

Migration of polycyclic aromatic hydrocarbons from creosote-treated roundwood in soil under controlled laboratory conditions

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Abstract: Creosote is used as a wood preservative in a variety of terrestrial and aquatic environments, and some of its components can be detrimental to ecosystem function at high enough concentrations. Therefore, it is important to quantify chemical migration from creosote-treated commodities to better understand their impact. This work measures the migration of 16 polycyclic aromatic hydrocarbons (PAHs) from creosote-treated southern pine and Douglas-fir roundwood posts set in soil contact in barrels under controlled laboratory conditions. Experiments were carried out in soils with both low and high organic matter (OM) content. PAH content was measured in soil over a 32-month period at two distances from the post surface (76 and 152 mm) and at three different depths from the surface (0–15 cm, 15–30 cm, and 30–46 cm). PAH concentration varied widely among the 16 different compounds measured, but generally PAHs with four or fewer rings were more abundant and more frequently found than larger five-ringed PAHs across sample types. It was difficult to identify clear patterns in PAH migration by distance from wood and depth from soil surface because levels were generally low (below 0.4 PPM), and the data was highly variable, which eliminated the possibility of differentiating means statistically in most cases. In many cases, PAH levels found in controls that contained untreated wood were similar to levels found in control soil that contained treated wood, indicating some PAHs found could originate from the soil or surrounding environment. The clearest trend found was that high OM soils much more frequently contained measurable levels of the different PAHs, which is likely due to the known affinity PAHs have for OM. This work provides some methodological insight into studying PAH migration in soils that can help explain PAH migration patterns in soils with different proportions of OM. It also shows that without wetting with liquid water or other physical disturbances faced by wood in service, PAH migration from creosote-treated wood into soil is minimal.

Keywords: Wood preservative; Environmental impacts; Douglas-fir; Southern pine

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Introduction

Creosote is a widely used industrial wood preservative for protecting utility poles, marine pilings, railroad ties, and other infrastructure-related treated wood commodities for protection against fungi, insects, and marine borers. As a wood preservative, creosote has been in use since the 1830s (Webster 1992). A byproduct of the destructive distillation of high-temp carbonized bituminous coal, creosote is a complex and variable mixture of polycyclic aromatic hydrocarbons (85% of mass), phenolic compounds (10% of mass), and heterocyclic aromatic compounds (5% of mass) (Mueller et al. 1989).

Polycyclic aromatic hydrocarbons (PAHs) are formed as a result of incomplete combustion from both natural and anthropogenic processes. They are found as persistent environmental pollutants in aquatic and terrestrial environments and have an affinity for organic matter (OM) in soils (Wilson and Jones 1993). Some PAHs are regulated by the United States Environmental Protection Agency (US EPA), which includes at least 16 PAHs its priority pollutants list, all of which are found as constituents of coal tar creosote (US EPA 2014). These regulations have implications for the use and manufacture of creosote-treated commodities. Understanding the quantity and scope of PAH migration from creosote-treated wood is important both in a regulatory context and for the end user.

Much of the prior literature measuring PAH migration from creosote-treated commodities focuses on marine environments (Bestari et al. 1998; Morrell et al. 2011). However, the majority of creosote-treated commodities used today are deployed on land either in ground contact or supported on a railroad ballast. Railroad ballasts act as functional buffers between creosote-treated railroad ties and surrounding soils and likely mitigate their impact on surrounding soils and waterbodies (Brooks 2004). Relatively limited information is available on PAH migration from commodities in direct soil contact.

Soil is a complex and highly variable medium for chemical migration which can modulate chemical movement. Several factors determine the rate of migration through and the sorption of organic contaminants in soil, which ultimately determines how much chemical can accumulate in soil. Humic substances, which are part of the organic fraction in soils, have been shown to aid in the sorption of hydrophobic organic compounds in some cases (Pan et al. 2008). PAHs specifically are well known to have an affinity for OM in bulk in soil, which has implications for their rate of migration in different soil conditions (Kariyawasam et al. 2022; Ossai et al. 2020). However, different fractions of soil OM interact differently with PAHs.

Humic substances of soils have a more complex relationship with PAHs, where some fractions have no affinity for PAHs and other fractions have condition-dependent affinity for PAHs (Ukalska-Jaruga et al. 2019). These prior findings suggest that the ultimate environmental impact of creosote-treated commodities on terrestrial systems depends in part on soil composition and the composition of soil OM.

In this study, the migration of PAHs from creosote-treated Douglas-fir and southern pine posts was quantified in controlled, indoor mesocosms over a 32-month period. Posts were set in high and low OM soil to measure the impact of soil composition on PAH accumulation in the soil medium. This work provides valuable methodological insights into studies on terrestrial migration of PAHs and can help better interpret future studies aimed at quantifying creosote's environmental impacts.

Methods and materials

Materials

Coastal Douglas-fir (*Pseudotsuga menziesii*) and southern pine posts 15–20 cm in diameter and 2.4 m long were treated with creosote according to the American Wood Protection Association (AWPA) Standard P1/P13-24, Standard for Creosote Preservative (AWPA 2024) at commercial facilities in the southeastern United States (southern pine) and Oregon (Douglas-fir) to Use class 4B retentions (160 kg/m³) (AWPA 2025). Posts were stored under cover until they were halved to 1.2 m test pieces prior to inclusion in the study. When they were halved, the creosote retention levels of the posts were determined according to the AWPA A6-20 Standard, Method for the Determination of Retention of Oil-Type Preservatives from Small Samples (AWPA 2020) as an aggregate sample for all posts included in the test. The assay zones (0–25 mm) of creosote-treated Douglas-fir posts contained 52 kg/m³ creosote and southern pine posts contained 143 kg/m³ of creosote.

Two types of soil were acquired from a local garden supply center, a high OM soil and a low OM soil. The high OM soil blend consisted of half loam collected from near the Willamette River and half 3-in-1 compost of dairy manure and composted bark fines. The low OM soil was unamended loam from the same source as the high OM soil. Each soil was analyzed at the Oregon State University Soil Health Laboratory according to their advanced nutrient profile procedures. A summary of parameters measured for each soil type is shown in Table 1.

Experimental Design

Fourteen food-grade, high-density polyethylene (HDPE) 55-gallon barrels with lids were used in this laboratory PAH

Table 1. Soil nutrient profile and composition of high and low organic matter soils used in this study.

Soil type	% C	% N	pH	PPM (mg nutrient/kg soil)		
				PO ₄	NO ₃	NH ₄
High organic matter	6.6	0.16	6.95	0.6	4.3	2.1
Low organic matter	0.1	0.01	7.36	BQL	1.5	0.3

Soil type	PPM (mg nutrient/kg soil)							
	Ca	Mg	K	B	Cu	Fe	Mn	Zn
High organic matter	3079	923	813	1.1	3.1	115	59	3.7
Low organic matter	1952	654	97	0.2	1.1	24	2	0.6

BQL = below quantification limit.

migration study. A circular hole large enough to accommodate the posts was cut into each barrel lid to allow the top of the creosote-treated posts to stand upright. Tare weights were obtained for the barrels with lids prior to the addition of soil to account for the total mass of soil added. High OM soil to a depth of 15 cm was added to seven of the barrels and low OM soil was added to another seven barrels. Six halved creosote-treated posts 15–20 cm in diameter and 1.2 m long of each species were installed into these barrels. Three of the six creosote-treated Douglas-fir and three of the six creosote-treated southern pine posts were installed into high OM soil barrels, and the remaining three creosoted posts of each species were installed into low OM soil barrels. All posts were installed with the uncut (creosote penetrated) end-grain down into the soil column. One untreated Douglas-fir post was installed in a barrel containing each soil type to serve as low and high OM controls.

After installing posts, another 76 cm of soil was added into each barrel on top of the original 15 cm depth of soil to reach a depth of 91 cm. The total mass of soil added to each barrel was measured. The moisture-holding capacity of each type of soil was first determined using previously described methods (Bouyoucos 1935) in lab. Both soil types were wetted to a moisture content of 20%, which was the approximate moisture holding capacity of the low OM soil. The soils were then lightly tamped down to compact the soil to increase the ease of soil-core sampling. Lids were placed onto each of the barrels with a large plastic bag placed over the top of the posts and placed in between the lid and the barrel to minimize evaporation (Figure 1).

