

# Watershed-Based Sources of Polycyclic Aromatic Hydrocarbons (PAHs) to the Greater Los Angeles Coastal Region

Liesl L. Tiefenthaler and Dr. Eric D. Stein

*Southern California Coastal Water Research Project*

[www.sccwrp.org](http://www.sccwrp.org)



# Why is Stormwater a Serious Issue?

- ◆ Storm water (and dry weather urban runoff) are potentially major sources of pollutants.
- ◆ Runoff can result in detrimental effects in terms of:
  - Human and ecological health
  - Economics, safety, and aesthetics
- ◆ Regulatory requirements to manage storm water and dry season runoff.
  - MS4, TMDL, NPDES, NPS

# So what's going on??

- ◆ **Difficult to understand and predict all the many influencing factors that effect storm water.**
  - **Highly variable concentrations**
  - **Many sources**
  - **Obviously very complex process!**
- ◆ **Effective management requires tools to increase our understanding.**
  - **Monitoring**
  - **Source characterization and identification**
  - **Model development**
  - **BMP siting and design**

# Key Questions

- ◆ **What are the long term trends in storm water?**
  - **How have patterns in sources changed over time?**
  - How has the discharge of specific pollutants changed over time?
- ◆ **What are the current “patterns” of storm water loading**
  - What are expected ranges of variability?
  - **How do different land use types contribute to storm water loading?**
  - What processes influence patterns and variability in storm water loading

# PAH Fate: General Concepts

- ◆ **Class of complex organic compounds**
  - Low and High Molecular Weight
- ◆ **Formed from the incomplete burning of organic material**
  - coal, wood, soot, oil and gas
- ◆ **Enter the air and water through**
  - automobile and airplane exhaust
  - industrial and wastewater discharges
  - atmospheric deposition, urban runoff

# Why are PAHs Important?

- ◆ **Persistent bioaccumulative compounds**
  - carcinogenic and mutagenic
- ◆ **Associated largely with particulates**
  - Hydrophobic / low solubilities
- ◆ **Cumulative impacts of chronic pollution from non-point sources**  
**not well-documented** in southern CA

# Summary of Wet Weather Sampling

## 2001 - 2004

| Mass Emission Sites      | Event Rainfall |           |        | Total     |
|--------------------------|----------------|-----------|--------|-----------|
|                          | < 0.5"         | 0.5"-1.0" | > 1.0" |           |
| LAR above Arroyo Seco    |                | 1         |        | 1         |
| Verdugo Wash             |                | 2         |        | 2         |
| LAR at Wardlow           |                |           | 1      | 1         |
| Arroyo Seco              |                | 1         | 1      | 2         |
| Ballona Creek            | 1              | 3         |        | 4         |
| Dominguez Channel        | 1              | 1         |        | 2         |
| Santa Monica Canyon      |                |           | 1      | 1         |
| Open Space Arroyo Sequit |                |           | 1      | 1         |
| <b>Total No. Storms</b>  |                |           |        | <b>14</b> |

# Wet Weather Data Collection

- ◆ Intensive sampling of mass emission sites
- ◆ 10-15 discrete samples collected approx every 30-60 min over the duration of the storm
  - Continuous flow and precipitation
  - TSS, Bacteria, Nutrients, Metals, Pesticides, Organics
- ◆ Data used to create “pollutographs”

