different stages, all of which can overlap and have mini-stages associated with them. These stages are: Problem Identification, Agenda Setting, Policy Making, Budgeting, Adoption and Implementation, and Evaluation (Slack 2013; Austin 2015). This research evaluated three steps of the policy process: Problem Identification, Agenda Setting, and Policy Adoption for the chosen study areas.

During the Problem Identification part of the policy process, communities (which can include citizens, organizations, and legislators) first become aware of the coal tar sealant issue. Individuals can become aware of issues such as coal tar sealants through popular media outlets like online news articles or through environmental organizations who perform outreach programs. The issue must be relatable to people in the community in order for them to care, and to see the issue as a problem. For example, finding elevated PAH levels in creeks from coal tar sealants only matters if those levels are causing ecosystem damages.

The next step, Agenda Setting, occurs when policy makers become aware of a problem and decide it is important enough to be put on their political agenda. Certain characteristics make a problem more appealing to policy makers than others, such as a short timescale and a high potential for success. Issues which can be addressed in a shorter timescale are more appealing to policy makers, because their term in office can be short. Also, efforts in which constituents see direct results are preferred. When defining a problem, policy makers must also make sure the issue is well understood, and there is a general agreement on the importance of the problem. In the case of coal tar sealants, numerous organizations and media articles were involved in bringing the issue to the attention of law makers. In addition, it is an issue that lawmakers have the capacity to fix in a short amount of time and see direct results from. Also, the detrimental effects of the product are well documented. However, industry groups have refuted these claims of detrimental effects, making it difficult for some policy makers to stand behind a bill that bans the sealant.

The Policy Making procedure involves coming up with the best approach to solve the problem at hand. Different branches of the government, along with interest groups, can be part of this process. Policy makers evaluate options in the hopes of finding one which best meets the desired goal. This pre-evaluation is termed ex ante, because the actual outcomes of the regulation are unknown, and are instead being theorized. Many types of evaluation methods exist to help policy makers choose their best option, these include cost-benefit analysis, risk assessment, multi-criteria analysis, etc. If policy makers wish to decrease PAH emissions from coal tar sealants, banning the product outright is one option they could consider. Scientific studies that show the harmful effects of coal tar sealants, along with case studies from regions that have banned the sealant, can help with ex ante evaluations of potentially banning the product.

Budgeting also plays a role in what policies get on the agenda and how policies are constructed. After all, policy makers must decide how much money they are willing to spend on an issue. Generally speaking, in the case of coal tar sealant bans, budgeting is not be an issue since bans are relatively inexpensive. However, money can be allocated in a ban under certain circumstances, for example creating a budgeting fund for coal tar sealant research or for PAH remediation activities.

Policy Adoption and Implementation involves the phases of passing a coal tar sealant regulation, and seeing that is it put in place. The adoption step includes refining the policy through the bureaucratic process, which can result in the policy being altered through numerous committees. Once in its final stage, the policy must be voted on. At his stage an inaction or a defeat is also considered policy making. If a policy does pass, implementation is the next step. This process is often carried out by institutions other than those who made the policy. Depending on the policy, implementation could involve adopting new rules or regulations, providing certain services or products, etc. Some policies are much easier to adopt than others. In general, coal tar sealant bans tend to be relatively simple to implement. Many bills to ban coal tar sealants at the state level are similar in nature in that they call for a complete ban of the product by a certain date. Therefore, the process of formulating the bill does not have to take that long. Bans are also easy to implement because alternatives are available. Implementation would become difficult if, a bill calls for the removal of all coal tar sealed surfaces currently in place.

The final step in the policy process is Evaluation. To determine the effectiveness of a policy, it must be assessed after a certain period of time. Policy evaluation after implementation is termed ex post and takes into account the monitoring and reporting of data. Many parties can contribute to this step, including legislators, organizations, citizens, and media. Through investigative reporting, the media can shed light on what policies may or may not be working. Universities can also help in this process by conducting assessments on implemented policies. Evaluation of a policy can expose problems, and a new round of policy making can start in order to alleviate these issues. For coal tar sealants, the evaluation period can take place in two parts. First, it is important to identify if citizens and companies have actually stopped using and selling coal tar sealants after a ban has been put in place. The second step, which has yet to be utilized at the state level, involves evaluating PAH levels after a ban has been put in place. Because PAHs are persistent, they remain in the environment for many years even if a source is stopped. Therefore, for PAHs, this type of ex post evaluation may not occur for five to ten years after a ban has been put in place.

For this research, it is important to focus on the Problem Identification, Agenda Setting, and Policy Adoption steps. Focusing on these steps tell us how coal tar sealant use was first identified as an issue for the study area and what factors played a role in getting it banned or not banned. Initial stages of problem identification, for example, where the initial concerns due to research on PAHs in the state, or due to reading about PAH effects in other states. This may help our understanding of why a coal tar sealant ban bill ended up successfully passing or not. Evaluating the end stages of the bill, including the stages it went through, the final votes, and any opposition, also helps in understanding why it may or may not have passed. Note that these steps tend to overlap in cases when numerous bills are attempted and coal tar sealant studies continue to be conducted.

Collected Data

Data was gathered in the form of governance mapping, documentary research, and interviews. Governance mapping was the first step of the process, and was performed to identify all actions, forces, and entities which play a role in the coal tar sealant issue. This includes, but is not limited to, such things as government and non-government agencies and organizations and the actions they perform, market forces, and social norms. In practice, much of the results of this step informed the material included in Chapter Two, "Background", which included information about the history of knowledge and laws affecting the regulation of PAHs and the use of coal tar sealants. It also included information about the entities playing a role in the issue, including organizations and publications. Documentary research was then conducted to explore issues gleamed from the governance mapping process in more detail, with the focus on reports, newspaper articles, and scientific papers relevant to the case study being explained. The documentary research also helped to inform the material in Chapter Two.

In order to gain information highly specific to the four cases, interviews were also conducted. Prior to the interviews, permission was granted from Michigan Technological University's Institutional Review Board (IRB). The IRB determined the research would be exempt from formal review, because the interviews presented no more than minimal risk and would not compromise and privacy or confidentiality of the participants. The interviews were recorded and transcribed, and all interviewees confirmed their willingness to be recorded for the study (IRB 2015). All audio recordings and transcriptions were kept private, and only used for this study. For a list of interview questions, see Appendix One.

The goal was to interview legislators who proposed the ban bills in their states and organization leaders from key environmental groups who advocated for the bans. Both were asked how they first heard about the coal tar sealant issue, why they decided to put the effort into introducing the bill or advocating for a ban, if there has been any opposition in the state regarding the bill, and why they believe the bill was successful (or unsuccessful) in their state. If the bill was successful, they were also be asked if actual implementation has been successful. If the bill was not successful, they were asked if they will continue advocating for a ban. Multiple bills may have been introduced in the states over the years, and may continue to be introduced, but only the latest bill was fully explored. Other key players who have affected the national coal tar sealant story were also interviewed. These players are the USGS, who has completed a lot of research on the issue and was part of the initial discovery of coal tar sealants being a major PAH source, Tom Ennis the creator of a Coal Tar America blog and campaign, and the Pavement Coating and Technology Council an industry group that opposes sealant ban bills.

Chapter 4: Results and Discussion

This section summarizes the case examples being used in this study: Washington, Minnesota, Illinois, and Maryland. Each summary is divided into sections associated with Problem Identification, Agenda Setting, and Policy Adoption. The Problem Identification section outlines the scientific studies that have been carried out in the state with regards to PAHs and coal tar sealants, as well as describes other ways citizens were exposed to the issue, such as newspaper articles. This section also summarizes what has been done at local levels in the state, such as city bans, that might serve to bring the issue to the attention of policy makers at the state level. Because this study only evaluates state level bills, local level bills are considered as a problem identification step before considering a statewide bill. The Agenda Setting segment examines efforts to enact a statewide bill, with the emphasis on the last bill attempted. For each, the sponsor of that bill was asked how they heard about the issue and why they decided to pursue a statewide ban. The Policy Adoption section includes the results of the last bill attempted, including what happened during the bill's hearings and the final outcome of the bill. A brief at the end of each case explores the factors influencing why a coal tar sealant bill did or did not pass.

For each state evaluated, as much data was collected and analyzed as was available. For example, audio recordings of hearings were available online for Washington and Minnesota, but not for Illinois and Maryland. Interviews were also conducted with influential actors in each state, as well as with national players in the coal tar sealant issue. Both the bill sponsor and an environmental group were asked to be interviewed. However, in the case of Maryland, only the delegate that sponsored the bill was interviewed as no environmental groups influential in the case were identified. News articles and scientific studies concerning PAH releases and coal tar sealants in the states were also evaluated. For a summary of the data collected and evaluated, see table 4.1.

Table 4:1 Source of Data for Case Studies

Table 4:1: Analyzed data which was available. No online bill hearing audios or transcripts were available for Illinois and Maryland. Studies in State represent specific studies which were completed in the state and attributed PAH contamination to coal tar sealants.

State	Interviews	Hearing Transcripts/ Audio	Studies in State	Local Ban(s) in State
Washington	Bill Sponsor Washington Environmental Council Representative	Yes	Yes	Yes
Minnesota	Two Minnesota Pollution Control Agency Representatives	Yes	Yes	Yes
Illinois	Bill Sponsor DuPage River Salt Creek Workgroup Representative	No	Yes	Yes
Maryland	Bill Sponsor	No	No	Yes
National Level	United States Geological Survey Pavement Coatings and Technology Council Coal Tar Free America Founder			

Washington State

In July 2011 Washington became the first state to enact a statewide ban on the use and sale of coal tar sealants. The bill prohibits sale of coal tar sealant product after January 1, 2012, and prohibits use of the product after January 1, 2013. To the knowledge of the bill's sponsor, there has been no opposition since it was successfully passed, and there has been no reports of coal tar sealant use in the state.

Problem Identification

Prior to enacting the statewide ban in 2011, agencies in Washington were well aware of issues regarding both PAHs and coal tar sealants. Two studies began in 2007 which reviewed PAH emissions and sources in the state. And in 2009, the Washington Department of Transportation stopped using coal tar sealant for their work. These measures helped justify the importance of enacting a statewide ban of coal tar sealants.

