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science for a changing world

Causes of Increasing Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in U.S. Lakes

U.S. Department of the Interior
U.S. Geological Survey

PAHs are increasing in urban lakes

Van Metre et al., Environ. Sci. Technol., 2005

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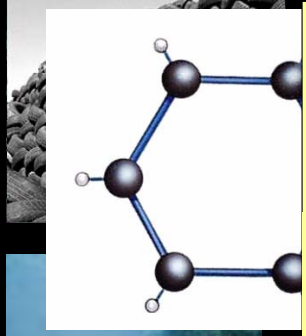
What are polycyclic aromatic hydrocarbons (PAHs)?



Benzo(a)pyrene

Naphthalene

Pyrene

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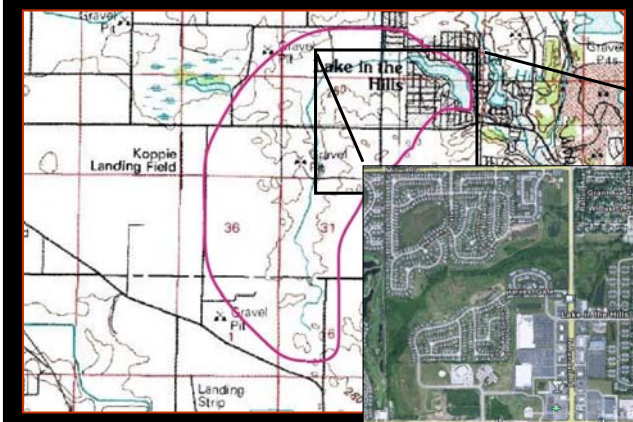
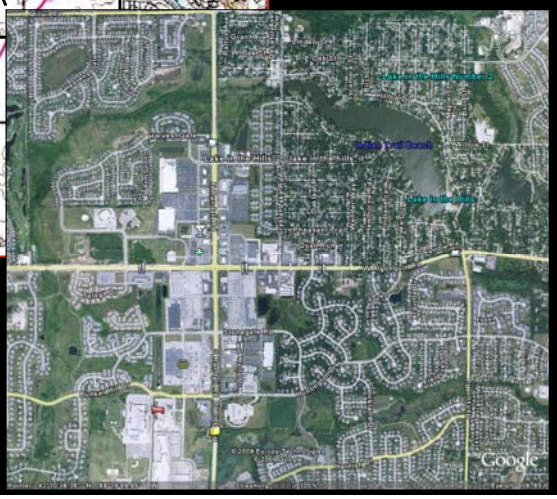
Lake in the Hills, near Chicago



In 1975, 11% urban



In 2000, 78% urban

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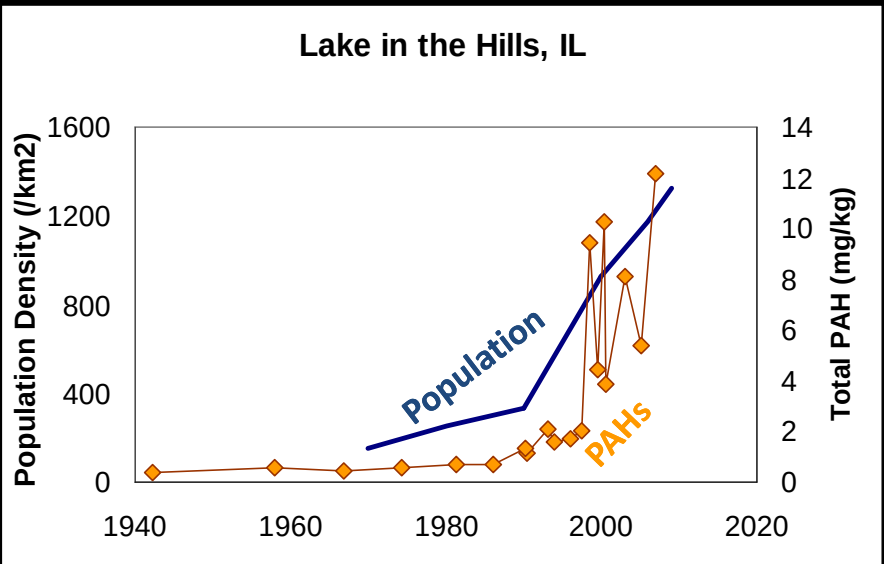
Population and PAH in lake sediment



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City of Austin measures PAH concentrations greater than 1,500 mg/kg

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What could be the source?