Barrels were incubated at ambient indoor conditions for 32 months. Background soil samples were taken before exposure to creosoted posts. Soil samples were taken at three points: 3, 12, and 32-months after installation. Soil samples were taken



Figure 1. Photo of post-in-barrel test showing southern pine and Douglas-fir posts set in soil within plastic drums. Posts were covered with plastic sheeting to prevent dust from accumulating on the surface, and one pine post is shown uncovered just before sampling.

using a 2.5 x 61 cm (1.0 x 24 in.) stainless steel soil sampler to obtain 46 cm (18 in.) soil cores. Soil cores were taken at two distances from the post, 76 mm (3 in.) and 152 mm (6 in.) with the center of the soil sampler centered at each sampling distance. For each sampling period, the soil cores were taken 60° clockwise from the previous sampling location to reduce disturbances between samplings. The 46 cm (18-in.) soil cores were divided into three sections of about 15 cm each (6-in.): an upper 0–15 cm, middle 15–30 cm, and lower 30–46 cm section. Each soil section (upper, middle, or lower) was homogenized and retained for PAH extraction. The soil corer was cleaned of all soil between each core taken by wiping off excess soil, rinsing the corer with water while cleaning with a brush, and finally spraying it down with ethanol and wiping it dry. All soil samples taken in this study were frozen until extracted for 16 PAHs, as described in the section below.

PAH soil extraction procedure

Triplicate 10 g subsamples of each soil sample were extracted via the following method. Each 10 g subsample was placed into a pre-weighed 50 mL Falcon tube; 20 mL of a 2:2:1 acetone: ethyl acetate: isooctane (v/v) mixture was added to each Falcon tube and weighed again. The samples were hand-shaken to remove any sediment stuck to the bottom of the tube then sonicated for 5 minutes. A modified QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) (Agilent Technologies, Santa Clara, CA) technique was performed in this study. The procedure consisted of two steps, extraction and cleanup via dispersive solid-phase extraction (dSPE) (Anastassiades et al. 2003; Forsberg et al. 2011). The samples were then treated with a single QuEChERS packet consisting of a salt mixture containing 6 g of magnesium sulfate and 1.5 g of sodium acetate. After addition of the QuEChERS packet, the tubes were weighed (after drying the tubes after the initial sonication) and sonicated for another 5 minutes, followed by 5 minutes of centrifugation at 5,000 RPM.

All supernatants were transferred to a pre-weighed 20 mL amber glass scintillation vial and weighed to determine solvent recovery on a weight basis. Samples were then concentrated under a gentle stream of house air for approximately 15 minutes and weighed again. A 1.5 mL aliquot was then transferred to a 2 mL dispersive solid phase extraction (dSPE) microcentrifuge tube and sonicated for 5 minutes. The SPE tube was then centrifuged for 5 minutes at 5,000 RPM and a final 1 mL aliquot of supernatant was transferred to an amber autosampler vial and frozen until GC-MS analysis. The remaining supernatant in scintillation vials was retained and frozen, should future analysis be necessary.

GC-MS analysis

Sixteen PAHs listed as EPA priority pollutants were quantified using gas chromatography-mass spectrometry (GC-MS) according to modified previously published procedures (Martinez et al. 2004). All standards and samples were analyzed using a Shimadzu GCMS-QP2010S gas chromatograph mass spectrometer (Shimadzu, Kyoto, Japan) utilizing selective ion monitoring (SIM) and a Restek DB-5MS column 30.0 m long, 0.25 μm thick, and 0.25 mm internal diameter (Restek Corp. Bellefonte, PA). Instrument injection was operated in splitless mode with a 3.5 mm glass liner with de-activated glass wool. A 1 μL injection was performed at 275°C. Chromatography of the 16 PAHs of interest was attained at a column flow rate of 2.50 mL/min using HP-5 grade ultra-high purity helium as the carrier gas. Column oven temperature was set to 70°C,

held for 2 min, ramped to 265°C at a rate of 10.0°C/min and held for 18.5 minutes, for a total run time of 40 minutes. Mass spectrometer ion source and interface temperature were 225°C and 275°C, respectively, with a solvent cut time of 5 minutes. If no signal was detected using GC-MS, a value of zero was assigned to the PAH concentration in the extract and any non-detects were used to calculate average values shown below.

Calibration curves were generated by preparing standards from a 2000 $\mu\text{g/mL}$ 16-PAH standard reference standard from Sigma Aldrich (St. Louis, Missouri) in dichloromethane. Concentrations of PAH standards prepared from the 2000 $\mu\text{g/mL}$ stock solution were 0.005, 0.01, 0.1, 0.5, and 1.0 $\mu\text{g/mL}$.

Results and discussion

Concentrations of PAHs in soil were collected and summarized as mg PAH per kg of soil (PPM) for each PAH, and data for six PAHs that are known, or potential carcinogens, are shown below (Figures 2–6). Average PAH levels for all types were below 0.4 PPM. PAH concentrations were also highly variable at most sampling location/timepoint combinations, leading to high coefficients of variation for many of the average values. This made it very difficult to identify trends among the data because most of the averages could not be statistically differentiated from one another. In most cases, PAHs with four or fewer rings were found at higher concentrations in soil samples taken from barrels, and larger five-ringed PAHs were found less frequently. Control samples also had detectable levels of many PAHs that were like those found in barrels containing creosote-treated wood. This suggests that some of the PAH signal detected originated from the soil or the surroundings of the barrel mesocosms. The barrels were located in a shop space that had been used for wood preservation research for several decades. While the soil microcosms were covered with a lid and plastic sheeting to limit any cross contamination, incidental introduction of dust from the surrounding environment may have resulted in some contamination of the controls. In some cases, the 32-month sampling resulted in more positive detections of PAHs in the controls, as compared to earlier sampling points (Figure 3–6). This may be a result of greater exposure to the surrounding environment over the course of the experiment. Data summarizing migration patterns of the remaining 10 PAHs is available in the supplemental information (Table S1-3).

Average naphthalene concentrations in soils were low at all sampling points, and all averages were below 0.08 PPM (Figure 2). In addition, in most cases, naphthalene levels found in soil taken from untreated controls were similar to those found in