Beginning in 2000, Washington's Department of Ecology (WDOE) began studying persistent, bioaccumulative toxics (PBTs), and initiated Chemical Action Plans (CAPs) to address concerns associated with certain PBTs. The goal of the CAPs are to evaluate sources and releases of chosen PBTs, and to recommend actions in order to minimize human and ecosystem harm from the chemicals. In 2007, PAHs were chosen to be evaluated under a multi-year CAP study which was finalized in 2012. PAHs were chosen because the WDOE recognized the human and ecosystem health concerns associated with PAH releases, and also realized that addressing PAH issues could help with learning and reducing other combustion byproducts, such as dioxins (Ecology 2007).

In the CAP for PAHs, many sources are identified, including coal tar sealants. However the sealants did not appear to be a major source. Before the ban, industry estimates show that Washington used 400,000-600,000 gallons of coal tar sealant annually. Based on literature values and release rates of PAHs from coal tar sealant, the WDOE estimated annual PAH releases from coal tar sealant to be 1,195 kg/yr in the state. This estimate also does not take into account legacy PAHs from previous coal tar sealant use or PAHs released from volatilization from the sealant, so the results could be underestimated. According to the PAH CAP, the highest PAH source in the state comes from creosote treated wood, which releases 270,000 kg/yr and is responsible for 50% of total releases. In this particular study, PAH releases from coal tar sealant were estimated to account for less than 1% total PAH releases per year (Ecology 2012).

In 2007, another multi-year study began in an effort to address toxic hazards in Washington, which also showed coal tar sealants as minor PAH source. The study focused on Puget Sound, an ocean inlet on the northwest coast of Washington. Hundreds of contaminated sites surround the inlet and numerous habitats have been degraded. In order to address concerns about toxics in the areas, the WDOE teamed with the Puget Sound Partnership, and other organizations, to produce a toxic chemicals assessment study. The study took place from 2007 to 2011, and analyzed loading rates of numerous chemicals, identified chemical sources, and listed priority actions in an effort to control chemical pollution. PAHs were one of the chemicals found in high concentrations in the Puget Sound basin. The WDOE estimated total PAH releases to the basin to be 310,000 kg/yr. Based on the fifteen chemicals analyzed, PAHs ranked the fourth highest in the basin. Because PAH concentrations were high and opportunities to control some releases were available, the WDOE listed the chemical group as a priority, meaning that actions should be taken immediately to reduce releases. In this study, the largest PAH source identified was from woodstoves and fireplaces, which accounted for roughly 107,000 kg/yr of releases. Coal tar sealants were still identified as a minor source, releasing roughly 920 kg/yr of PAHs, less than 1% of total PAH releases in the basin (Ecology

2011).

Even though coal tar sealants were a minor PAH source overall, studies by the USGS suggested that they could be a major source at the local level. In one 2008 study, PAH concentrations in dust swept from pavements (parking lots and driveways) across the U.S., were measured. In Washington, nine surfaces were swept, and the resulting median PAH concentration for the lots were 5.2 mg/kg. However, one sealcoated lot had a concentration of 850 mg/kg, suggesting that this lot was sealed with coal tar based sealant (Van Metre, Mahler et al. 2009). Two years later, a study analyzed PAH concentrations and sources for forty urban lakes throughout the U.S. Two lakes in Washington, Lake Ballinger and Lake Washington, were analyzed for this study. Results showed that although PAH concentrations were low in the lakes, .4 mg/kg for Lake Washington and 16.61 mg/kg for Lake Ballinger, coal tar based sealants were responsible for 60-80% respectively, of the PAH contamination (Van Metre and Mahler 2010).

Based on scientific studies which linked coal tar sealants to high PAH releases, the Washington State Department of Transportation made a decision to stop using the product in 2009. Thomas Baker, the State Materials Engineer for the DOT, stated in a letter that the department stopped using the product because of its toxicity. The DOT now uses asphalt based products, which Baker stated as “being comparable in price and performance, and do not pose the environmental risks that have been associated with coal-tar emulsions” (Baker 2011). Although coal tar sealants were previously only used by the DOT for parking areas in rest stops, the department believes that the switch to asphalt will help protect Washington’s waterways and environment from an important PAH source (Baker 2011; Transportation 2011).

Agenda Setting

The coal tar sealant ban bill in Washington State was put on the agenda by David Frockt, a democratic state senator. When asked how he first heard about the issue of PAHs and coal tar sealants, he responded it was bought to his attention in 2010, from an article by InvestigateWest. The article, “Study sees parking lots dust as cancer risk” was co-published by InvestigateWest and msnbc.com, and was the first national story that highlighted the toxic effects of coal tar based sealants. The article discussed the findings by USGS regarding coal tar sealant, as well as local bans of the product (McClure 2010). However, the Washington senator credits an environmental group, the Washington Environmental Council, for pushing to get the bill on his agenda. As a freshman senator, Frockt wanted to get involved in environmental issues, so sought out the Washington Environmental Council for advice on what he could do. The environmental group suggested a coal tar sealant bill. They remarked that the issue was “a little bit below the radar, but worth taking a look at”. The Washington Environmental Council first became aware of the problem through the studies conducted by the USGS (Interview 1 2015; Interview 2 2015).

Policy Adoption

Washington State was the first to propose, and enact, a statewide bill to ban the sale and use of coal tar sealants. Washington State’s bill, HB 1721- Preventing storm water pollution from coal tar sealants, was introduced to the House of Representatives on January 1st, 2011. After going through the House Committee on Environment, and the Rules Committee, the bill passed the house with a vote of 67 to 30 with bipartisan support. In the senate, the bill was passed through the Environment, Water & Energy

Committee and Rules Committee, and passed the senate with a vote of 36 to 12. On May 5th, 2011 the Governor signed the bill in law. While in committee, the technical changes were made to the bill, such as the enactment date. The final bill states that after January 1st, 2012, no person or retail facility may sell a pavement product that contains coal tar. And after July 1st, 2013, no person is allowed to apply a coal tar pavement product to a driveway or parking area. A notice of corrective action will be provided by the Department of Ecology to any person who violates this law. A fiscal note was also provided with the law which states that it will have no capital budget impacts (Committee on Environment 2011; Environment and Senate Committee on Environment 2011; Steinmann 2011).

Although the bill was successfully passed, there was opposition at both the House and Senate committee hearings. The opposition came from the Pavement Coatings and Technology Council (PCTC), as well as from a scientist with an engineering and scientific consulting firm, Exponent, hired by the council. During the House Committee on Environment hearing, the Exponent scientist argued that the USGS results which showed high PAH levels from coal tar sealcoat was inaccurate, and in fact multiple sources could be blamed for elevated PAH levels. The scientists also stated that there is a similar PAH fingerprint among coal tar sealant and other products, making it impossible to identify coal tar sealant as a large source. During the hearing in the Environment, Water & Energy committee, the PCTC came on stronger. According to the bill's sponsor, "When the bill moved to the legislator over in the senate, they [the PCTC] were more organized, and it was a little bit of a narrow victory. We definitely had some opposition" (Interview 2 2015)

The PCTC and the Exponent scientist challenged the conclusions of the USGS. The Exponent scientist stated that his firm had used the methods employed by the USGS to measure and identify PAH sources in Lake Ballinger, and their results showed the lake was not effected by PAHs from coal tar sealant. The scientists also stated that the USGS did not account for enough sources when doing their analyses. In addition, the Exponent scientists shared the results of a study they did in Austin, TX, after a citywide ban was put in place. This study did not show a decrease in PAH levels after the ban was implemented. A representative from the PCTC also talked about the dangers of passing a ban when one is not needed. It would be reckless to pass a ban, they stated, because if it passes on “flimsy science” then citizens would lose faith in their elected officials. Passing a ban in Washington could also lead to other states passing bans, which would hurt numerous businesses throughout the country. The PCTC representative also argued that is still unknown if PAHs from coal tar sealants are contaminating stormwater, and the government should hold off on a ban until results from the Department of Ecology’s studies were available (Committee 2011; Senate Environment 2011).

The United States Geological Survey (USGS) also appeared at the hearing to present their findings on coal tar sealants, but argued neither for nor against the ban. In regards to the PCTC’s claim that the science performed by the USGS was not adequate, the USGS representative stated they used a sampling and identification method developed by the EPA. The USGS representative also gave a presentation on all studies the agency has completed that provided evidence of coal tar sealant being a large contributor to PAH pollution in streams and lakes. The USGS discounted the Austin, Texas, study by the PCTC, stating that they sampled PAH pollution just two years after the ban, when it would take upwards of fifteen years for PAH concentrations to decrease due to their persistence. The USGS representative also pointed out that although PAH pollution from coal tar sealant may not be a large issue statewide, it is still a large local source. Early results from the Department of Ecology's studies also showed high PAH levels in the state, making it a chemical which they saw as important to reduce. The studies in the state that showed coal tar sealant as a PAH source were a major motivation for passing the bill (Committee 2011; Senate Environment 2011).

Based on the testimonies given, the legislators were more convinced by the USGS results compared to those of the PCTC, according to the bill's sponsor:

> "I think there was one study that they [PCTC] went to that after Austin TX did their ban, that in fact the PAH levels showed no difference, and of course I think that's because there is a latency period before you'd expect anything to show up. At that point the environmental committee in the house didn't receive it very well" (Interview 2 2015).

In part, the bill was successfully passed because of the support it received from numerous organizations, who were able to communicate the importance of the ban. Organizational actors the supported the ban included the Department of Ecology, Department of Natural Resources, the Washington Environmental Council, the Association of Washington Cities, and the People for Puget Sound. When talking about why the bill successfully passed, despite opposition, the sponsor of the Washington State bill stated: "You got to have a champion who can cut through all of the falling stuff, who can cut right to the core of what's going on, and bat down those arguments" (Interview 2 2015).

Of the arguments made by the bill supporters, an important one involved protecting Washington's stormwater ponds from contamination. Protecting stormwater from contamination use was already a large priority for the state because a bill to ban copper brake pads was put in place in 2010 for this reason. Some argued passing the bill would save money, because less money would need to be put into PAH remediation. The bill's sponsor also made the claim that being the first to pass a statewide ban would make Washington a "frontrunner in the issue", and send a message to other states in the U.S.