1,500 mg/kg in creek sediment

• Fresh asphalt	1.5
• Weathered asphalt	3
• Fresh motor oil	4
• Brake particles	16
• Road dust	24
• Tire-wear particles	86
• Diesel engine emissions	102
• Gasoline engine emissions	370
• Used motor oil	440

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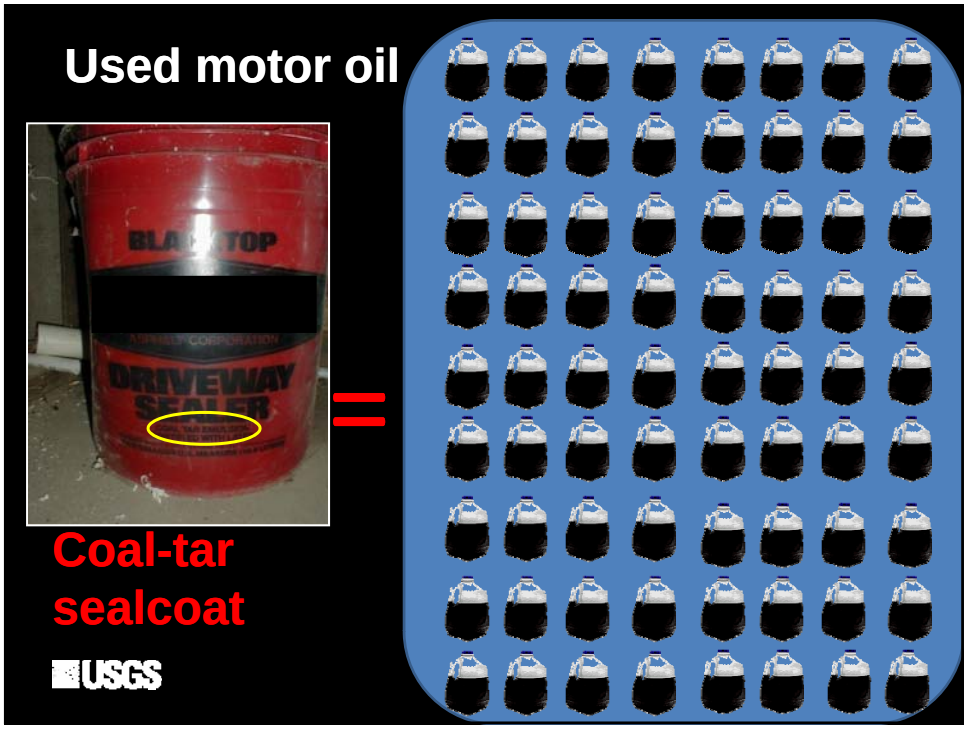
Pavement Sealcoat