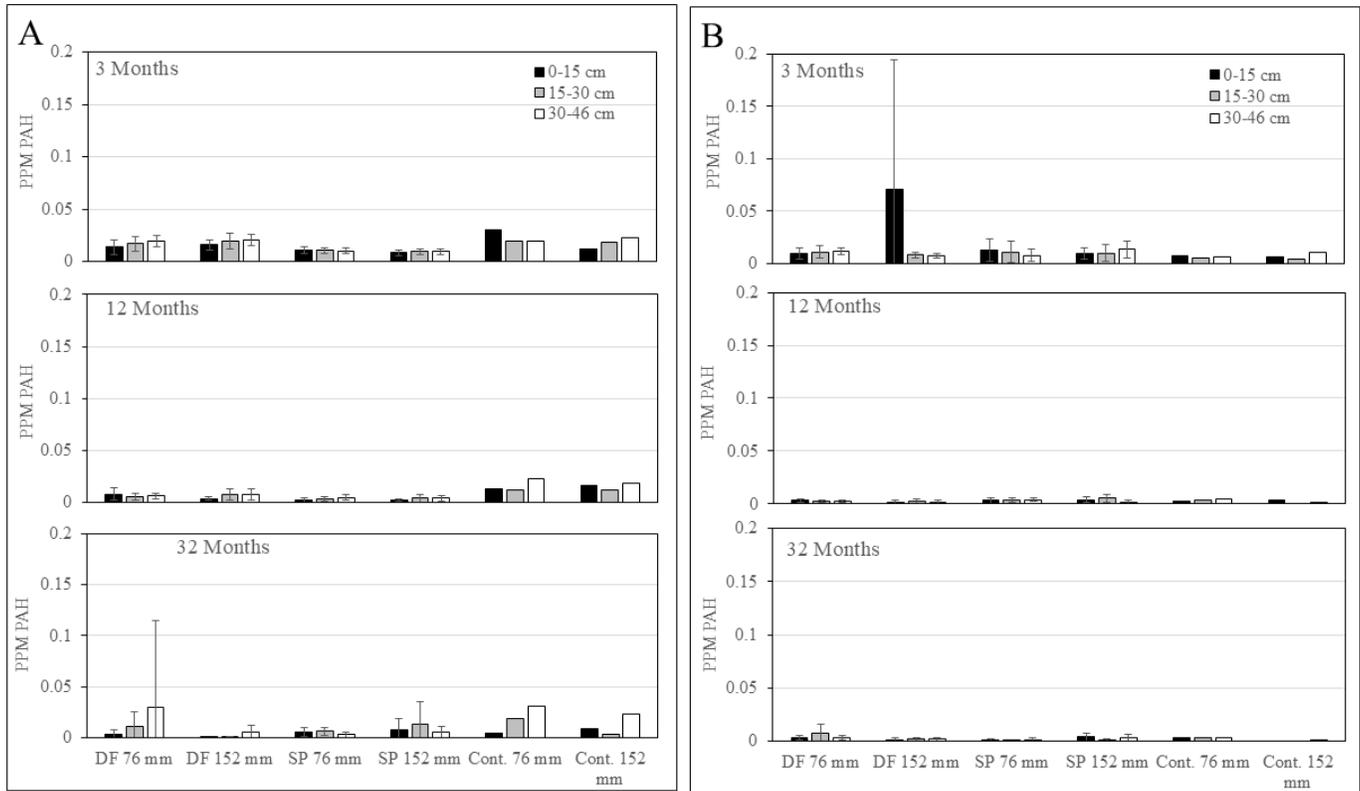


Figure 2. Average naphthalene concentration in high organic matter soil (A) or low organic matter soil (B) sampled at three depths, 0–15, 15–30, and 30–46 cm below the soil surface around southern pine (SP) or Douglas-fir (DF) posts either 76 or 152 mm from the post surface. The samples were taken 3 months, 12 months, and 32 months after installation.

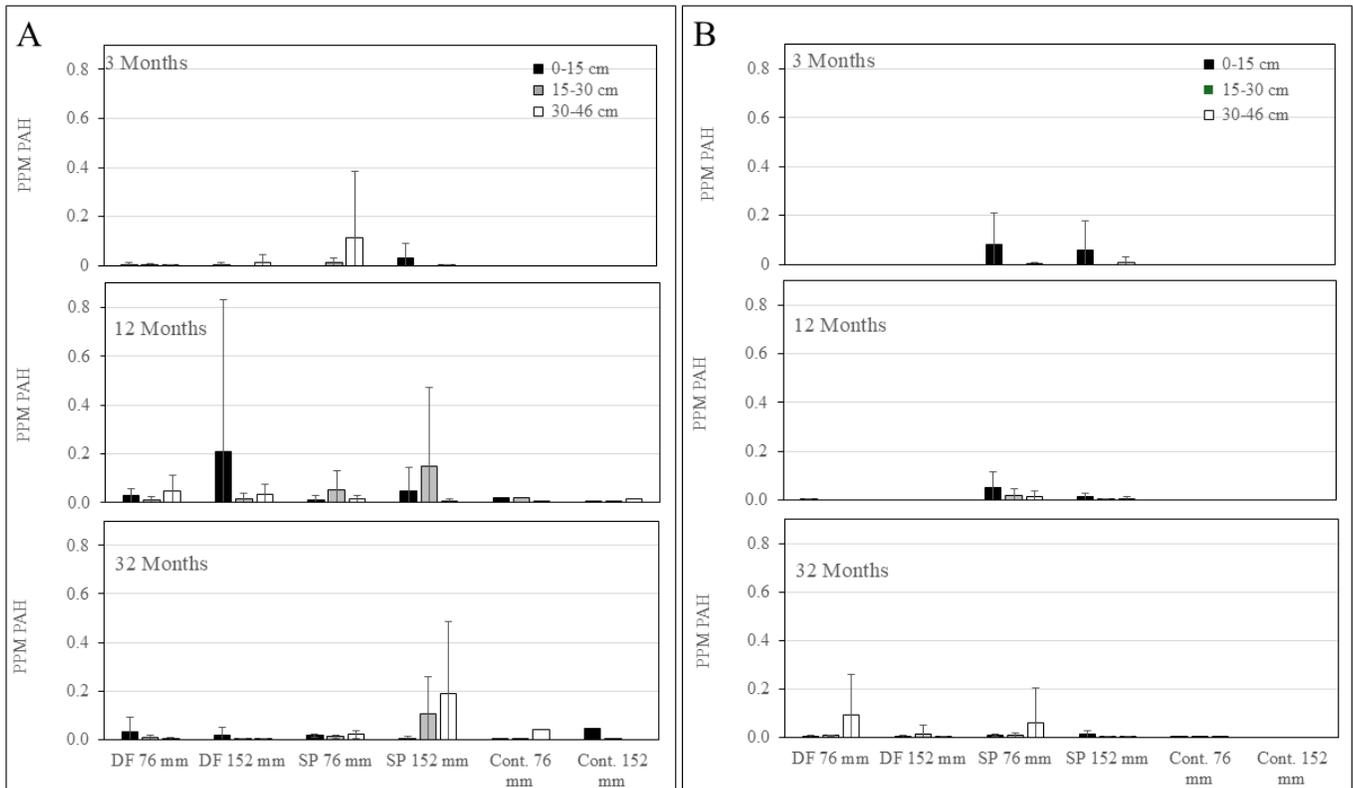


Figure 3. Average Benz[a]anthracene concentration in high organic matter soil (A) or low organic matter soil (B) sampled at three depths, 0–15, 15–30, and 30–46 cm below the soil surface around southern pine (SP) or Douglas-fir (DF) posts either 76 or 152 mm from the post surface. The samples were taken 3 months, 12 months, and 32 months after installation.

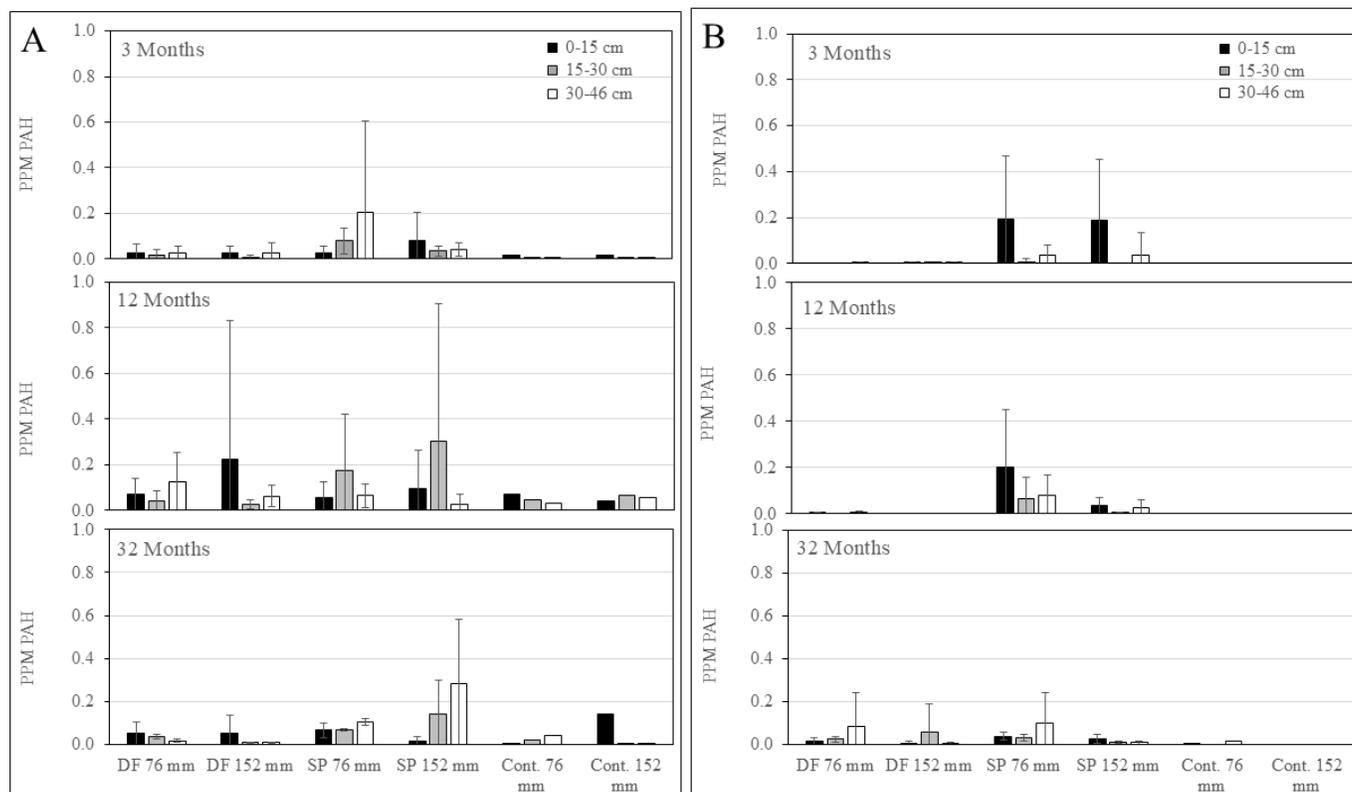


Figure 4. Average chrysene concentration in high organic matter soil (A) or low organic matter soil (B) sampled at three depths, 0–15, 15–30, and 30–46 cm below the soil surface around southern pine (SP) or Douglas-fir (DF) posts either 76 or 152 mm from the post surface. The samples were taken 3 months, 12 months, and 32 months after installation.