Finally, there was just no obvious reason not to ban it. Coal tar sealant is not widely use in the state and the ban would not hurt businesses. In fact no local businesses showed up to lobby against it. The Department of Transportation already banned the product and there was a substitute readily available at a comparable price. And, even if not widely used, once can argue that any amount is too much if it could endanger the wellbeing of citizens or ecosystems (Committee 2011; Senate Environment 2011).

Discussion

Key factors relevant to the decision making process in Washington State were:

- Local studies showing that coal tar sealant is a large local source of PAHs to people and ecosystems.
- Little coal tar sealant use statewide, which made banning the product relatively easy.
- A local ban by the Department of Transportation in years prior to the statewide attempt.
- Strong support from a strong bill sponsor and environmental organizations.
- Support from a state agency, the Washington Department of Ecology.

- National opposition from the PCTC, but no local opposition.
- USGS present at bill hearings, which presented research it had performed on coal tar sealants in the state.

The ban on coal tar sealant use began July 1st, 2013, and to the senator's knowledge there have been no issues with people or companies not abiding to it.

Minnesota

On May 20th, 2013, Minnesota became the second state to enact a statewide ban of coal tar sealants. The bill prohibited the use and sale of coal tar sealant by January 1st, 2014, as well as allocated money for further research and bill enforcement. To the knowledge of the Minnesota Pollution Control Agency (MPCA), a main advocator of the bill, it has been successfully implemented, and there has been no reports of continued coal tar sealant use in the state.

Problem Identification

The USGS studied numerous sites throughout Minnesota which linked high PAH contamination to coal tar sealant use. In a 2000 study, ten lakes in six urban areas across the U.S., including two in Minnesota, were core sampled for PAHs, which allows one to determine how levels of the compound changed over time. PAH levels in Lake Harriet, in Minneapolis, MN, showed a peak PAH concentration in the 1950s, with levels decreasing until the 1980s, when increases began again. The peak in the 1950s could have been due to the rapid increase in urbanization that happened in this time period. The decrease after the 1950s is attributed to a shift from coal based heating to natural gas and oil, as well as increases in power plant efficiency. The increase in the 1980s was attributed to an increase in other PAH sources, such as increased vehicle traffic. The range of PAHs from the core sample in this lake was from a low of .43 mg/kg to a high of 48 mg/kg dry wt. Palmer Lake, in Brooklyn Center MN, was the second Minnesota lake sampled. This area experienced a later period of urbanization, growing 29.6% in the 1970s to 65.6% urban land use in the 1990s. PAH concentrations in Palmer Lake increased substantially after 1990. PAHs in the core sampled ranged from .5 to 45.7 mg/kg dry wt (Van Metre, Mahler et al. 2000).

The results of the 2000 USGS paper were supported by later studies. In 2009, when the USGS collected dust samples from paved lots across the U.S. and analyzed PAH concentrations, dust was collected from six sealcoated parking lots in Minneapolis MN. These lots had a median concentration of 570 mg/kg of total PAHs (Van Metre, Mahler et al. 2009). The 2010 USGS study, in which 40 urban lakes were sampled for PAH concentrations, analyzed concentrations both in Laker Harriet and Palmer Lake. Palmer Lake had a total PAH concentration of 34.1 mg/kg, of which 24 mg/kg was attributed to coal tar sealant. Lake Harriet had a total PAH concentration of around 40 mg/kg, of which about 20 mg/kg was attributed to coal tar sealant. The higher concentrations in Harriet Lake, and lower amounts attributed to coal tar sealant, are consistent with previous findings by the USGS. Because the area around Harriet Lake urbanized earlier, past coal use is responsible for more of the PAH loadings (Van Metre and Mahler 2010).

A study by The Metropolitan Council, a policy making and planning agency in Minnesota, also suggested coal tar sealants were an issue in the state. In 2006, a study performed in the Twin Cities sampled ten sites, including stormwater and natural ponds, with the sediments analyzed for a range of nutrients and contaminants. PAH concentrations ranged from 0.2 - 65.8 mg/kg dry wt., with an average of 11.0 mg/kg dry wt. Benzo[a]pyrene (including BaP equivalents) concentrations ranged from 0.19 to 7.28 mg/kg dry wt. In five of the ponds, sediment exceeded Minnesota's soil reference value (SRV) for benzo[a]pyrene, greatly increasing disposal costs (Crane, Grosenheider et al. 2010).

A year later, municipalities across Minnesota also became aware of high PAH contamination when they began remediating stormwater retention ponds. Stormwater ponds have been in use in Minnesota for several decades. In the 1980s, untreated stormwater runoff was the leading cause of nonpoint pollution to waterways in Minnesota. To solve this problem, numerous stormwater ponds were installed across the state. Beginning in the 1990s, the MPCA required the use of stormwater ponds, and regulated stormwater discharges for 235 communities across the state through the Municipal Separate Storm Sewer System (MS4) permit program under the National Pollutant Discharge Elimination System (NPDES). Now, there are roughly 20,000 stormwater ponds in the Minneapolis-St. Paul, MN metropolitan area. The ponds usually last 20-30 years, and sediment removal is recommended every 8-12 years to keep the ponds performing correctly.

Many of the stormwater ponds across the state are over 15 years ago, and quickly becoming filled with sediment that must be removed in order to keep the ponds functioning. Before any sediment is removed it is sampled to determine if it is contaminated. If any contaminant present is concentrations above a reference value, then remediation must be done. Reference values for numerous PAHs concentrations can be found in the Minnesota Stormwater Manual. Benzo(a)pyrene, for example, has a soil reference value (SRV) of 2 mg/kg dry weight. (Crane, Grosenheider et al. 2010; Stollenwerk, Smith et al. 2014).

In 2007, residents of White Bear Lake MN noticed that Lily Lake Pond, a stormwater pond in their area, appeared polluted. The residents petitioned for their city officials to look into their concerns. After testing sediments in Lily Lake Pond and Varney Pond, it was discovered that pollutants in both exceeded the MPCA's recommended levels for BaP (Mohr 2008). For Varney Pond, the BaP equivalent (a group of PAHs which are added together and classified as BaP) concentrations exceeded the SRV, which placed these sediments under a level 3 dredged material classification, meaning the sediment is not suitable for use or reuse and must be specifically managed depending on the chemical contamination. The cost of properly dredging and removing the PAH contaminated sediment from the pond would cost an excess of $500,000, since PAHs cannot be broken down naturally and must be placed in a special lined landfill. Because of this high cost, other communities across Minnesota have been hesitant to sample their own stormwater ponds for fear they would have the same results. If just 10% of the stormwater ponds in the Twin Cities metro area needed to me remediated to the level that Varney Pond needed, then disposal costs could reach $1 billion. Municipalities looked to the MPCA and their legislatures for help in paying for the remediation costs, as well as sought studies to find out where the contamination was coming from (Mohr 2008; Crane, Grosenheider et al. 2010; Mahler, Metre et al. 2012).

Based on studies by the USGS, the MPCA assumed that the PAH contamination which was being found in stormwater ponds across the state was due to the use of coal tar sealants. In order to study the issue further, a representative from the MPCA applied for a grant from the legislative commission. This grant was not funded, but a legislator in the commission then drafted a bill to get it studied (Interview 4 2015). On March 23rd, 2009, bill HF 1991 was introduced into the house by Representative Bev Scalze. Its companion bill, SF 2045, was introduced into the senate on April 3rd. The senate bill was later incorporated into Omnibus Cultural and Outdoor Resources Finance Bill (HF 1231) which passed on May 18th, 2009. The coal tar sealant section of HF 1231 does the following:

- Prevents state agencies from purchasing coal tar sealcoat after July 1st, 2010
- By January 15th, 2010, the commissioner of the MPCA must notify state agencies and local governments about the potential contamination of PAHs to stormwater ponds.
- By January 15th, 2010, the commissioner of the MPCA must establish a schedule and information requirements to state agencies and local governments for reporting on their stormwater pond management methods.
- The commissioner of the MPCA must develop best management practices (BMP) for state agencies and local governments regulated under NPDES or MS4 (Municipal Separate Storm Sewer Systems) state disposal system permit for treatment and cleanup of contaminated sediment in stormwater ponds. In order to do this, the commissioner shall sample stormwater pond sediments for PAHs and other contaminants, investigate screening methods for providing better cost effective contamination results of sediment, and develop a guide to test, treat, remove, and dispose of PAH contaminated sediments.

Under the bill, $155,000 was given the first year for the MPCA to notify governments of potential coal tar contamination, to establish a stormwater pond inventory schedule, and to develop BMPs for treating and cleaning up contaminated sediments. Under this requirement, the MPCA developed management options for PAH reduction in stormwater ponds which include pollution prevention, source control efforts, BMPs including infiltration and filtration methods, sediment remediation, and reuse options for less contaminated sediment. The MPCA noted that the best pollution and source control option would be a statewide ban on coal tar sealants. For the second year, $345,000 was given to develop a model for the restricted use of undiluted coal tar sealants, and to provide small grants to communities for cleanup costs associated with contaminated sediments from stormwater ponds. In order to be eligible for the grant, the community must have adopted an ordinance to restrict the use of coal tar sealants in their boundaries (Murphy 2009; Crane, Grosenheider et al. 2010).

The MPCA study funded by HF 1231 to sample PAHs from stormwater sediment was published in 2013. The study sampled sediment from fifteen stormwater ponds in the Twin Cities metropolitan area in order to determine PAH concentrations and sources. Total PAH concentrations in the ponds ranged from 2.5 to 234.9 mg/kg dw. Several environmental forensic techniques were used to find PAH sources. The analyses concluded that coal tar sealants were responsible for 67.1% of all PAH contamination to the ponds, followed by vehicle related sources at 29.5%. Ecological and human health risks were also calculated. PAH levels in three of the ponds were high enough to put benthic invertebrates at risk, and nine ponds were high enough to put human health at risk. The nine ponds that exceeded human health risk levels would need to employ more expensive cleanup techniques (such as disposal in lined landfills) when the sediments are dredged (Crane 2013).