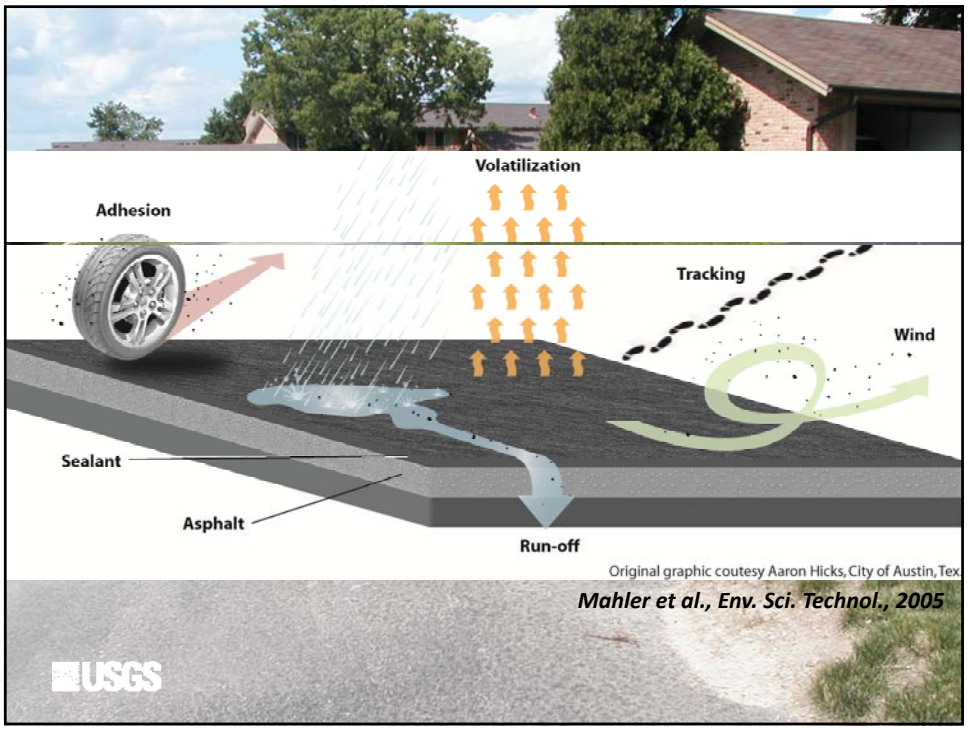
Asphalt-based

50

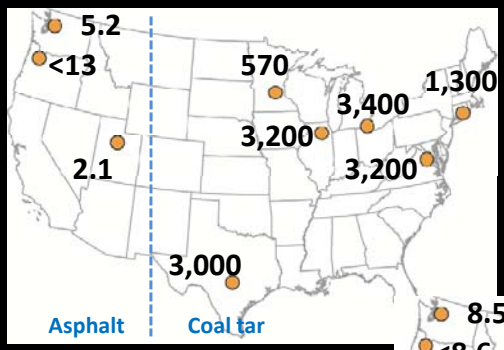
Coal-tar-based

100,000


Used motor oil
DRIVEWAY
SEALER
=
Coal-tar sealcoat
USGS

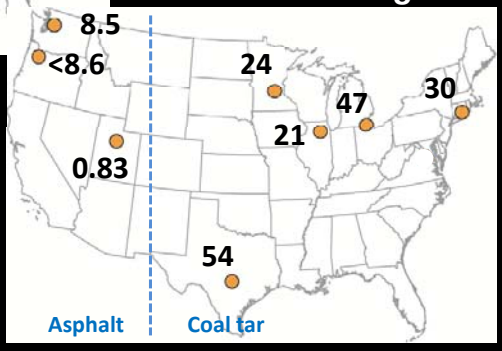

Volatilization
Adhesion
Tracking
Wind
Sealant
Asphalt
Run-off
Original graphic coutesy Aaron Hicks, City of Austin, Tex
Mahler et al., Env. Sci. Technol., 2005
USGS

Sealed Parking Lots (mg/kg)



Van Metre et al., Environ. Sci. Technol., 2009

Unsealed Parking Lots



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What's causing upward trends in PAHs?