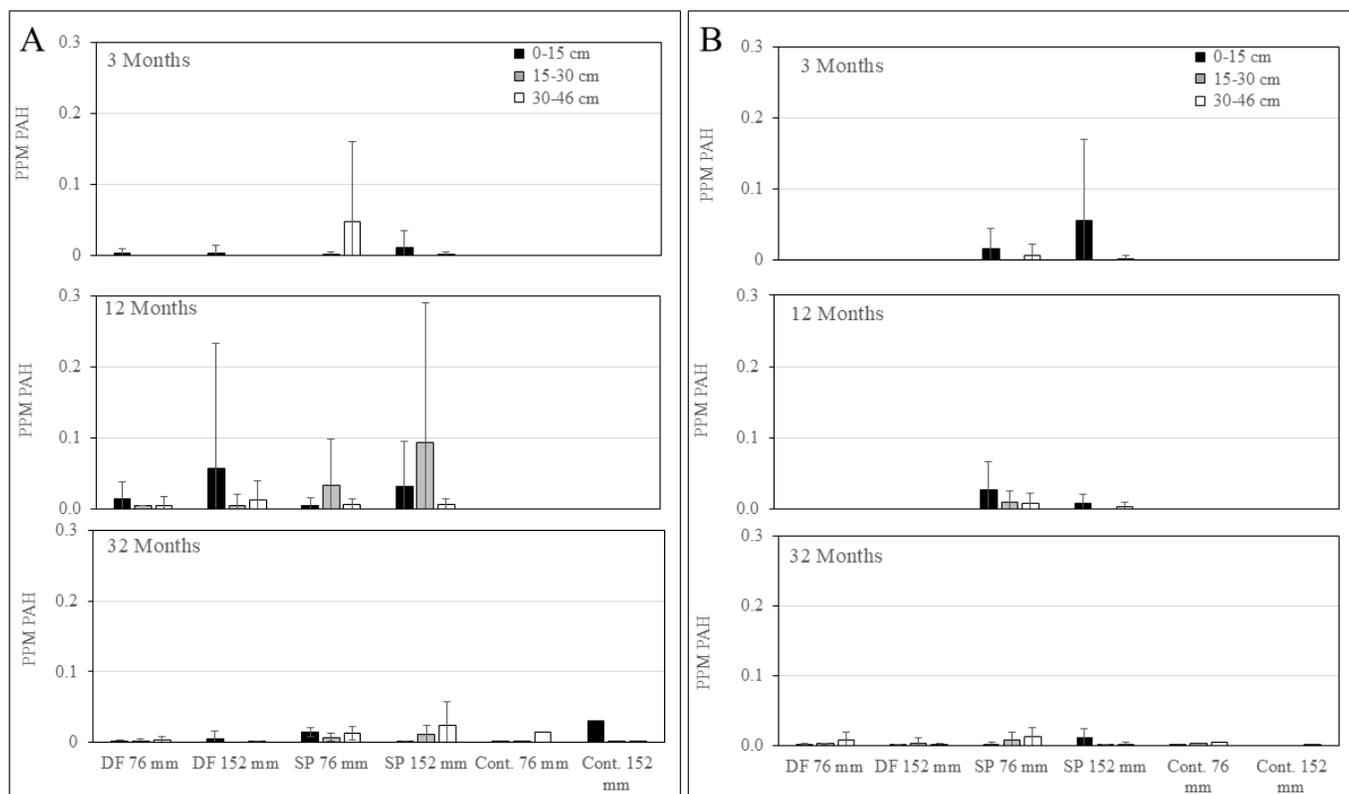


Figure 5. Average benzo[a]pyrene concentration in high organic matter soil (A) or low organic matter soil (B) sampled at three depths, 0–15, 15–30, and 30–46 cm below the soil surface around southern pine (SP) or Douglas-fir (DF) posts either 76 or 152 mm from the post surface. The samples were taken 3 months, 12 months, and 32 months after installation.

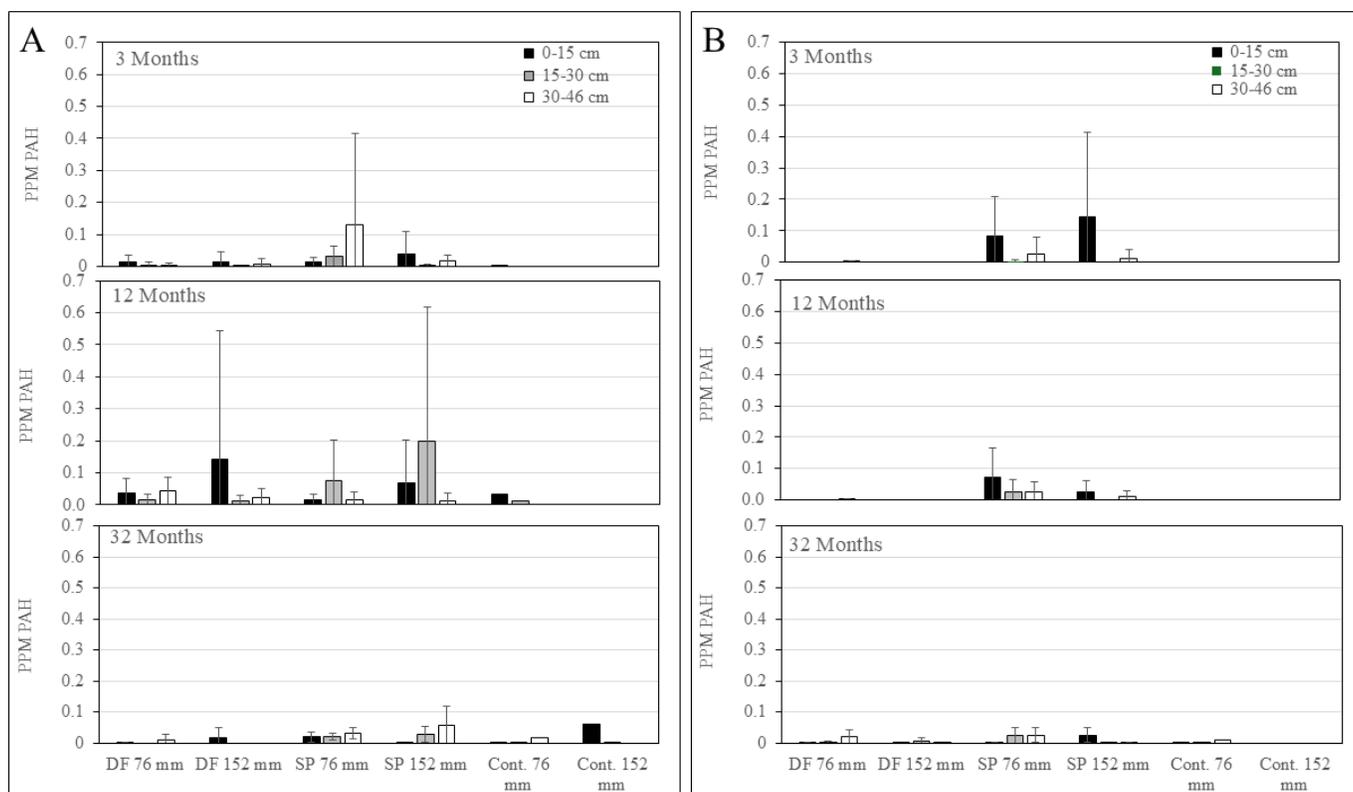


Figure 6. Average combined benzo[b] and [k] fluoranthene concentration in high organic matter soil (A) or low organic matter soil (B) sampled at three depths, 0–15, 15–30, and 30–46 cm below the soil surface around southern pine (SP) or Douglas-fir (DF) posts either 76 or 152 mm from the post surface. The samples were taken 3 months, 12 months, and 32 months after installation.

soil sourced from barrels containing creosote-treated wood. This suggests that the soil or the environment the experiment was run in was a source of naphthalene that could have accounted for most or all of the naphthalene measured here. No major trends among different sampling depths, distances from the posts, wood species, or time from experiment start were apparent. High organic matter soils had naphthalene levels that trended higher than those found in low organic matter soil in the 12- and 32-month sampling points, but levels were similar at the earliest, 3-month timepoint. This could be due to a higher affinity of naphthalene for soil organic matter, which allowed it to adsorb to high OM soil more effectively.