# Summary of PAH Data

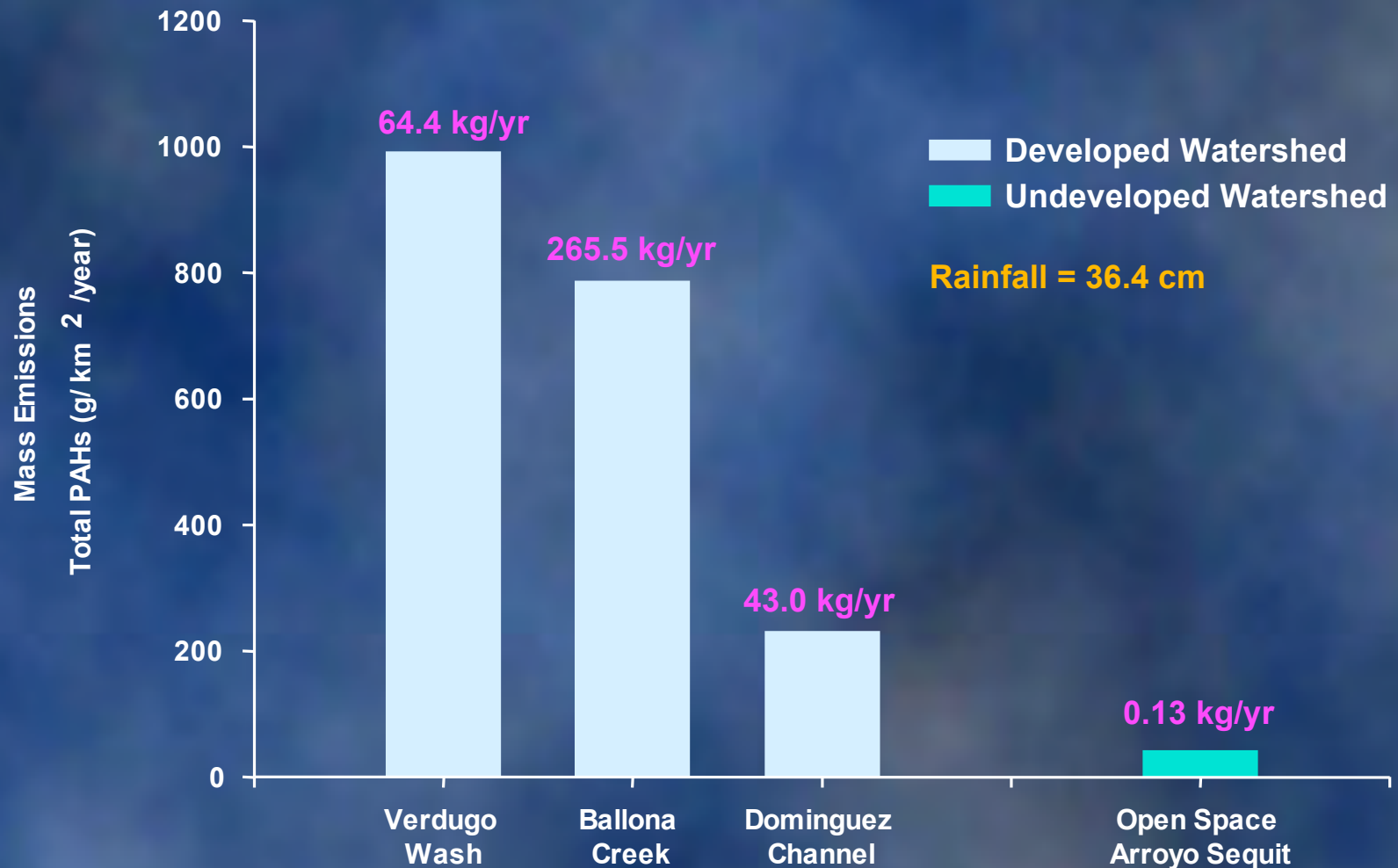
- ◆ **Total PAH and 21 individual PAHs**
- ◆ **9 storms**
  - Feb 2001, April 2001, Nov 2001 (2),  
Mar 2002, May 2003, Oct 2003, Feb 2004 (2)
- ◆ **8 different mass emission sites**
  - Developed watershed (6 sites)
  - Undeveloped watershed (2 sites)
- ◆ **14 total site events**

# Factors Influencing Stormwater PAHs

- ◆ **Developed vs. Undeveloped watersheds**
  - Watershed size ranged from 31 to 2161 km<sup>2</sup>
- ◆ **Rainfall**
  - Ranged from 0.11 to 3.16 inches
- ◆ **Peak Flow**
  - Ranged from 3.0 to 756.7 cms