Agenda Setting

After the 2009 bill to fund PAH research was passed, a bill was attempted in 2010 to ban the use of coal tar sealants statewide. On March 8th, 2010, Representative Scalze introduced house bill HF 3456; its companion bill SF 3133 was introduced a day later in the senate. The bill, if it passed, would have prohibited the use and sale of the product, unless the purchaser signed a form stating it would not be used in the state. Any person who violated the terms of the bill could have been fined up to $1,000. This bill, however, never made it out of committee. Supporters of the bill included a resident from White Bear Lake (a community which had already banned coal tar sealant use), the League of Minnesota Cities (an organization which supports local government in the state through education and advocacy), and the MPCA. The supporters talked about the PAH contamination they found in the state, which they attributed to coal tar sealant. They also talked about costs associated with stormwater pond cleanups. The Pavement Coatings Technology Council testified in opposition of the bill, indicating that a ban on coal tar sealants would have no impact on the PAH concentrations in Minnesota's stormwater ponds and would simply hurt small businesses. The PCTC representative backed up these claims with a study by a forensic scientist they hired. The scientist sampled sediments in some of Minneapolis's stormwater ponds and argued that the PAH contamination was not coming from coal tar sealant, although no other source was named as the main contributor. The 2010 ban bill did not pass, potentially due to the strong opposition (Scalze 2010; Scalze(b) 2010).

Despite the 2010 bill to ban coal tar sealant not passing, organizations and cities in Minnesota continued their efforts to ban the use of coal tar sealants. In 2010, the MPCA received a Great Lakes Restoration Initiative grant through the EPA to conduct pollution prevention outreach about coal tar sealants in the Great Lakes Region. The MPCA partnered with Freshwater Future (a Michigan NGO), the Michigan Department of Environmental Quality, the University of Wisconsin-Extension Solid and Hazardous Waste Education Center, the Great Lakes Regional Pollution Prevention Roundtable, and the U.S. Environmental Protection Agency to conduct this outreach. Under the grant, the MPCA and their partners identified safer alternatives to coal tar sealants, asked companies and other entities to stop using and selling the product, and hosted webinars about coal tar sealant issues. Under this outreach program, the MPCA signed up roughly 25% of sealcoat contractors in Minnesota to pledge not to use coal tar sealants. The MPCA also has numerous resources on their website for people who want to learn more about coal tar sealant issues (Agency 2014; Interview 3 2015).

Bans across the state and continued media coverage helped keep the coal tar sealant issue alive in the state. Star Tribune, one of Minnesota's top newspapers, has published eight stories from 2010 to 2014 pertaining to coal tar sealants, including bans, the science supporting them, and the cost of PAH contamination (StarTribune 2015). Despite opposition from industry, the community of White Bear Lake banned the use of coal tar sealants in 2010, the first in Minnesota to do so (Nicklawske 2010). After this, many municipalities followed suit and banned the product in their communities, including Minneapolis in 2012 (Liebl 2013). From 2010 to 2014, 28 municipalities across Minnesota, covering roughly 20% of the state's population, banned the use of coal tar sealants. In 2013, the State of the River Report mentioned the coal tar sealant issue in Minnesota, summarizing the costs of stormwater pond cleanup associated with PAHs. The State of the River Report, written by the National Parks Service and the Friends of the Mississippi River, outlines the current status of the Mississippi river, including things like ecological health and contaminants of concern (Russell and Weller 2013).

In 2013, a third coal tar sealant bill was introduced at the state level in Minnesota. Representative Rick Hansen introduced the house bill, HF 1423 on March 11th, 2013; the senate companion bill was introduced on March 14th by Senator Bev Scalze. The bill would ban the use of coal tar sealants statewide by January 1st, 2014 (Hansen 2013). When asked by a reporter what motivated them to introduce the coal tar sealant bill, the sponsor stated that they "represent several first-ring suburban Twin Cities communities (Mendota, Lilydale, Mendota Heights, West Saint Paul, and South Saint Paul) where lakes may be negatively impacted by PAHs" (Ennis 2013). The sponsor also stated that they have supported PAH reduction regulations in the past, therefore it made sense to support this bill as well. *Policy Adoption*

The house and senate bills to ban coal tar sealants in Minnesota were added to the Omnibus legacy bill (HF 1183/SF 1051), which passed on May 20th, 2013. The Omnibus legacy bill was a compilation of bills for the 88th legislature that dealt with allocating money from the clean water fund and parks and trails fund to specific causes. The coal tar sealant portion of the bill states that the sale and use of coal tar sealant in the State of Minnesota would be banned, effective starting January 1st, 2014. The sale of coal tar sealant can continue if the buyer signs a form stating they will not use the product in the state. And exemptions of the bill are possible for research purposes. Money was given to the MPCA for further coal tar sealant research and enforcement purposes. In total, $100,000 was allocated from the clean water fund to the MPCA to inform and educate the public about coal tar sealants and to enforce the ban. This ban also repeals the 2009 bill, which only banned the product use for government agencies (Ennis 2013; Hansen 2013; Kahn 2013).

The bill passed easily, with little opposition. Organizations and people testifying in support of the bill included: Minnehaha Creek Watershed District residents, Minnesota Association of Watershed Districts, the director of public works for the city of White Bear Lake, the League of Minnesota Cities, a representative from Upper Midwest Sealcoat Manufacturing, and the Minnesota Pollution Control Agency. Proponents of the ban stated it was necessary because of the high remediation costs cities are facing when it comes to cleaning up their stormwater ponds. The ban was also supported because alternatives to coal tar sealant were available at the same cost, and many suppliers in the state had already banned the product. According to officials from White Bear Lake and the League of Minnesota Cities, numerous municipalities contacted them with “interest in a statewide ban, and questioned why one has yet to occur”. No organizations or individuals testified in opposition of the bill. Although it is not clear exactly why opponents, especially the PCTC, didn’t show up to the hearing, an MPCA representative said they following about it:

> “I believe that their [PCTC’s] lobbyist they had in Minnesota had been replaced, or wasn't working for them at that time, so they didn't seem to be aware of the bill language. So they were not at the hearings” (Interview 4 2015).

The only question concerned the amount of inventory left, and if this would negatively impact merchants. The sponsor of the bill replied that they have talked to merchants, who stated they had a year's worth of inventory left, which is why the ban doesn't start for roughly a year after the bill's passage (Hansen 2013).

When asked why they believed the 2013 bill was successful, one representative from the MPCA believed the biggest factor was the cost. They stated:

> "It's a huge economic cost for the municipalities. One staff member here… estimated that the cost of disposing of these contaminated sediments from the storm water ponds might cost a billion dollars just for the estimated twenty thousand storm water ponds in the metro area. And there's not enough landfill space to put all that material, so what do you do with it, so it's a big problem" (Interview 4 2015).

Another MPCA staff member believed that it was many factors, over the years, which eventually led to a successful statewide ban. They stated:

> "I've worked to promote awareness in reduction efforts in Minnesota and other states. Minnesota was ready do this, and other states are less so, if a statewide ban is what people are after. We had USGS research done here.. so there's always this, is it an issue here? question which arises, so that started concerns. Then follow up work elsewhere here [was] more in depth, in Minnesota waters, and the fingerprinting coal tar/PAH profiles made the case more strongly. Then the cities started acting. And from roughly 2010-2013 we got up to about 28-29 cities I recall, got local ordinances, so there was a strong argument just to make it statewide in the 2013 legislature" (Interview 3 2015).

The MPCA representative went on to state that Minnesota has a stricter stormwater permitting system compared to other states, and municipalities abiding to it sometimes incurred large costs when it came to stormwater pond cleanups, due to PAHs. They also stated that Minnesota has no manufactures of coal tar pitch, so it's possible the opposition did not successfully mobilize against the ban for this reason.

Discussion

Key factors relevant to the decision making process in Minnesota were:

- Local studies that showed coal tar sealants were widely used in the state and PAH contamination from the sealant is high.
- High stormwater pond cleanup costs, which numerous municipalities were experiencing due to PAH contamination of their ponds by coal tar sealants.
- Funded research and outreach from the 2009 bill and the EPA grant, that suggested coal tar sealants were an issue in the state. The outreach also got communities on board to ban the product.
- Local bans that occurred throughout the state, covering 20% of the state's population prior to the statewide ban
- Multiple bills, that continued to bring the issue to the attention of legislators
- Weak Opposition from the PCTC, which occurred at the 2010 bill hearing but not the 2013 hearing.
- No local business opposition occurred at any of the hearings.
- Strong support in the form of environmental agencies, state agencies, and strong sponsors.

The ban on coal tar sealant use began January 1st, 2014, and to the MPCA's knowledge there have been no issues with people or companies not abiding to it

Illinois

The state of Illinois has attempted to enact statewide policies for coal tar sealant regulations three times. The first attempted bill, SB3509, would have given municipalities the right to ban the product without seeking permission from the state, which some those with under 25,000 residents normally must do. Two additional bills were attempted which would have banned the use and sale of coal tar sealants statewide. All attempted bills were unsuccessful, and while the last bill that was filed, HB2401, is technically still in committee, the sponsor does not believe it will pass. The sponsor of HB2401 hopes that more education on the subject will help, and they will be attempting another statewide ban bill in the future.

Problem Identification

Studies by the USGS and local environmental organizations have shown the harm the sealants are posing on citizens and ecosystems in Illinois. In the study by the USGS, in which dust was collected from sealed lots across the U.S., and PAH levels were analyzed, seven sealed lots were analyzed in Illinois. These lots had a median PAH concentration of 3,200 mg/kg. Two driveway samples from homes in a suburb of Chicago, Lake in the Hills, had PAH concentrations of 5,800 and 9,800 mg/kg, which were the highest levels found in the study (Van Metre, Mahler et al. 2009). A year later, the USGS conducted its study of PAH concentrations and sources for forty urbanized lakes in the U.S. That study measured one lake in Illinois, Lake in the Hills, and showed that PAH concentrations greatly increased in the lake over the last twenty years, which they attributed to coal tar sealant use (Van Metre and Mahler 2010). The USGS scientist later stated that this town was the “poster child” for coal tar sealant contamination. Lake in the Hills was once a small town with little development, but over the last twenty years it became urbanized and many big-box stores moved in. Now, about 40% of paved areas draining into the community’s manmade lake are covered with coal tar sealant, and over the last twenty years PAH pollution in that lake has gone up tenfold (McClure 2010).