Average benz[a]anthracene concentrations in soil were all at or below 0.2 PPM, and for most of the extracts analyzed, levels found were near or below the detection limit of the method used here (Figure 3). Variation was too high to confidently resolve differences within each soil type at different sampling locations. However, for some sampling locations around treated Douglas-fir posts after 3 and 12 months set in low OM soil, no benz[a]anthracene was detected at all, and levels trended lower in the low OM soil as compared to high OM soil samples. Low average levels of benz[a]anthracene were detected in most of

the high OM control soil samples (5.5–20 PPB), and in only three of the low OM soil controls (1–4 PPB). Interestingly, the highest average levels of benz[a]anthracene found were in samples taken 152 mm away from treated Douglas-fir or southern pine posts, opposite to a decreasing concentration trend from the post surface that would be expected.

Chrysene was found at somewhat higher average concentrations levels than the other PAHs discussed here, but all average chrysene concentrations were under 0.4 PPM (Figure 4). Chrysene was detected in most samples around creosote-treated wood, except those taken 12 months after installation at 152 mm away from treated Douglas-fir posts. Variation was too high to confidently resolve differences within each soil type at different sampling locations. Low average levels of chrysene were detected in all of the high OM control soil samples, ranging from 0.2 to 139 PPB. Chrysene was less frequently detected in low OM controls and was only at 0.003–0.013 PPM 32 months after installation. Soils taken around treated southern pine posts in many cases appeared to have more consistently higher chrysene levels, possibly due to the higher creosote loadings in these posts. However, statistical comparisons could not resolve differences due to the high level of variation in the data.

Benzo[a]pyrene was found in most soil samples taken around creosote-treated posts except for Douglas-fir posts in low OM soil after 12 months and the middle depth soil sample taken 76 mm (6 in.) away from the surface of treated Douglas-fir posts in high OM soil. Where it was found around creosote-treated posts, average benzo[a]pyrene levels ranged from 0.0002 to 0.093 PPM, and where it was found around control posts, average concentrations ranged from 0.0001 to 0.029 PPM. No benzo[a]pyrene was detected in any of the 12-month control samples. Variation was too high to confidently resolve differences within each soil type at different sampling locations. Soils taken around treated southern pine posts in some cases appeared to have more consistently higher benzo[a]pyrene levels, possibly due to the higher creosote loadings in these posts. However, statistical comparisons could not resolve differences, due to the high level of variation in the data.

Benzo[b] and [k] fluoranthene were considered together because chromatographic separation of the two compounds was insufficient to demarcate individual peaks. Where present around creosote-treated wood, average concentration of these compounds ranged from 0.05 to 199 PPB, and where present around control, concentrations ranged from 0.3-62 PPB. Detection in control soils was sporadic: only 8.3% of 3-month control samples, 16.7% of 12-month control soil samples, and 66.7% of 32-month control samples had detectable levels of benzo[b] and [k] fluoranthene. Average concentrations in control samples ranged from 0.3 to 61 PPB. Variation was too high to confidently resolve differences within each soil type at different sampling locations.

Soil samples were analyzed for a total of 16 PAHs in this study (Table S1-3). Trends varied slightly for each PAH, but migration was generally low, likely due to the absence of rainwater in this study. Despite their low solubility, rainwater can mobilize PAHs from creosote-treated wood surfaces (Konkler et al. 2020). The limited PAH migration measured from posts under controlled conditions not subjected to rainfall may suggest that rainfall is one of the primary drivers of PAH migration from creosote-treated commodities in ground contact.

For most PAHs measured here, averages soil concentrations trended higher in the high organic matter soil. This is due to the higher affinity PAHs have for soil organic matter than inorganic elements in soil (Kariyawasam et al. 2022; Ukalska-Jaruga et al. 2019). This trend suggests that soil characteristics can help modulate PAH accumulation around creosote-treated commodities. It would be beneficial to understand the soil characteristics in any study of PAH migration from creosote-treated wood to better explain migration patterns.

Conclusions

This work shows that in the absence of wetting and physical disturbances faced by creosote-treated wood when in service, very low levels of PAHs migrate from treated commodities. Chemical migration that was detected was sporadic and did not follow expected concentration gradients in relation to distance from wood surfaces. Background PAHs present in the soil or environment contributed to the overall PAH signal, and this should be a consideration in interpreting data in subsequent studies of the environmental impact of creosote-treated wood. The properties of the soil play a role in determining the efficiency of PAH capture in soil, with higher organic matter soils retaining more PAHs. Soil properties should be considered in any study of chemical migration from creosote-treated wood. This work will provide useful methodological insights for the future study of chemical migration from creosote-treated in service.

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Appendix: Supplemental Tables

Table S1. Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 3 months in soil barrel mesocosms.

Naphthalene concentration (ppb) ^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	13.7 (7.2)	17.0 (7.1)	19.8 (5.3)	16.1 (4.8)	19.6 (7.1)	21.0 (5.4)	9.3 (5.4)	11.0 (6.2)	11.5 (2.9)	71.2 (123.4)	7.8 (3.0)	7.2 (2.3)
	-	30.6	20.0	19.2	11.9	19.0	22.8	7.2	5.4	6.2	5.8	4.0	10.5
Southern pine	+	11.3 (3.2)	10.7 (2.5)	10.3 (2.8)	8.7 (2.6)	9.6 (2.6)	9.5 (2.5)	12.7 (10.6)	10.7 (10.2)	7.7 (5.5)	9.3 (5.6)	9.9 (7.7)	13.3 (8.5)
	-	30.6	20.0	19.2	11.9	19.0	22.8	7.2	5.4	6.2	5.8	4.0	10.5

Acenaphthylene concentration (ppb) ^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	0 (0)	0.4 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0.8	0	0	0	0	0	0	0	0	0	0	0
Southern pine	+	0 (0)	0.1 (0.1)	1.9 (4.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	9.9 (7.7)	0 (0)	0 (0)
	-	0.8	0	0	0	0	0	0	0	0	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

Acenaphthene concentration (ppb) ^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	138.2 (147.7)	140.0 (86.5)	92.0 (32.2)	91.0 (33.8)	143.3 (87.6)	165.9 (83.8)	4.8 (7.6)	5.2 (7.8)	4.2 (6.6)	67.0 (119.2)	3.8 (5.8)	2.8 (4.6)
	-	239.9	107.0	91.9	80.3	255.6	315.6	0 (0)	0 (0)	0 (0)	200.0 (300.0)	0 (0)	0.5 (0.5)
Southern pine	+	63.1 (60.6)	78.7 (45.9)	77.4 (40.1)	62.3 (23.1)	69.0 (55.7)	75.0 (51.3)	4.9 (6.2)	600.0 (1.2)	0 (100.0)	6.3 (9.2)	100.0 (400.0)	700.0 (700.0)
	-	239.9	107.0	91.9	80.3	255.6	315.6	0 (0)	0 (0)	0 (0)	200.0 (300.0)	0 (0)	500.0 (500.0)

Table S1 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 3 months in soil barrel mesocosms.