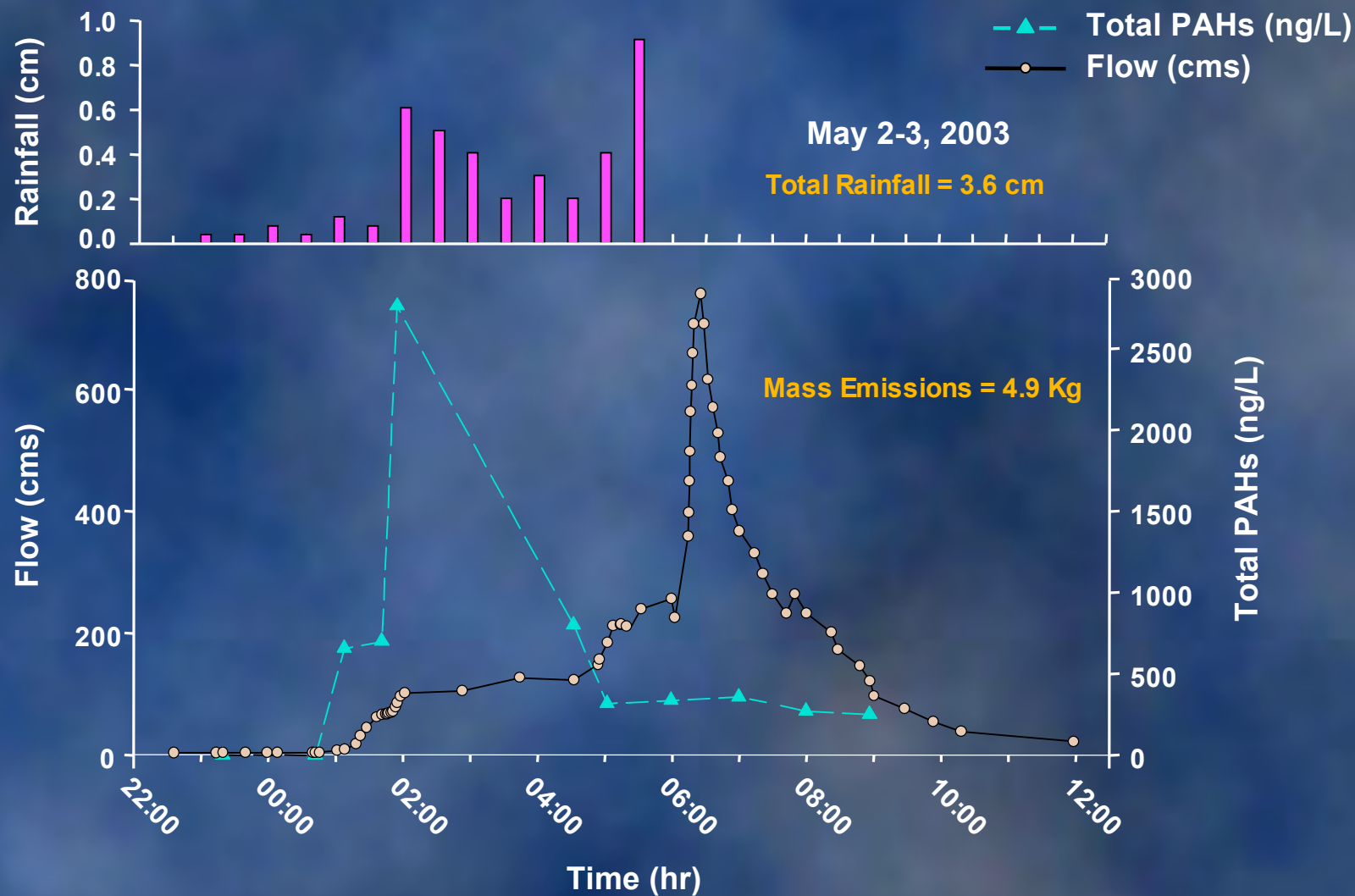
# Distribution of PAHs in Area-Weighted Watersheds