Work by the DuPage River Salt Creek Workgroup (DRSCW) also suggests that coal tar sealants are a large contributor to the PAH contamination of waterbodies in the state. The workgroup was set up in early 2000 to improve river systems in the state, because many municipalities were not happy with how well the state was protecting these ecosystems. The DRSCW is composed of 57 members made up of representatives from local communities, publicly owned treatment works, and environmental organizations located in the East and West branches of the DuPage River and Salt Creek, in Northeast Illinois, which encompasses 360 mi^2 of land. Between 2006 and 2008 the DRSCW did a full biological analysis of 42 stream sites in their watershed. The analysis measured both physical and chemical indicators which were known to harm aquatic life. PAHs were not initially a chemical of concern in the area, but through chemical analysis the researchers found extremely high concentrations of the compounds in every sample. Of the 42 sample sites, 32 (76%) were above the probable effect levels for PAHs, meaning it is statistically likely the concentrations will harm aquatic life. The other ten samples were above the threshold effect levels, meaning there may be some impacts on aquatic life. Because PAHs were surprisingly high in the sampled areas, the workgroup did more research in PAHs and discovered studies by the USGS on coal tar sealants. Since there are not many factories, waste sites, or brownfields in the area, the workgroup attributed the PAH contamination to coal tar sealants, which are used throughout the communities (McCracken 2013).

The research that the USGS performed was brought to the attention of the public through a 2011 article in the Chicago Tribune entitled “New doubts cast on safety of common driveway sealant.” This article points out that high PAH contamination levels can be from coal tar sealants, and not necessarily from passed sources which cleanup efforts have focused on. Knowing the sources of PAH contamination is important because lot of money has been spent to clean up PAH contamination in the Chicago area. For example, $50 million was spent in the mid-2000s to dispose of 300,000 tons of contaminated soil in Barrie Park, an area in in the western Chicago suburb of Oak Park. This area had coal tar dumped on it in the late 1800s from a manufactured gas company, and had PAH contamination of 0.3 ppm. And in 2007, money was spent to dig up the yards of more than three dozen homes in Chicago’s Little Village neighborhood, which has been contaminated from coal tar leaking from a nearby abandoned roofing plant. PAH contamination at this site was 10 ppm. However, the PAH contamination from both of these cases were nowhere near the PAH levels found by the USGS in Lake in the Hills, which were upwards of 9,600 ppm. Since the initial article in 2011, the Chicago tribune has published over a dozen which directly pertain to, or mention, the use of coal tar sealants in the state (Hawthorne 2011; Ennis 2014 (a); Tribune 2015).

Following the 2011 article, coal tar sealant bans began occurring throughout the state of Illinois. The town of South Barrington banned the use of coal tar sealants in 2012, and the City of Winnetka did the same in 2014. Many members of the DRSCW have also signed a memorandum of understanding (MOU) to not sell or use coal tar sealed products. Under the DRSCW MOU, public work units from five villages, two cities, and one county have agreed to stop the use of coal tar sealed products. Government use restrictions of coal tar sealant have also been adopted in the counties of DuPage and McHenry. Other cities in Illinois, including Chicago, have unsuccessfully attempted bans; some blame industry involvement for their failures (Ennis 2014 (a); Club 2015; Newlon 2015).

Agenda Setting

Three bills pertaining to coal tar sealant use have been attempted at the state level in Illinois. The first bill, SB3509, was filed February 8th, 2012 by republican senator Pamela J. Althoff. The bill was referred to the Assignments Committee and then the Environment Committee. On January 1st, 2013, the bill was adjourned "sine die," meaning it was postponed indefinitely. This bill would have amended the Counties Code and given the board of county commissioners of each county the right to prohibit the use of coal tar sealants. Currently, municipalities with smaller than 25,000 residents are not allowed to make decisions on municipal matters without permission from Springfield, according to the Home Rule. Therefore, those under Home Rule are allowed to enact a coal tar sealant ban in their community without the state's permission, whereas those not under the rule cannot (Althoff 2012).

The second bill, HB4599, was filed in the House on February 4th, 2014 by democratic representative, Laura Fine. After going through the Rules Committee, the bill was passed to the Environment Committee where it failed to pass. The bill was then re-

referred to the Rules Committee. On December 3rd, 2014, the bill was adjourned sine die (Fine 2014). SB3431, a companion bill to HB4599, was filed February 14th, 2014 in the Senate. This bill was referred to the Assignments Committee, then the Environment Committee, but on January 13th, 2015 it was also adjourned sine die (Cullerton 2014).

The last attempted bill, HB2401, was filed February 10th, 2015, by representative Fine. The bill was referred to the Rules Committee, then the Environment Committee. It was amended to exclude highways from the coal tar sealant ban, and re-referred to the Rules Committee. As of March 27th, 2015, the bill is still sitting in the Rules Committee. The last two bills contained the same texts and requirements, but the last bill pushed the adoption of the ban back one year. The bill would amend the Environmental Protection Act in the state, and would prohibit the sale of coal tar sealant after January 1st, 2016, and the use of coal tar sealants after July 1st, 2017. Violating the ban could result in a $1,000 fine for the first offense, and up to a $5,000 fine for the second (Fine 2015). Although no fiscal notes were made for the statewide bills, a cost benefit analysis performed by the DuPage River Salt Creek Workgroup suggests that asphalt based emulsions in the State of Illinois are comparable in price with coal tar based sealants. Also, the cost over the lifetime of the sealers is comparable, especially considering the cleanup costs associated with PAH remediation, making asphalt sealers even more competitive (Workgroup 2012).

When representative Fine was asked when she first heard about the issue, she replied it was through the Great Lakes Legislative Caucus (Interview 5 2015). The Great Lakes Legislative Caucus is a nonpartisan group of state lawmakers from the eight Great Lakes states and two Canadian provinces. The goal of the caucus is to facilitate the exchange of knowledge about Great Lakes issues, to strengthen the role of legislators in policy making, and to promote the protection and restoration of the Great Lakes (Governments 2012). The sponsor heard about the issue in a 2013 caucus conference when a lawmaker from Minnesota talked about coal tar sealants and how they were able to ban it in their state. After hearing about coal tar, the sponsor did more research into the issue and decided to try a ban in Illinois. She thought it would be easy to put in place, considering Minnesota could do it, but soon found out otherwise. She stated: "The fact that Minnesota was able to get it through was encouraging, but it's been very challenging to get it through in my state" (Interview 5 2015).

Policy adoption

Although no transcripts or recordings are available for the bills' committee hearings, information about the bills' opponents are available. The bill HB4599, for example, was opposed by 34 people representing 16 different companies and organizations: The Chemical Industry Council of Illinois, the American Coatings Association, Koppers, Inc (a global chemical and materials company), Illinois Retail Merchants Association, Illinois Manufacturers' Association, the Associated General Contractors of Illinois, Illinois Chamber of Commerce, Home Builders Association of Illinois, NAC Supply Inc. (a pavement product retailer), The Northeastern Illinois Federation of Labor, Teamsters Joint Council 25 (Chicago's labor union), the National Federation of Independent Business, the Illinois Statewide School Management Alliance, United States Steel Corporation, the Pavement Coatings Technology Council, and Bonsal American (a pavement product retailer). Industry organizations also banned together to produce a two-page brief on why coal tar sealants should not be banned in Illinois. The document states that there is no evidence that PAHs from coal tar sealants have detrimental health effects, nor is there evidence that high concentrations of PAHs are released from the sealant. It is also stated that thousands of jobs exist in Illinois involved with the manufacturing, processing, and applying of coal tar sealants. According to the document, since there are certain seasons in which only coal tar can be applied and not the alternative products, a ban on coal tar sealants would reduce the times in which sealers can be applied by 20%, which results in 20% less work, 20% less income, and 20% more time on unemployment.

Only four proponents of the bill were present during committee hearings, the Natural Resources Defense Council, The Environmental Law and Policy Center, The Illinois Environmental Council, and The Illinois Chapter of the Sierra Club. Although many of these claims by the bill's opponents can be disputed, the supporters of the bill may not have had enough evidence to convince the legislators that a ban was worthwhile. When asked why they thought previous bills to ban coal tar sealant failed in Illinois, the sponsor for the current ban bill stated: "Because of the opposition. There is strong opposition from the chemical companies and they worked to kill the bills" (Association., Illinois. et al. 2014; Ennis 2014 (b); Ennis 2014 (c); Interview 5 2015).

Numerous more organizations supported the second bill, HB2401, including: The Conservation Foundation, DuPage River Salt Creek Workgroup, Environmental Defenders of McHenry County, Healthy Schools Campaign, Illinois Environmental Council, Illinois Public Health Association, McHenry County, Respiratory Health Association, and the Sierra Club, Illinois Chapter. When interviewed, a representative from the DuPage River Salt Creek Workgroup stated that they presented their research on

PAHs and coal tar sealants at the environment committee hearing. They went onto say that since Illinois already regulated used motor oil, it made sense for them to regulate coal tar based sealants too, because they are made up of similar compounds (Club 2015). The representative also claimed that asphalt based sealants are just as good, but there are arguments on whether sealant is really needed or not:

> "I do work with a number of DOTs and they're pointing out that they don't really even use sealants anymore….. they treat it at the time when they put down the product, a sealant would actually inhibit the application of some of those other agents" (Interview 6 2015).

Despite strong support from the environmental community, industry opponents of the 2015 bill were able to stop it.

It has been reported that numerous big businesses, labor interests, school districts, and chemical interests fought against the second coal tar sealant bill in the state (Ennis 2015). During the second bill hearing, opponents talked about potential job losses the thousands of job losses that would occur in the state, if a ban was passed. Opposition from the school districts also helped stop the bill, according to the DRSCW representative present at the bill hearing:

> "I think one of the things I remember at the time, which was a little bit of a surprise was the amount of pressure that school districts.. I guess they had called around a lot of school districts and said… the cost of maintaining your parking lots are going to go up if these guys get this ban in place, and I think that really made an impression on a lot of the people who were voting." (Interview 6 2015).

When asked about the current bill's status, the sponsor stated that it did not look as though the bill would be able to get out of committee, therefore it was decided that they would keep working on it, and attempt to introduce it once again at a later date. Lack of education is one reason that the sponsor stated was an issue with getting the bill passed:

> "I think part of the challenge in passing the bill is that many people don't understand the issue, they've never heard of coal tar and they don't know what it is. I think what we need to do in order to get the legislation through is to really do a good job in educating people on what coal tar is, and the damage that it causes" (Interview 5 2015).