		Fluorene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	37.7 (10.1)	92.3 (87.3)	99.7 (98.6)	52.6 (33.2)	45.5 (29.7)	107.8 (153.8)	10.2 (12.5)	12.3 (10.2)	23.0 (20.9)	16.3 (14.7)	10.1 (7.9)	8.9 (7.5)
	-	49.6 (9.0)	37.2 (11.1)	32.0 (3.7)	20.5 (20.8)	21.7 (4.4)	23.8 (4.3)	6.1 (1.6)	4.0 (1.6)	2.4 (900.0)	1.3 (1.2)	1.6 (400.0)	3.0 (2.1)
Southern pine	+	23.5 (18.9)	63.1 (82.2)	356.5 (797.0)	73.0 (104.3)	26.1 (12.7)	20.4 (8.4)	78.4 (93.7)	15.4 (14.2)	24.7 (39.0)	43.4 (57.7)	8.6 (8.3)	31.3 (32.3)
	-	49.6 (9.0)	37.2 (11.1)	32.0 (3.7)	20.5 (20.8)	21.7 (4.4)	23.8 (4.3)	6.1 (1.6)	4.0 (1.6)	2.4 (900.0)	1.3 (1.2)	1.6 (400.0)	3.0 (2.1)

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Phenanthrene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	22.2 (9.8)	21.3 (13.1)	19.7 (11.8)	23.3 (13.4)	28.3 (19.8)	35.3 (17.6)	0 (0)	1.7 (3.6)	6.2 (12.1)	9.2 (11.8)	2.6 (4.9)	1.3 (2.6)
	-	50.3 (6.4)	22.9 (7.1)	15.9 (5.7)	12.9 (6.0)	17.5 (7.2)	25.0 (2.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Southern pine	+	21.4 (22.0)	41.5 (28.4)	164.9 (340.1)	40.7 (50.7)	27.1 (6.8)	26.5 (4.7)	27.8 (39.1)	800.0 (1.6)	3.8 (7.1)	18.8 (29.9)	0 (0)	4.9 (9.2)
	-	50.3 (6.4)	22.9 (7.1)	15.9 (5.7)	12.9 (6.0)	17.5 (7.2)	25.0 (2.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Anthracene (ppb)^a

		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	4.5 (5.7)	0 (0)	0 (0)	0 (0)	0 (0)	7.5 (22.5)	0 (0)	0 (0)	0 (0)	1.7 (5.2)	0 (0)	0 (0)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Southern pine	+	1.0 (2.5)	40.0 (66.3)	60.0 (134.6)	15.2 (26.1)	300.0 (800.0)	2.4 (1.9)	28.7 (43.6)	0 (100.0)	600.0 (1.2)	20.5 (37.0)	0 (0)	3.8 (11.3)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

^aValues are means of three replicate samples with one standard deviation in parentheses.

Fluoranthene concentration (ppb)^a

		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	37.7 (10.1)	92.3 (87.3)	99.7 (98.6)	52.6 (33.2)	45.5 (29.7)	107.8 (153.8)	10.2 (12.5)	12.3 (10.2)	23.0 (20.9)	16.3 (14.7)	10.1 (7.9)	8.9 (7.5)
	-	49.6 (9.0)	37.2 (11.1)	32.0 (3.7)	20.5 (20.8)	21.7 (4.4)	23.8 (4.3)	6.1 (1.6)	4.0 (1.6)	2.4 (900.0)	1.3 (1.2)	1.6 (400.0)	3.0 (2.1)
Southern pine	+	23.5 (18.9)	63.1 (82.2)	356.5 (797.0)	73.0 (104.3)	26.1 (12.7)	20.4 (8.4)	78.4 (93.7)	15.4 (14.2)	24.7 (39.0)	43.4 (57.7)	8.6 (8.3)	31.3 (32.3)
	-	49.6 (9.0)	37.2 (11.1)	32.0 (3.7)	20.5 (20.8)	21.7 (4.4)	23.8 (4.3)	6.1 (1.6)	4.0 (1.6)	2.4 (900.0)	1.3 (1.2)	1.6 (400.0)	3.0 (2.1)

Pyrene (ppb)^a

		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	26.0 (12.3)	52.0 (54.5)	57.0 (64.6)	28.9 (24.9)	19.8 (18.6)	61.9 (96.4)	0 (100.0)	100.0 (400.0)	5.8 (12.9)	7.1 (9.0)	1.2 (3.7)	500.0 (1.3)
	-	23.1 (6.8)	9.2 (4.9)	9.2 (2.0)	31.6 (21.1)	6.2 (2.5)	6.3 (6.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Southern pine	+	17.3 (16.4)	56.4 (70.5)	296.8 (666.6)	62.8 (99.8)	17.3 (11.8)	14.9 (11.1)	68.3 (92.6)	2.7 (6.1)	13.4 (25.8)	31.1 (46.8)	100.0 (200.0)	13.3 (18.2)
	-	23.1 (6.8)	9.2 (4.9)	9.2 (2.0)	31.6 (21.1)	6.2 (2.5)	6.3 (6.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S1 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 3 months in soil barrel mesocosms.

		Benzo[g,h,i] concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Southern pine	+	0 (0)	0 (0)	7.8 (19.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.2 (3.6)	21.5 (49.1)	0 (0)	0 (0)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Indeno[1,2,3-cd] pyrene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	0 (0)	0 (0)	0 (0)	0.2 (0.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Southern pine	+	0 (0)	0 (0)	11.5 (28.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2.4 (7.1)	26.2 (59.7)	0 (0)	0 (0)
	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S2. Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 12 months in soil barrel mesocosms.

		Naphthalene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	7.9 (5.9)	5.9 (3.2)	6.3 (2.9)	3.8 (1.9)	8.1 (5.6)	8.2 (5.4)	3.3 (1.7)	2.3 (1.3)	2.9 (1.1)	1.7 (1.4)	2.2 (2.1)	1.9 (1.7)
	-	13.0	12.0	22.7	16.4	12.3	18.5	2.8	3.9	4.2	4.1	0	1.2
Southern pine	+	2.4 (2.0)	3.6 (1.9)	4.8 (2.8)	2.6 (1.2)	4.3 (3.7)	4.1 (2.7)	3.2 (3.0)	3.3 (2.3)	3.9 (1.9)	3.8 (2.7)	5.4 (3.7)	1.9 (1.6)
	-	13.0	12.0	22.7	16.4	12.3	18.5	2.8	3.9	4.2	4.1	0	1.2

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Acenaphthylene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	3.0 (5.4)	0 (0)	500.0 (1.6)	1.0 (3.0)	0 (0)	400.0 (1.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0
Southern pine	+	0 (0)	0 (0)	0 (0)	400.0 (1.2)	1.2 (3.8)	0 (0)	1.2 (3.5)	600.0 (1.7)	300.0 (1.0)	1.7 (2.6)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Acenaphthene concentration (ppb) ^a											
		High organic matter soil						Low organic matter soil					
Species	Creosote	76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	45.1 (33.9)	16.7 (10.3)	14.9 (12.0)	15.8 (15.5)	33.4 (30.6)	36.1 (35.5)	300.0 (1.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	25.3	28.6	32.0	24.0	18.3	31.8	0	0	0	0	0	1.7
Southern pine	+	29.9 (18.6)	22.3 (12.9)	15.5 (8.1)	22.0 (36.5)	10.1 (8.1)	7.6 (4.4)	56.6 (76.2)	26.3 (42.4)	15.8 (20.0)	58.7 (63.6)	6.2 (4.5)	6.7 (6.1)
	-	25.3	28.6	32.0	24.0	18.3	31.8	0	0	0	0	0	1.7

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S2 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 12 months in soil barrel mesocosms.

		Fluorene concentration (ppb) ^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	24.1 (19.2)	8.5 (5.8)	8.0 (7.5)	9.1 (12.9)	15.1 (12.8)	16.4 (13.6)	300.0 (1.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	12.7	18.5	14.1	13.9	9.6	17.1	0	0	0	0	0	0	0
Southern pine	+	17.4 (9.5)	13.5 (8.5)	7.6 (4.6)	6.1 (6.3)	16.1 (25.1)	3.9 (4.2)	20.9 (27.0)	7.3 (10.3)	6.6 (8.1)	21.8 (22.5)	3.4 (3.7)	3.1 (2.6)	
	-	12.7	18.5	14.1	13.9	9.6	17.1	0	0	0	0	0	0	

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Phenanthrene concentration (ppb) ^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	37.3 (29.9)	15.8 (12.7)	20.8 (17.3)	34.7 (61.9)	20.1 (8.0)	26.4 (10.5)	3.5 (6.9)	0 (0)	2.1 (2.7)	1.6 (3.3)	600.0 (2.0)	0 (0)	
	-	26.8	32.7	33.0	36.2	30.1	35.6	0	0	0	0	0	0	
Southern pine	+	23.2 (11.8)	45.2 (42.9)	19.3 (9.6)	16.6 (17.0)	53.0 (93.4)	7.9 (8.7)	78.5 (103.0)	28.2 (36.9)	23.8 (25.9)	68.6 (73.4)	9.1 (5.6)	17.8 (16.0)	
	-	26.8	32.7	33.0	36.2	30.1	35.6	0	0	0	0	0	0	