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Environmental forensics: PAH "fingerprints"

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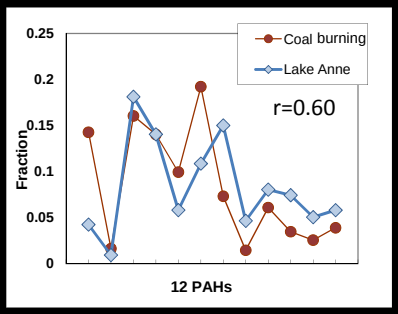
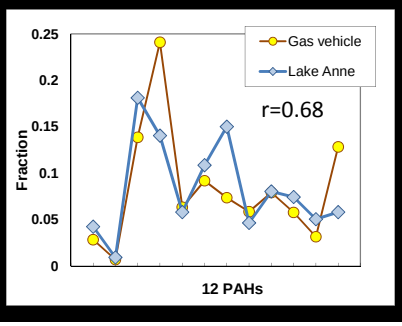
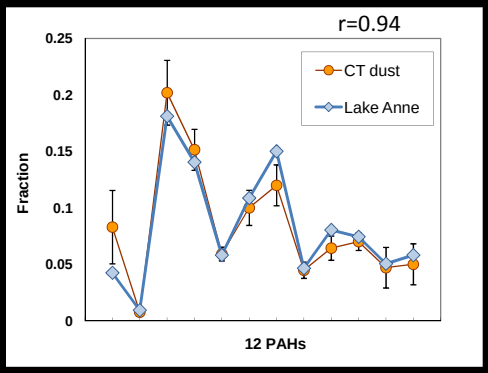
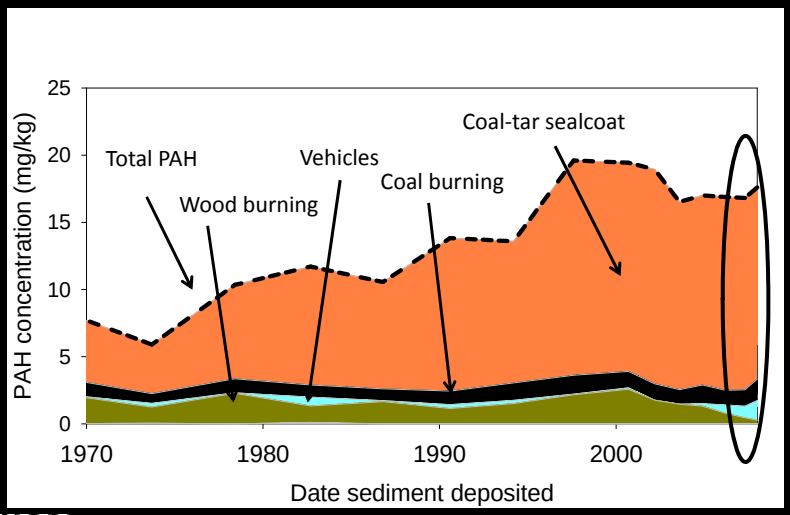
PAH fingerprints and Lake Anne sediment







Sources of PAHs to Sediment in Lake Anne Reston, VA



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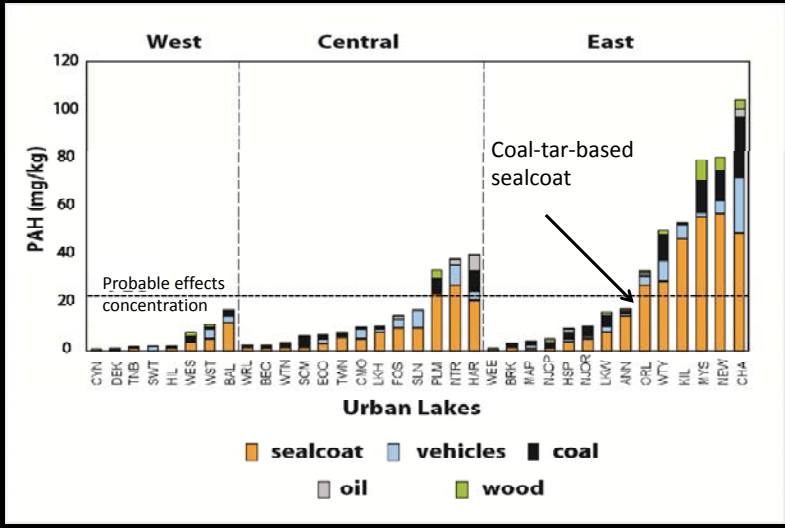
PAH sources to U.S. urban lakes