The DRSCW representative stated there were questions about whether alternatives were really as good as coal tar sealants. Also, loss of jobs was a big concern for many of the legislators. The DRSCW representative stated: "Illinois is a very sort of union heavy state, and that kind of issue [issues which would decrease jobs], politicians are very cautious about it" (Interview 6 2015).

Discussion

Key factors relevant to the decision making process in Illinois were:

- Local studies that showed coal tar sealants were widely used in the state and PAH contamination from the sealant was one of the highest found by USGS studies.
- Local bans are continuing to occur throughout the state.
- Two bills have been attempted in the state, and another one will be attempted in 2016.
- Strong support in the form of environmental organizations and strong sponsors.
- No government agency support.

- Strong local opposition in the form of state manufacturers, companies, and school districts.
- National opposition from the Pavement Coatings Technology Council.
- Job impacts in the state, according to the PCTC that could be as high as a thousand jobs lost if a statewide ban occurred.

In the future Illinois may be able to successfully ban coal tar sealants at the state level. Currently, however, the opposition is too strong for bill to be passed. In order to increase the chances the bill will pass in the future, the sponsor of HB2401 stated that they plan on working with environmental groups in order to communicate the issue more clearly to citizens (Interview 5 2015).

Maryland

A bill to ban coal tar sealant statewide in Maryland was attempted in 2012. After a mistake with the bill's requirements the bill was withdrawn and another one has yet to be attempted. It is unclear if one will be attempted in the future, but bans have since passed in the state at the county level.

Problem Identification

Although no studies have been performed in Maryland concerning contamination from coal tar sealants, PAH contamination is an issue in the state. In 2012, a report produced by the EPA, USGS, and U.S. Fish and Wildlife Service examined toxic contaminants in the Chesapeake Bay and found that PAH contamination had been detected at various locations, with the highest concentrations near Baltimore Harbor, the Anacostia River, and the Elizabeth River. In fact, over 60% of native fish in the

Anacostia River have developed tumors due to PAHs. However, where these PAHs are coming from (not only what source, but what state) is debated (Phelps 2011; EPA, USGS, et al. 2012).

Many problem identification factors, such as discovering local PAH contamination and enacting local bans, occurred after the statewide bill was introduced. Therefore, although these factors did not help to inform that statewide ban bill, they could be used to inform future bills. For example, it was recently discovered that PAH contamination was present in Lake Whetstone, a lake in Montgomery County Maryland. Sediment in the lake was beginning to build up, causing an island to form at the mouth. Upon noticing the sediment build up, residents requested that the county dredge the lake. Before dredging began, the county decided to perform a biological, chemical, and physical analysis on the lake sediment. The chemical analysis showed elevated levels of PAHs were present in the sediment, high enough to cause harm to wildlife. After consulting with the Maryland Department of the Environment, those dredging the lake were told that the PAH contamination in the sediment was too high to be dumped in the local area. Instead, the sediment had to be taken offsite to a special facility that was capable of storing it. The total cost of the dredging project was $2.84 million, but it was not reported how much of that was due to the special accommodations which had to be taken as a result of the PAH contamination. In addition, no further analysis was done to discover the source of the PAH contamination (Stubbs 2015).

Prior to the statewide ban attempt, the Maryland Department of Transportation and the Department of General Services stated that they no longer used coal tar sealant products on the parking lots and driveways they manage (Stein 2012). After the statewide ban attempt, two countywide ban were enacted in the state. The first countywide ban occurred in Montgomery County on September 11th, 2012, which was successful despite industry oppositions at hearings (Ennis 2012). The second ban occurred in Prince George's County in April 2015 (Ennis 2015 (c)). These two counties are the two highest populated counties in the state, with a combined population of 1,885,847 people, making up 32% of that state's population (Bureau 2014).

Agenda Setting

Maryland's bill to ban coal tar sealants statewide, HB369, was introduce by democratic Delegate Dana Stein on February 1st, 2012. Stein first heard about the issue from an article in a Chicago paper. Although he could not remember the title of the article, or the exact paper, given the time frame it was most likely the article, "New doubts cast on safety of common driveway sealant" in the Chicago Tribune, which also brought the issue to the attention of Illinoisans. After researching the topic further, Stein decided it was an important issue for Maryland to tackle, given the importance of the ecology in the state, he stated:

> "In Maryland, especially with the Chesapeake Bay, all those tributaries, we're very conscious about pollutants that can get into waterways through runoff, and other means, so it just seemed like the right thing to do" (Interview 7 2015).

The sponsor also stated that they heard a large county in Maryland was also looking into limiting the use of coal tar sealants. Therefore, there was awareness about it in the state.

House Bill 369 would have banned the manufacture, sale, and use of coal tar sealants in the state of Maryland by an unspecified date. The bill included a fiscal note which stated that a coal tar sealant alternative may not meet the Federal Aviation

Administration (FAA) standards, which specifies how surface treatment on runways must perform. In order to make sure the ban was properly enforced, if it did pass, funds would be provided to hire an environmental compliance specialist to handle complaints and enforcement of the bill. At the local level, the fiscal note claims that local government expenditures could increase if coal tar based sealants are more expensive. However, the counties of Calvert and Howard and the cities of Frederick and Havre de Grace have stated that the bill would have no economic impact for their communities. With regards to economic impacts on small businesses, the fiscal note states there would be no impact, as The Department of Legislative Services is not aware of any small businesses in Maryland that produce coal tar sealants (Stein 2012; Stein 2012 (b)).

Policy Adoption

The coal tar sealant ban bill was withdrawn by its sponsor on February 27th, 2012, after it was heard in the Environment Matters committee. According to reports, three attendees, including a representative from the Washington DC government and two members from the environmental community, spoke in favor of the bill, but they were outnumbered by industry opponents. The industry opponents made numerous claims about the bill's impact on jobs in the state, stating that 3000 jobs would be lost if this bill were to be implemented. Opponents also claimed that there is no link between coal tar exposure and human health, and that consumers prefer coal tar based sealants over the alternatives. It was also pointed out that the Baltimore-Washington International Airport in the state would lose funding from the FAA if they didn't use coal tar sealant on the runway (Ennis 2012 (b)).

In the end, however, the bill was withdrawn because there was an error in the bill’s text. According to the sponsor:

> “I had been told that there was no manufacturing of coal tar sealants in Maryland… the bill was fairly broad based and included banning the manufacture of coal tar sealants, so I didn't think that would have any impact because my understanding was there wasn't any. Well it turns out there are a couple plants in Maryland and I did not find this out until the day of the hearing, so it's one of those "oh no" moments” (Interview 7 2015).

Therefore, during the bill hearing, when industry and organized labor representatives showed up to oppose the bill, the sponsor was caught off guard. According to the sponsor’s accounts, opponents said that 50-100 jobs would be lost (which conflicts with other reports), but because the bill would “directly impact a fair number of jobs,” it was withdrawn (Interview 7 2015).

It has been three years since the failed ban bill in Maryland, and no attempts have been made since then to ban coal tar sealants at the state level. When asked if he would be introducing a ban law again, the sponsor initially stated:

> “I thought about possibly reintroducing it next year, without the manufacturing limitation, but I sort of realized if.. that was the biggest problem, but the opponents would come back as well if I had a bill that just eliminated the sale of distribution of coal tar sealants they would probably argue that it would reduce sales and have a potential impact on un-employment, so I just dropped the issue” (Interview 7 2015).

However, the sponsor went on to ask about other municipalities that have banned the product, and once they found out about the bans in Montgomery County and Prince

George’s county they replied: “Maybe I'll take another look, those are two of the biggest jurisdictions in Maryland, so, if they banned it maybe there would be some support” (Interview 7 2015).

Discussion

Key factors relevant to the decision making process in Minnesota were:

- Strong local opposition from companies, state manufacturers, and organized labor representatives.
- National opposition from the Pavement Coatings Technology Council.
- Weak support from environmental groups which did not help bring the ban bill on the agenda, or advocate for another bill after the 2012 failure.
- Weak sponsor support, who withdrew the bill and did not introduce it again.
- No local government agency support.
- Job impacts, upwards of 3,000 jobs losses estimated by the PCTC.
- Threat of the loss of millions of dollars in Federal Aviation Administration funding, according to PCTC.
- Local bans, which occurred after the 2012 state ban attempt.

Unlike the other states, Maryland’s coal tar sealant bill was withdrawn before it had a chance to fail or succeed. However, given the opponents which testified against it, it was unlikely to pass even if it had not been withdrawn.

National Level Players

Two key organizations played pivotal roles when it came to reasons a coal tar sealant ban was successful or not: The United States Geological Survey (USGS) and The Pavement Coatings Technology Council (PCTC). Although the USGS has only been present at two statewide bill hearings (Washington and Maine), their science was consistently cited in all hearings and bill policy notes. The PCTC also produced scientific results of their own, attempting to discredit the USGS findings, which may have stopped some ban bills from passing. Unlike the USGS, the PCTC was present at numerous bill hearings, and not only presented their science, but also testified about potential job losses in the state if a coal tar sealant ban was passed.

Another important player in this issue is Tom Ennis, the author of the Coal Tar Free America blog. Ennis works for the city of Austin, Texas, and has been involved with the coal tar sealant issue from the beginning. Although not present at most of the bans, and not a large contributor to ongoing scientific studies, Ennis' blog has been a tremendous resource to individuals and communities who are interested in learning about the coal tar issue. On his blog, Ennis has kept up to date with all the coal tar bans across the nation, and writes stories both locally and nationally based about the coal tar sealant issue.

These national players in the coal tar sealant issue are able to look at the problem from a broader perspective. Representatives from the USGS and PCTC, along with Tom Ennis, were interviewed for this study. They were asked what their role is when it comes to coal tar sealant bans, and were also asked to evaluate why they believe bans have been, or have not been, successfully implemented at the state level. Their views on the coal tar sealant problem are discussed here.

United States Geological Survey

Members of the USGS' national water quality assessment (NAWQA) program first became aware of elevated PAH levels in the early 2000s. The objective of NAWQA was to assess contaminant trends from lakes across the U.S. Sample cores were taken from the lakes and the scientists were surprised to see elevated PAH levels, especially in urban lakes, occurring in more recent sediment. According to the USGS representative:

> "We saw that concentrations of some [chemicals in] sediments, like DDTs, PCBs, and lead, whose uses have been regulated, have been decreasing in later sediments. But we did notice that PAHs had increasing concentrations in more recent sediment, mostly in urban lakes. This is a surprise because a number of papers were published in the 1980s that said that concentrations of PAHs were decreasing because of improvements of things like burning of coal for home heating and atmospheric emissions" (Interview 9).