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Anthracene (ppb) ^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	11.9 (13.3)	3.3 (2.8)	10.0 (9.3)	22.1 (62.5)	1.5 (2.6)	6.9 (6.5)	0 (0)	0 (0)	1.6 (2.5)	0 (0)	0 (0)	0 (0)	0 (0)
	-	4.3	6.3	4.9	6.2	6.1	8.0	0	0	0	0	0	0	0
Southern pine	+	17.1 (19.2)	33.0 (42.8)	12.4 (8.5)	13.9 (19.6)	52.9 (105.5)	4.2 (6.8)	47.6 (60.6)	14.4 (23.1)	15.5 (17.5)	22.4 (17.6)	5.7 (8.5)	7.3 (9.6)	
	-	4.3	6.3	4.9	6.2	6.1	8.0	0	0	0	0	0	0	

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Fluoranthene concentration (ppb) ^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	24.1 (24.2)	10.9 (10.2)	31.7 (49.1)	41.2 (94.1)	10.3 (4.8)	23.7 (16.1)	6.9 (7.3)	0 (0)	2.6 (3.6)	4.4 (6.6)	1.3 (2.7)	0 (0)	
	-	36.6	18.5	28.6	27.7	22.5	14.2	0	0	0	0	0	0	
Southern pine	+	4.0 (4.2)	15.8 (11.6)	7.5 (4.2)	30.4 (51.3)	48.8 (103.5)	3.3 (5.4)	85.0 (88.3)	28.9 (37.9)	25.6 (23.6)	60.8 (51.2)	7.5 (5.2)	18.5 (14.8)	
	-	36.6	18.5	28.6	27.7	22.5	14.2	0	0	0	0	0	0	

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Pyrene (ppb) ^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	20.4 (21.0)	6.3 (5.7)	21.8 (35.8)	29.5 (58.5)	8.1 (5.4)	15.5 (16.1)	8.2 (8.3)	0 (0)	1.8 (3.0)	5.5 (8.4)	1.2 (2.4)	0 (0)	
	-	31.0	12.3	17.5	18.7	19.7	8.6	0	0	0	0	0	0	
Southern pine	+	7.4 (8.3)	22.3 (29.0)	7.5 (4.3)	108.4 (208.8)	113.2 (243.7)	6.3 (9.1)	84.4 (69.2)	24.3 (32.2)	20.8 (19.4)	56.1 (37.7)	6.6 (5.1)	14.1 (11.1)	
	-	31.0	12.3	17.5	18.7	19.7	8.6	0	0	0	0	0	0	

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S2 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 12 months in soil barrel mesocosms.

		Benzo[g,h,i] concentration (ppb)^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	0 (0)	0 (0)	0 (0)	26.3 (80.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern pine	+	0 (0)	15.3 (47.1)	0 (0)	13.8 (42.1)	45.9 (103.5)	0 (0)	8.0 (13.2)	2.0 (6.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Indeno[1,2,3-cd] pyrene concentration (ppb)^a												
Species	Creosote	High organic matter soil						Low organic matter soil						
		76 mm away			150 mm away			76 mm away			150 mm away			
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	
Douglas-fir	+	0 (0)	0 (0)	4.4 (0)	26.3 (80.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern pine	+	0 (0)	15.3 (47.1)	0 (0)	13.8 (42.1)	78.6 (178.4)	0 (0)	31.3 (46.0)	11.7 (19.9)	4.1 (8.5)	12.0 (15.0)	0 (0)	0 (0)	0 (0)
	-	0	0	0	0	0	0	0	0	0	0	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S3. Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 32 months in soil barrel mesocosms.

		Naphthalene concentration (ppb)^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	3.6 (4.2)	10.6 (14.9)	30.2 (84.4)	0 (0)	0.2 (0.6)	5.8 (6.1)	3.3 (2)	7.3 (8.1)	2.9 (2.2)	1.3 (2)	1.5 (1.8)	1.5 (1.9)
	-	4.1	18.3	31.3	9.2	3.4	23.3	3.1	3	2.8	0	0	0.8
Southern pine	+	5.5 (4)	6.1 (3.9)	2.8 (2.7)	7.1 (11.2)	13.3 (22)	5.5 (5.2)	0.8 (1.3)	0 (0.1)	1.4 (2)	3.9 (3.8)	0.6 (1.2)	3.2 (3.1)
	-	4.1	18.3	31.3	9.2	3.4	23.3	3.1	3	2.8	0	0	0.8

		Acenaphthylene concentration (ppb)^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	0 (0)	0.3 (0.8)	0 (0)	0 (0)	0 (0)	0 (0)	0.1 (0.3)	0.2 (0.6)	0 (0)	0 (0)	0 (0)	0 (0)
	-	0	6.3	4.1	0.7	0	1.9	0	0	0	0	0	0
Southern pine	+	0.6 (0.9)	0.2 (0.6)	0.1 (0.2)	0.4 (0.9)	1.9 (3)	0 (0)	0 (0)	0 (0.1)	0 (0)	2.1 (2.6)	0 (0)	0.1 (0.3)
	-	0	6.3	4.1	0.7	0	1.9	0	0	0	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S3 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 32 months in soil barrel mesocosms.

		Acenaphthene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	197.8 (240.2)	109.7 (81)	41.3 (42.2)	20.3 (16.2)	16.2 (12.9)	17 (7.9)	43.8 (68.7)	31.8 (52.9)	5.5 (8)	0 (0)	0 (0)	18.9 (25.3)
	-	0	319.9	296.9	31.3	0	124.6	0	0	21.5	0	0	0
Southern pine	+	59.6 (83.9)	109.5 (135.3)	13.3 (12.8)	27.1 (57)	94.6 (144.3)	9.6 (7)	5.1 (6.9)	20.1 (16.2)	5.6 (14.4)	23.1 (32.7)	0 (0)	1.3 (2.5)
	-	0	319.9	296.9	31.3	0	124.6	0	0	21.5	0	0	0

		Fluorene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	8.9 (7.9)	8.4 (10)	12.3 (20.6)	119.3 (275.4)	1.2 (2.9)	0.1 (0.2)	33 (43.9)	24.1 (19.6)	48.4 (65.8)	8.5 (11.6)	11.7 (13)	34.3 (41.8)
	-	1.3	9.5	3.8	115.5	2.1	9.4	4.6	1.6	11.2	64.2	0	6.2
Southern pine	+	12.3 (5)	12.3 (5.5)	31.5 (20.8)	16.7 (21.5)	38.6 (45.5)	84.6 (127.7)	28.5 (17.3)	49 (38.3)	11.2 (14.7)	31.6 (36.3)	1 (2.2)	6.9 (7.2)
	-	1.3	9.5	3.8	115.5	2.1	9.4	4.6	1.6	11.2	64.2	0	6.2

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Phenanthrene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	36.7 (29.7)	20.7 (43.5)	122 (233.9)	24.4 (59.8)	0.2 (0.6)	9.8 (21.6)	237.1 (403.7)	108.2 (197.5)	97.7 (141.8)	1.4 (3.6)	16.4 (28.6)	0.3 (0.6)
	-	0.3	61.7	48.6	61.8	1.9	6.6	1.1	8.1	62.4	0	0	0
Southern pine	+	19.6 (15.8)	16.4 (5)	47.6 (56.4)	13 (10)	124.5 (178.4)	38.6 (53.3)	6.8 (4.4)	238.3 (329.6)	329.5 (377)	12.8 (9.4)	0.3 (0.6)	7.2 (8.2)
	-	0.3	61.7	48.6	61.8	1.9	6.6	1.1	8.1	62.4	0	0	0

		Anthracene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	16.8 (9.9)	17.7 (10)	48.5 (95.9)	24.4 (59.8)	0.2 (0.6)	9.8 (21.6)	13.8 (9.2)	18.3 (15.9)	11.9 (8.1)	1.4 (3.6)	16.4 (28.6)	0.3 (0.6)
	-	16.6	43.6	39.8	33.4	13.4	23.3	18.4	16.9	2.8	284.7	6.5	0.8
Southern pine	+	21 (13.5)	13.4 (10.1)	14 (9.4)	15 (9.4)	23 (22.1)	14.1 (11)	9.7 (5.6)	1.8 (3.1)	5.8 (7.9)	12.8 (9.9)	5.4 (4.1)	10.1 (7.6)
	-	16.6	43.6	39.8	33.4	13.4	23.3	18.4	16.9	2.8	284.7	6.5	0.8

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Fluoranthene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	8.9 (7.9)	8.4 (10)	12.3 (20.6)	119.3 (275.4)	1.2 (2.9)	0.1 (0.2)	33 (43.9)	24.1 (19.6)	48.4 (65.8)	8.5 (11.6)	11.7 (13)	34.3 (41.8)
	-	1.3	9.5	3.8	115.5	2.1	9.4	4.6	1.6	11.2	64.2	0	6.2
Southern pine	+	12.3 (5)	12.3 (5.5)	31.5 (20.8)	16.7 (21.5)	38.6 (45.5)	84.6 (127.7)	28.5 (17.3)	49 (38.3)	11.2 (14.7)	31.6 (36.3)	1 (2.2)	6.9 (7.2)
	-	1.3	9.5	3.8	115.5	2.1	9.4	4.6	1.6	11.2	64.2	0	6.2

Table S3 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 32 months in soil barrel mesocosms.