Van Metre and Mahler, Sci. Total Environ., 2010

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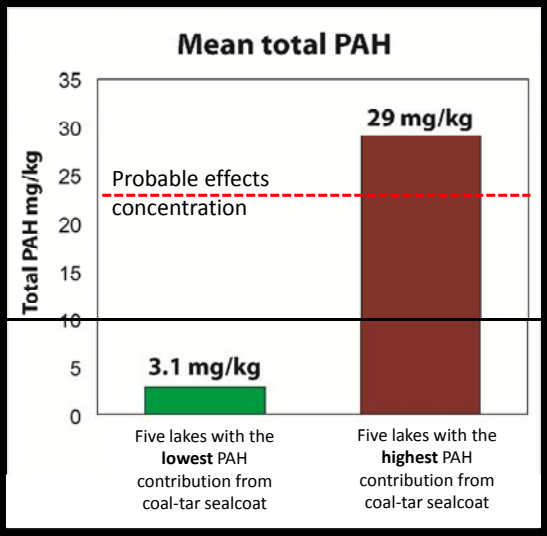
Without coal-tar-based sealcoat, the urban PAH baseline is low



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Biological effects

Bommarito et al., 2010, Ecotoxicology
Bommarito et al., 2010, Chemosphere
Bryer et al., 2009, Environ. Poll.
Bryer et al., 2006, Ecotoxicology
Scoggins et al., 2006, J. NABS

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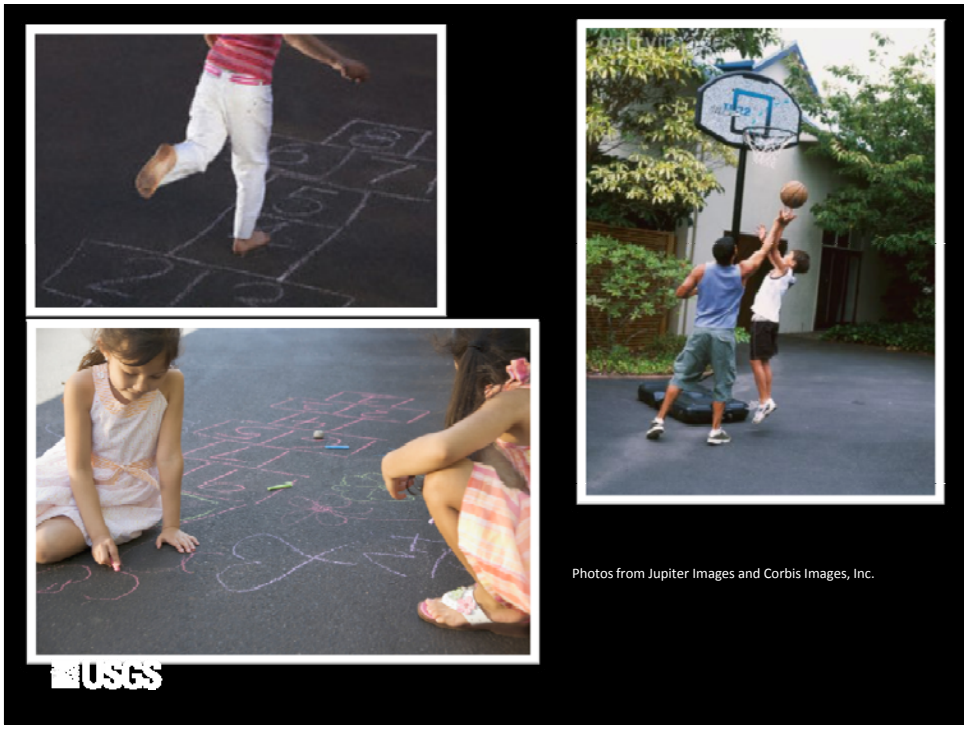
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Photos from Jupiter Images and Corbis Images, Inc.