At the same time, the same USGS scientists were working with the city of Austin, Texas on a stormwater runoff study. The City of Austin was also measuring contaminants in streambed sediment, and noticing elevated PAH levels. After this, the USGS decided to embark on a study to figure out where these PAHs in urban areas were coming from. For the past ten years, studies by the USGS have arrived at the same conclusions: a large part of PAH contamination in urban areas is due to coal tar sealants. The USGS has published eighteen studies in scientific journals, which outline coal tar sealants as a source of PAHs, and as a harm to both human and ecosystem health. And according to the USGS representative, all other research on coal tar sealants has produced the same results the USGS have gotten, "with the exception of papers that have been funded by the coal tar sealcoat industry." If invited, the USGS scientists are willing to present their research at bill hearings, they can neither advocate for, or against, a ban bill. As a federal government agency, the USGS also cannot state why it believes some statewide bans have been successful, while others have not (Van Metre, Mahler et al. 2000; Interview 9; USGS 2015).

The Pavement Coatings Technology Council

The PCTC was formed in 1992, under the name Pavement Coatings Technology Center, to establish sealer material and application guidelines to improve pavement sealer quality and performance. It was originally made up of sealer producers and suppliers, and headquartered in the College of Engineering at the University of Nevada- Reno. Over the years the organization has mainly conducted research projects dealing with coal tar sealant application and quality. However, the organization's goals changed when the City of Austin began questioning the safety of coal tar sealants in 2004. According to an interview from an article, with the PCTC executive director:

> "PCTC decided it needed to be proactive, by educating government agencies and the public about coal tar and countering misinformation that has appeared in the marketplace concerning sealers by making sure the right information is getting out" (Hegeman and Stewart 2009).

The PCTC is now a pro-coal tar, pro-sealcoating organization, and defends attacks on coal tar sealants, despite the fact that many of its members sell or produce both asphalt and coal tar based sealants. The PCTC is also a not for profit trade organization, and receives funding from its members. As of 2012, members of the PCTC included: Bonsal American, Inc., Coopers Creek Chemical Corp., Corsicana Technologies, Inc., Cosmicoat of Western NY, Dalton Enterprises, Inc., Kentucky-Tennessee Clay Co., Koppers, Inc., Lone Star Specialties, LLC, Neyra Industries, Inc., Ruetgers Canada, Inc., STAR, Inc., Stella-Jones Inc., Surface Coatings Co., The Brewer Company, Unimin Corp., Vance Brothers, Inc., VelveTop Products (Hegeman and Stewart 2009, Hegeman and Stewart 2012, PCTC 2015).

After the PCTC changed their goals, they decided to be proactive in the coal tar sealant debate by funding research and testifying at ban hearings. Originally, the PCTC was going to fund research into how effective sealcoating really is, but no papers have been published about this yet. However, scientist funded by the organization have published three articles in scientific journals which state coal tar based sealants may, or may not be, a large PAH source (Hegeman and Stewart 2009). The PCTC has also showed up at numerous hearings to oppose potential bans from being passed. When asked about their role in ban hearings, a representative from the PCTC stated:

> "We try to go. But, you know, in some cases, just the timing doesn't work out. We are not the government, we don't print money. We have a budget we have to work within, so sometimes we have to prioritize. But we try to make as many of the hearings as we can, that we know about" (Interview 10 2015).

They have also helped the coal tar industry thwart bans, for example by holding a webinar entitled "How to fight for your sealcoating business" which shows "how you can be successful in defense and what to say to customers, media, and even state and local officials who have questions about the lifeblood of your business" (PCTC 2013).

When asked why they believe coal tar sealant ban bills have been successful in some states but not others, a PCTC representative stated the following:

> "The vast majority cases where these bills have been introduced, they've been introduced from the political side and not from the responsible regulatory agency in that state. So, for example, we have had bills introduced to ban in several states where in fact the state regulatory agency does not support the ban, because they've been introduced on the political side without the recommendation of the responsible agency" (Interview 10 2015).

The representative goes on to state that Washington and Minnesota were able to pass bans because they had the support of a government agency behind them. In addition to this, local opposition of a ban is needed to stop it from occurring. In the case of Washington, the PCTC did not have support from "the people in the ground," because little coal tar sealant use occurred in the state, therefore, there was no local opposition (Interview 10 2015).

Coal Tar Free America- Tom Ennis

Tom Ennis, a Sustainability Officer for the City of Austin, has been involved in the coal tar sealant issue for over ten years. He found out about the problem of PAHs and coal tar sealants upon taking a job with the City of Austin in 2005 when they were beginning their PAH study. When asked why he started the Coal Tar Free America blog, Ennis stated that he (and others in the City of Austin) thought the coal tar sealant issue would be simple, and assumed that after the ban took place in Austin everyone would stop using the product. Ennis realized this wasn't the case, stating:

> "And after five years of that you realize that was not going to be the case, and industry sort of mobilized and began making strange statements about the scientific research. And scientists generally don't respond to accusations and

hyperbole in popular press, they just do their research. So there seemed to be a gap, no one was really advocating" (Interview 8 2015).

In the interview, and in an article he wrote, Ennis outlined factors on why he thinks some bans have been successful, while others have not. In the article "Honestly, Does Your Community Have What It Takes?" Ennis used the analogy of a battery to see if communities have enough "power" to enact a ban bill. He outlined six factors that influence bans passing: citizen discontent, supporting research, industry activism, community circumstances, non-profit support, and sponsor attention. A few of these factors may be enough to pass a coal tar sealant ban, if they are strong enough, or all the factors could work together to make a bill successful. Conversely, if a community is severely lacking in these factors, it could be enough to kill a bill (Ennis 2015 (b)). Ennis outlined these same factors in the interview, when asked why he believes some state bans have been able to pass and not others, one of his responses was:

> "I think if you do sort of go with that analogy that I laid out there as batteries, and you need enough amps if you will to get enough power to accomplish a ban,... I see where you've got a passionate political leader and an empowered environmental leader, and that's about all you need. They will take care of the constituency and rally everybody, etc. and they will do what they can to overcome opposition" (Interview 8 2015).

Ennis also outlined the problems of lack of time and funding, he stated:

> "If people dedicated themselves full time to this, and understood the issue, this would get done a lot faster… I do this part time, I'm not retired, I do this nights and weekends, and lunch hours. And yes, there's a whole lot more people

> involved in this, but this is what you can do on a part time basis, imagine what you could do with a staff full time" (Interview 8 2015).

Ennis has been a strong advocate for coal tar sealant bans for the past decade, and his work has undoubtedly helped many bans pass.

Chapter 5: Conclusions and Implications

This comparative case analysis of four states has shown that numerous factors accounted for why coal tar sealant ban bills were, or were not, passed at the state level. Key players, such as the USGS, PCTC, and environmental organizations were instrumental in persuading (or dissuading) legislators to pass a ban on coal tar sealants. Some factors were shared amongst cases, and some were unique to the individual states. This section will outline the factors which influence statewide bans, and compare the factors among studied states.

This section will also outline the factors which can be used to improve decision making, specifically with regards to coal tar sealant bans in other states and the federal level. This case study can be used directly, to help states implement a ban in their boundaries, and can also be used indirectly to help enhance environmental policy. This section also briefly examines what this study suggests about the role of the states in serving as a testing ground for policies that may eventually be debated at the national level.

Conclusions

Many factors influenced the success or failure of the coal tar sealant bans examined in this case study. This section compares the factors among the states to draw out why some states were more successful than others when it came to implementing a ban. Analyzing these factors and the differences among the states can help to inform efforts to improve the decision-making process in other states, as well as at the national level.

To begin with, scientific studies that showed coal tar sealant use contributed to PAH contamination were performed in every state except Maryland. The USGS conducted two studies that analyzed PAHs releases from coal tar sealants. One study evaluated the releases of PAHs from parking lots, and the other assessed PAH concentrations in urban lakes. These studies tested sites in Washington, Minnesota, and Illinois, and determined that PAH contamination in the states, at least at the local level, was due in some part to coal tar sealants. On top of this, local studies were also performed in Washington, Minnesota, and Illinois by environmental organizations or state agencies that showed the same results as the USGS. In Maryland, no studies by the USGS, or any other organization, has examined the link between PAH contamination and the use of coal tar sealants. These studies also helped show the amount of coal tar sealant use in the states. Washington used very little of product, so a ban was easily implemented. On the other hand, Minnesota, Illinois, and Maryland all used large amounts of the product within their states.

Local bans were present in all states. In Washington and Maryland a ban was put in place by each state's Department of Transportation. In Minnesota and Illinois, city and county wide bans have been enacted. In both the Washington and Minnesota bill hearings, local bans were used as an argument on why a statewide ban would be beneficial. Local bans helped show legislators that this is something that state agencies, like the DOT, and citizens, care about. Local bans continue to be introduced and passed in Maryland and Illinois, which may factor into future statewide ban attempts.

Outreach and education are also important factors, which Minnesota made the best attempt at. From 2007 onward, the Minnesota Pollution Control Agency (MPCA) has been doing a number of outreach programs to educate people on the harms of coal tar sealants. In 2009 the MPCA received funding for research and outreach from a state bill and in 2010 received an EPA grant for similar purposes. These funds allowed the MPCA to study coal tar sealant contamination in Minnesota and host webinars to educate the public about coal tar sealants. After this, numerous Minnesota communities banned the use of coal tar sealants and many companies in the state stopped using the product. In Illinois, the current bill's sponsor hopes to increase outreach and coal tar sealant education in the state, which may help a future ban pass.

Having the cost of PAH contamination accounted for in the law is also important, and is another factor that only Minnesota benefited from. In Minnesota, many municipalities across the state were facing high cleanup costs of their stormwater ponds due to PAH contamination. Minnesota law specified a maximum level of PAH contamination in sediment, and the sediment in many stormwater ponds exceeded that value. A coal tar sealant ban appeared to be a quick and efficient way to reduce future costs associated with PAH inputs in the state's stormwater ponds. The costs associated with PAHs were highlighted in the ban bill, and money was given to communities for PAH cleanup costs. Remediation or human and ecosystem health costs due to PAHs was not highlighted in the debates associated with other state bills.