		Pyrene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	7.1 (6.1)	3.4 (3.2)	8.3 (13.6)	84.1 (191.9)	1.7 (3.4)	1.4 (3.8)	17.9 (15.3)	14.9 (10.7)	36.7 (55.6)	6.2 (8.2)	8.7 (10.6)	12.1 (13.8)
	-	0.2	4.5	3.2	97.2	0.6	1.7	2.6	0	6.4	0	0	0
Southern pine	+	11.7 (4.8)	7 (4.4)	22.3 (16)	14.8 (20.9)	24.8 (30)	63.9 (95.2)	41.6 (18.7)	41.1 (42.5)	10.9 (11.7)	45.8 (55.7)	0.6 (1.6)	4.8 (5.2)
	-	0.2	4.5	3.2	97.2	0.6	1.7	2.6	0	6.4	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Benz[<i>a</i>] anthracene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	33.5 (59.5)	6.2 (10.9)	3.9 (6.3)	17.3 (34.6)	0.8 (1.3)	1.2 (1.4)	4.5 (3.1)	7.1 (3)	92.9 (167.5)	3.6 (3.5)	14.4 (34.8)	1.6 (2)
	-	1.8	3.7	41.2	46.8	2.5	0	3.1	1.4	3.8	0	0	0
Southern pine	+	15.8 (6.6)	11.1 (6.5)	21.8 (16.2)	4.7 (6.2)	104.4 (155.7)	190.5 (297.7)	9.8 (3.2)	7.9 (10.4)	62.1 (142.3)	12.9 (12.9)	1.7 (2)	3.6 (2.5)
	-	1.8	3.7	41.2	46.8	2.5	0	3.1	1.4	3.8	0	0	0

		Chrysene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	50.9 (54.4)	36.4 (58.9)	16.1 (18)	51.4 (82.5)	6.7 (6.1)	6.5 (4.8)	12.5 (13.9)	21.5 (15.3)	83.6 (157.8)	5.3 (6.1)	53.6 (133.6)	3 (4.4)
	-	0.2	16.5	40.8	139.1	4.5	0.5	0.3	0	12.9	0	0	0
Southern pine	+	64.2 (33.8)	66.3 (44)	104.3 (71.9)	14.9 (19.9)	140.7 (159.8)	281.3 (386.9)	36.2 (20.1)	28 (14.6)	98.6 (139.1)	22.5 (22.5)	8.5 (7.4)	7.6 (7.5)
	-	0.2	16.5	40.8	139.1	4.5	0.5	0.3	0	12.9	0	0	0

^aValues are means of three replicate samples with one standard deviation in parentheses.

		Benzo[<i>b</i>] and [<i>k</i>] fluoranthene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	0.9 (1.8)	0 (0)	9.8 (17.2)	18.1 (31.9)	0 (0)	0 (0)	2.2 (1.8)	3.1 (2.7)	19.3 (22.2)	0.1 (0.2)	5.7 (11.7)	0.2 (0.3)
	-	0.4	0.5	17.3	61.7	0.3	0	0.6	0.5	9.4	0	0	0
Southern pine	+	20.1 (16)	19.3 (11)	31.9 (17.6)	0.3 (0.2)	27.4 (24.5)	58.9 (61.3)	0.4 (0.7)	24.7 (26.2)	26 (23.5)	26 (24.7)	0 (0.1)	1.2 (1.3)
	-	0.4	0.5	17.3	61.7	0.3	0	0.6	0.5	9.4	0	0	0

		Benzo[<i>a</i>] pyrene concentration (ppb) ^a											
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	1.3 (1.6)	1.6 (3.2)	3.5 (5.1)	4.7 (11.5)	0 (0)	0.4 (1)	1.4 (0.8)	2.3 (0.8)	8.1 (11.6)	0.4 (0.6)	3 (7.1)	0.9 (1.3)
	-	1.6	2.4	14.5	29.7	1.3	0.1	2.3	2	3.7	0	0	0.1
Southern pine	+	14.7 (6.7)	7.2 (5)	13.3 (9.8)	1.2 (0.7)	10.6 (13.1)	24 (33.3)	1.7 (2.7)	7.8 (11.2)	12.1 (13.4)	10.9 (12.5)	0.2 (0.5)	1.9 (2.3)
	-	1.6	2.4	14.5	29.7	1.3	0.1	2.3	2	3.7	0	0	0.1

^aValues are means of three replicate samples with one standard deviation in parentheses.

Table S3 (continued). Concentration of PAHs found in soil around southern pine and Douglas-fir posts after 32 months in soil barrel mesocosms.

Dibenz[a,h] anthracene concentration (ppb)^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	36.4 (19.9)	48.1 (35)	38.9 (6.5)	34 (11.9)	35.3 (7.2)	36.5 (8.7)	34 (11.9)	35.3 (7.2)	36.5 (8.7)	34.7 (10.4)	37.5 (5.4)	41.3 (16.1)
	-	36.4	8.3	10.3	65.9	29.1	31.1	51.3	45.6	41	1178.7	33.8	32.9
Southern pine	+	43.2 (24.3)	34.2 (11.5)	41.2 (10.2)	42.8 (13.3)	34.3 (7.5)	31.7 (9.8)	40.2 (12.6)	32.1 (6)	36.6 (6.5)	37 (9.4)	30.7 (5.6)	30.3 (13.5)
	-	36.4	8.3	10.3	65.9	29.1	31.1	51.3	45.6	41	1178.7	33.8	32.9

Benzo[g,h,i] concentration (ppb)^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	2 (4)	1.5 (2.6)	2.9 (4.6)	9 (14.5)	0 (0)	0 (0)	7.1 (4.7)	6.9 (3.8)	9.8 (7.1)	2.4 (3.4)	2.1 (0.3)	5.7 (6.8)
	-	9.1	10	9.3	32.8	7.3	1.8	12.8	11.4	2.3	0	0	1.9
Southern pine	+	18.2 (7.5)	5 (3.4)	14.2 (10.9)	7.3 (3.3)	6.4 (8.7)	12.5 (12.9)	7 (5.6)	5.5 (7.2)	9.2 (7.9)	10.4 (7)	5.3 (7.5)	6 (4.4)
	-	9.1	10	9.3	32.8	7.3	1.8	12.8	11.4	2.3	0	0	1.9

^aValues are means of three replicate samples with one standard deviation in parentheses.

Indeno[1,2,3-cd] pyrene concentration (ppb)^a													
Species	Creosote	High organic matter soil						Low organic matter soil					
		76 mm away			150 mm away			76 mm away			150 mm away		
		0-15 mm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Douglas-fir	+	4.4 (3.2)	6.6 (7.8)	6.8 (5.7)	12.4 (17)	2.3 (0.6)	2.4 (0.5)	7.7 (3.2)	7.9 (2)	10.7 (5.5)	4 (2)	7.1 (1)	7.7 (5.3)
	-	8.5	9.4	12.4	27.7	6.8	5.9	12	10.7	7.8	82.5	2.4	6.2
Southern pine	+	18.7 (8.3)	8 (2.7)	14.6 (10.4)	9.3 (2.3)	9.7 (7.6)	14.8 (14.8)	6.2 (4)	9.9 (10.6)	10 (6.2)	12.3 (5.7)	7.6 (6.1)	6.8 (3.3)
	-	8.5	9.4	12.4	27.7	6.8	5.9	12	10.7	7.8	82.5	2.4	6.2

^aValues are means of three replicate samples with one standard deviation in parentheses.