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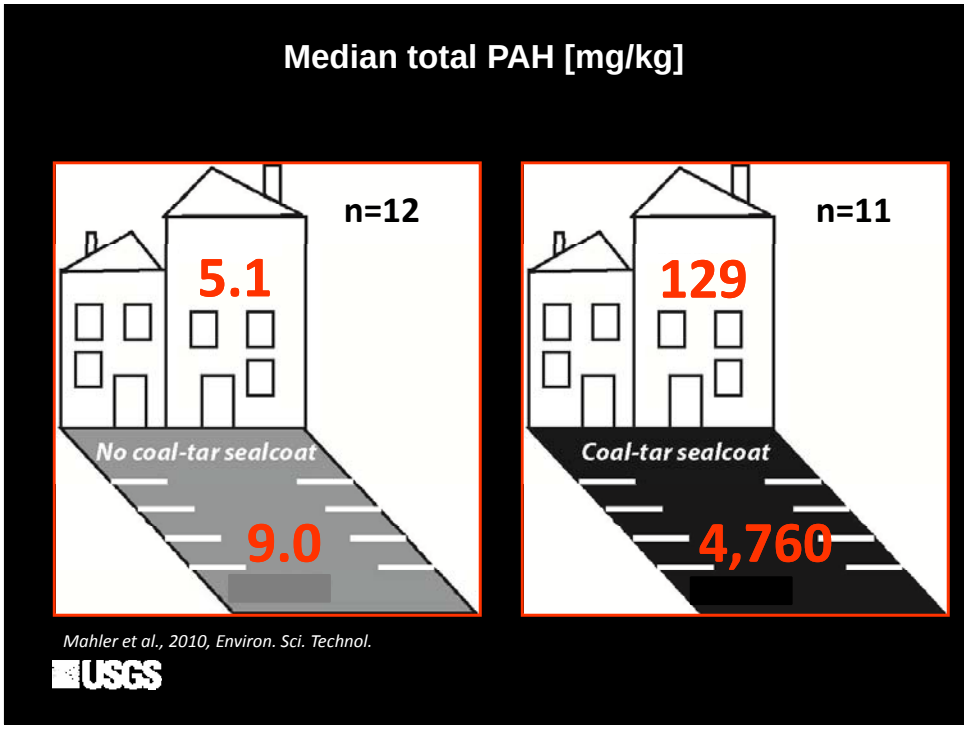
Median total PAH [mg/kg]
n=12
5.1
No coal-tar sealcoat
9.0
n=11
129
Coal-tar sealcoat
4,760
Mahler et al., 2010, Environ. Sci. Technol.
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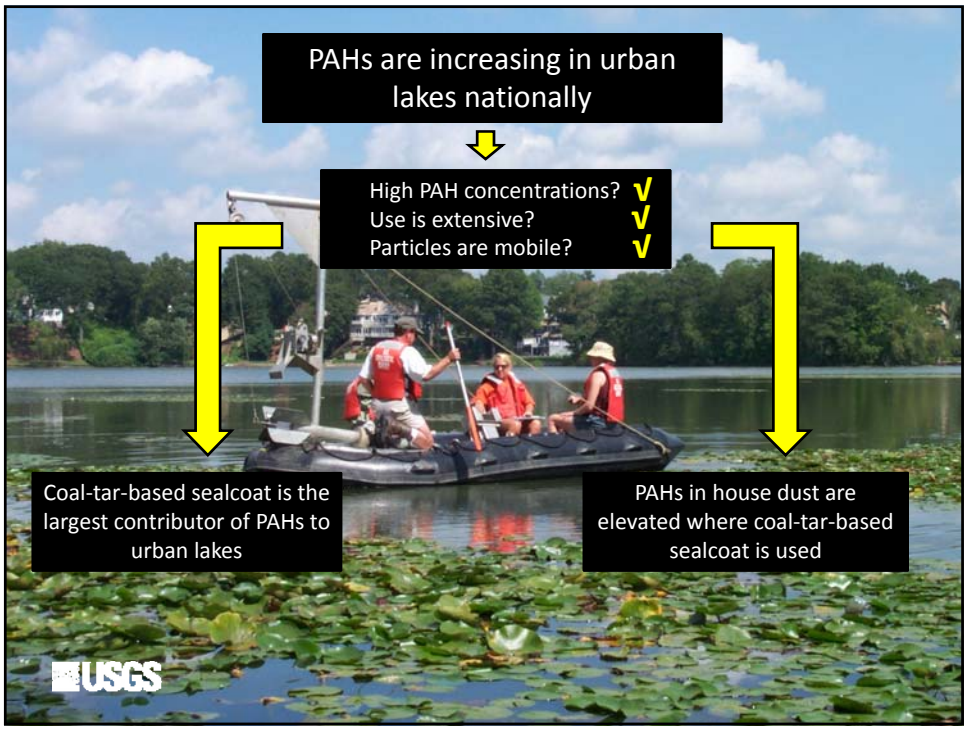
PAHs are increasing in urban lakes nationally
High PAH concentrations? √
Use is extensive? √
Particles are mobile? √
Coal-tar-based sealcoat is the largest contributor of PAHs to urban lakes
PAHs in house dust are elevated where coal-tar-based sealcoat is used
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http://tx.usgs.gov/coring/allthingssealcoat.html