The amount of support for a statewide ban varied amongst the states. Strong support from a resilient legislative sponsor and environmental organization was present in every state, except Maryland. In Washington, the bill's sponsor obtained help from the environmental group, Washington Environmental Council, in drafting and advocating for the ban. Also, the Washington sponsor invited the USGS to testify at the bill hearings.

The expert testimonies from the USGS at various hearings helped solidify the issue of coal tar sealants in the state. In Minnesota, Representative Bev Scalze was able to pass a bill to fund more research into the coal tar sealant issue. Although Scalze was unable to pass a statewide ban in 2010, she attempted again in 2013. The 2013 bill was also introduce in the house and was sponsored by another strong legislator, Rick Hansen, who was able get is passed. In Illinois, Representative Fine is continuing to try to implement a statewide ban, and the DuPage River Salt Creek Workgroup is a strong environment organization that has provided research and support for a ban. Maryland, on the other hand, had weak overall support. The sponsor of the statewide ban bill withdrew it shortly after it was introduced, and did not attempt to introduce it again. On top of this, no environmental organizations have advocated for another ban attempt.

Government agency support was cited as a major reason a ban is likely to pass at the state level. Government agency support was present in both of the states where a ban passed, Washington and Minnesota, but not in states where a ban failed. The Washington Department of Ecology testified in support of the statewide ban in Washington, and their science helped show that coal tar sealants were being used in the state. This level of support happened in Minnesota as well with the MPCA. The MPCA produced research showing coal tar sealants were a major PAH source to stormwater ponds. They also testified in support of all the coal tar sealant ban bills in the state.

The amount of opposition also varied by state. National opposition, in the form of the PCTC, occurred in every state. However, opposition, from local companies and organizations, occurred only in Illinois and Maryland. The arguments and influence of the PCTC appeared to be strengthened by the presence of local opposition. Local opposition was also tightly linked to the fear of job losses, which was raised as an issue in Illinois and Maryland. Both states also have manufacturing of coal tar within their boundaries, whereas Washington and Minnesota do not. According to opponents of the proposed bans, thousands of jobs in the manufacturing and distributing coal tar based sealants could potentially be lost if a ban bill were put in place. In Washington and Minnesota, jobs were less of an issue. This is because Washington used very little of the product to begin with, and many sealer companies in Minnesota agreed to stop using the product before a ban was even put in place.

Implications

The process of decision making associated with efforts to ban the use of coal tar sealant continues to evolve, as communities across the U.S. continue to become aware of the problem. Currently, nine states have tried to enact a ban, but only two have succeeded. This section, based on the experiences of the four cases studied here, outlines ways to improve the decisions making associated with debates over the use of coal tar sealants. This section also explores what this case study suggests about the emerging pattern of states being a proving ground for changes for federal environmental policies.

Improving Decision Making

This case study can be used to improve the quality of decision making associated with efforts to ban coal tar sealants. The following steps can be used by legislative sponsors to help make the process of enacting a coal tar sealant ban more efficient:

- Identify local studies in the state that linked PAH contamination to coal tar sealant use. The USGS has studied many sites throughout the U.S. which may be useful for this task. If no studies have be performed, the decision making process will be impaired, and some funds will be needed to conduct this research.

- Fund outreach programs to spread awareness of the problem. If coal tar sealant bans occur in a state as a result of outreach efforts, legislators will know that this is an issue their constituents care about.
- Find ways to make the costs of PAH contamination from coal tar sealants transparent. The costs of cleaning up stormwater ponds made this task easy in the Minnesota case. Stormwater pond remediation may be an underlying cost in other states as well, who are not yet aware of the problem. A cost benefit analysis between coal tar sealants and asphalt based sealants can also be used to make the full cost of coal tar sealants transparent.
- Invite knowledgeable organizations to hearings on the bill. In the case of coal tar sealants, the USGS is an important player to have testify at hearings. Although it is a federal agency, and cannot support or oppose a ban, they can present the results of their scientific studies and counter arguments against a ban that is rooted in claims of scientific uncertainties.
- Work with state environmental quality agencies. The only two ban bills that passed at the state level had the backing of an environmental state agency behind them. The decision making process will be much stronger if this agency gets involved in scientific studies linking coal tar sealant use to PAH contamination.
- If needed, introduce multiple bills. If the first ban bill is not successful, re-introduce it again. Attempt to identify why the bill failed, and fix it. In the case of Minnesota, for example, their first ban bill failed because the supporters did not

have enough evidence to prove the PAH contamination in their stormwater ponds was from coal tar sealants. After an MPCA study showed this was the case, the second ban bill was successfully passed.

Although these steps are specific to coal tar sealant bans, they may also be applicable to other state environmental policies. Policy makers can identify the factors which have helped this particular case be successful, and apply those factors to other issues.

Bringing it to the Federal Level

Dozens of coal tar sealant bans have successfully been enacted in the U.S. at the city, county, and state wide level. However, the national ban bill, H.R. 1625 failed to make it out of committee. But, as more information is learned about coal tar sealant at the state level, future efforts to ban it at the federal level will be better informed. Debates at the local level have fleshed out many issues related to enacting a coal tar sealant ban. Some of the recommendations made for improving decision making at the state level apply at the federal level, with regard to coal tar sealant regulations. However, even broader implications can be drawn from this case study that can help provide insight into the ways in which state level efforts to develop environmental policies can serve as a testing ground for national policies.

To begin with, this case study has shown how debates over scientific research at the state level can help to advance the science. In terms of coal tar sealants, research relating to PAH contamination from the sealants has improved over the years, and has been thoroughly debated at local committee hearings. Debates at the federal level can benefit from the science debates that have already occurred in the states, and the knowledge on which people have reached consensus can be applied to federal legislation. Lack of scientific knowledge has been shown to help prevent a bill ban from passing at the local level, so would most likely hinder a national bill as well.

The issue of uncertainty was highlighted in this case study and is a factor that if dealt with first at state level, would be less of a problem at the federal. For example, in the debate over banning coal tar sealants, there was uncertainty about alternatives and potential job losses. Through debates at the state level, such issues are being resolved. Debates have shown that the asphalt alternatives to coal tar sealants are comparable in price and quality. In addition, two states have banned the product without reports of job losses, and many sealer companies have stated they are capable of making the switch from one product to another. As the issue plays out more at the state level, the actual amount of job losses due to a ban will become clearer. Similar uncertainties would emerge in the development of other environmental policies. In cases where states serve as a testing ground, the level of uncertainty associated with these types of issues is reduced by the time national policies are developed. Also, by evaluating how states respond to these unknowns, federal policy makers would be better equipped to address these issues in a national law.

Unanticipated consequences have also been shown to arise from state debates. Unlike uncertainties, these are factors which are not realized when enacting a ban, but emerge when a policy is being debated, designed, or implemented. In this study of coal tar sealants, a feared loss of Federal Aviation Administration (FAA) funding which came up in the case of Maryland, is an example of something unexpected that emerged. If this was indeed an issue, states could potentially lose millions of dollars from the FAA if they stopped using coal tar sealant on airport runways. However, in practice, many airports in the U.S. have stopped using the product without loss of funding. Still, it is important to get as many factors as possible relating to an issue on the table before a policy is designed and implemented to ensure that unforeseen consequences do not cause complications once a policy is put in place.

The design of a bill can also be improved as the federal level when states serve as a testing ground for policies. For example, local coal tar sealant bills have also shown which timetable is preferred when starting a ban. Most statewide ban bills allowed for continued sale and use of coal tar sealant for one year after the bill was enacted. This allowed coal tar sealant manufactures, processors, and distributors enough time to unload their product, so as not to have any loss in revenue. The attempted national bill did account for a timetable similar to this, with manufacturing stopping a year after the bill's implementation, distributing being banned a year and a half later, and use of the product stopping two and a half years later. Both Washington and Minnesota were able to successfully stop the sale and use of coal tar sealants in their boarders within one to two years, so a national ban with a slightly longer time period should be achievable.

Another design issue, as learned in the case of coal tar sealant bans, has to do with fines. With coal tar sealants, most state bills included penalties in the bill language, with those breaking the law paying fines upwards of $1,000. However, it is not yet known how helpful such a clause is. There have been no reports of continued coal tar sealant use in either Minnesota or Washington. But, unlike Washington, Minnesota did not have a fine section within their bill. More time, and more successfully passed state bills, may identify if fines are needed to ensure a ban is properly enacted. These examples have shown how national policy makers can learn from the design of state bills before implementing national bills. How policy is designed is an important factor, and a significant amount of design knowledge can be produced when states enact their own policies before action is taken at national level.

In the past few decades, national environmental policies have been slow to address emerging concerns because of gridlock and the growing complexity of the regulatory process. As a result, policy-making has become more decentralized, with states taking the lead even when a national action may be appropriate. However, policy makers at the federal level can learn from states and take advantage of the knowledge that is produced at that level. This case study has shown how states can be used a proving ground for environmental policies, potentially leading to federal policies that are more efficient and effective. In the future, more policy case studies at the state level could be used similar to this one, on the banning of coal tar sealants, in which efforts at the state level are compared. These studies could then be used to provide insight into the emerging relationship between the states and federal government in the development of environmental policy.

Appendix One- Sample Interview Questions

Legislator Questions

1. When did you first become aware of coal tar sealants being identified as a problematic source of PAHs? In what context?

2. Why did you decide to introduce the coal tar sealant bill?

3. How did the hearings go for the bill? Was there any opposition/support? If so, in what form? (Organizations? Industry?)

4. Why do you believe the bill successfully passed (or not)?

5. If passed: Do you know if the implementation of the ban has been successful?

6. If not passed: Will you be trying the bill again? If so, will you be doing anything differently?

Environmental Organization Questions

1. Can you tell me about your general education and career background?

2. When did you first become aware of coal tar sealants being identified as a problematic source of PAHs? In what context?

3. What has your organization done in terms of this issue? Why did you decide to put funds/time into this particular problem?

4. Why do you believe this bill to ban coal tar sealants was successfully passed (or not)?

5. If passed: Do you know if there are any studies occurring to see if PAH levels have declined in the state since the ban has taken place? Is any monitoring being done?

6. If not passed: Will your organization continuing advocating for this issue?

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