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USGS publications on sealcoat and PAHs in peer-reviewed journals

Van Metre, P. C.; Mahler, B. J., 2010, Contribution of PAHs from Coal-Tar Pavement Sealcoat and Other Sources to 40 U.S. Lakes. Sci. Total Environ., v. 409, 334-344.

Mahler, B. J.; Van Metre, P. C.; Wilson, J. T.; Musgrove, M.; Burbank, T. L.; Ennis, T.; Bashara, T. J., 2010, Coal-tar-based parking lot sealcoat: An unrecognized source of PAH to settled house dust. Environ. Sci. Technol., v. 44, 894-900.

Yang, Y., Van Metre, P.C., Mahler, B.J., Wilson, J.T., Ligouis, B., Razzaque, M.M., Schaeffer, D.J., and Werth, C.J., 2010, Influence of coal-tar sealcoat and other carbonaceous materials on polycyclic aromatic hydrocarbon loading in an urban watershed. Environ. Sci. Technol., v. 44, p. 1217-1223.

Van Metre, P. C.; Mahler, B. J.; Wilson, J., 2009, PAHs underfoot: Contaminated dust from sealcoated pavements. Environ. Sci. Technol., v. 43, 20-25.

Van Metre, P.C., and Mahler, B.J., 2005, Trends in Hydrophobic Organic Contaminants in Lake Sediments Across the United States, 1970-2001. Environ. Sci. Technol., v. 39, p. 5567-5574.

Mahler, B. J.; Van Metre, P. C.; Bashara, T. J.; Wilson, J. T.; Johns, D. A., 2005, Parking lot sealcoat: An unrecognized source of urban PAHs. Environ. Sci. Technol., v. 39, 5560-5566.

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How do some sources compare? Milligrams of PAH in:

- One storm on a CT sealed driveway **56 mg**
  (Mahler et al., 2005)
- One storm on a CT sealed driveway **174 mg**
  (Watts et al., 2011)
- Driving 12,000 miles (tail pipe) **56 mg**
  (Bergvall and Westerholm, 2009)
- Driving 23,000 miles (tire wear) **56 mg**
  (Aatmeeyata, 2010)
- One storm on an unsealed driveway **0.86 mg**
  (Mahler et al., 2005)

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