2003 - 2004 Water Year

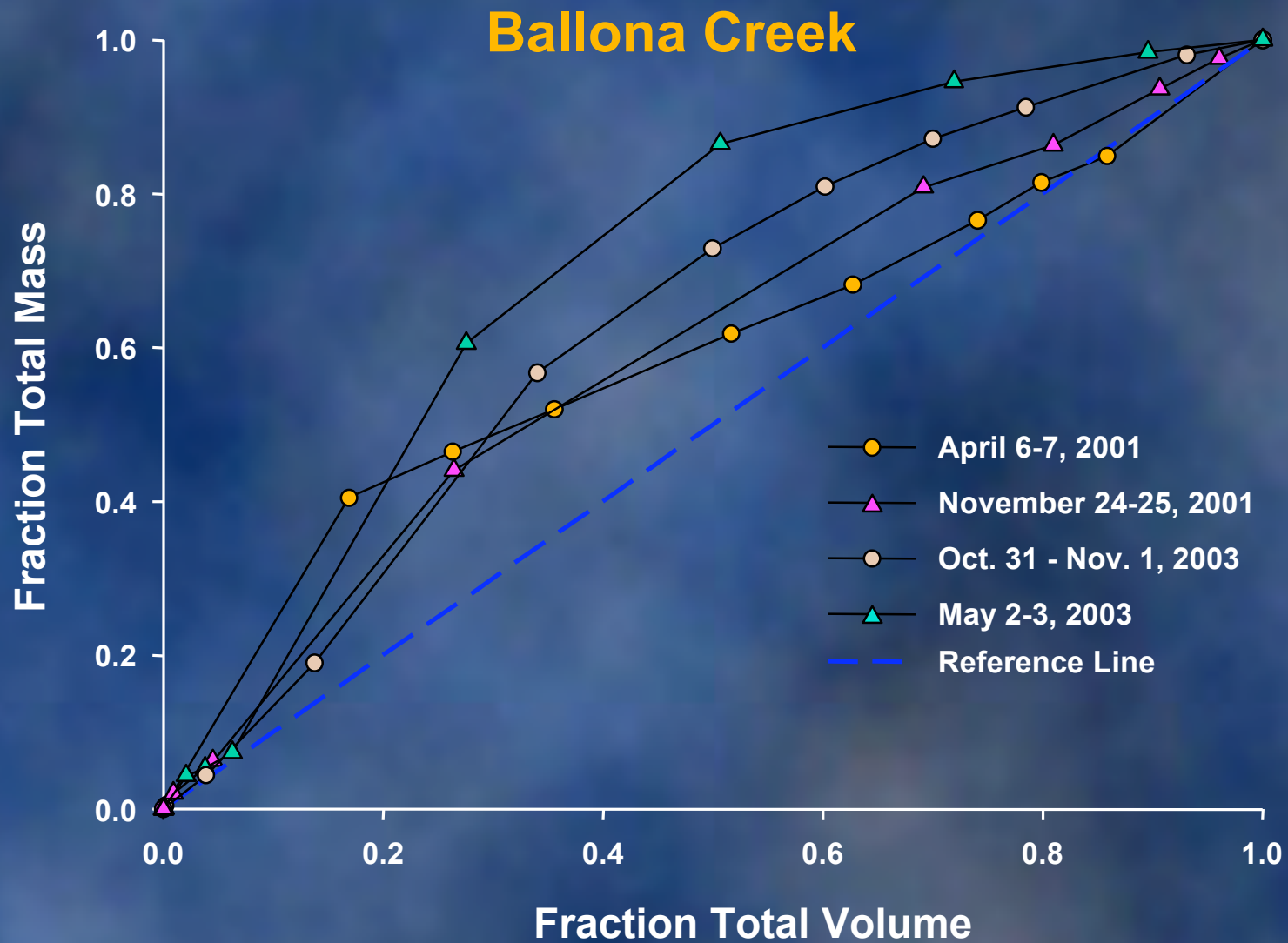


# Within-Storm Variability

## Total PAHs in LA River at Wardlow

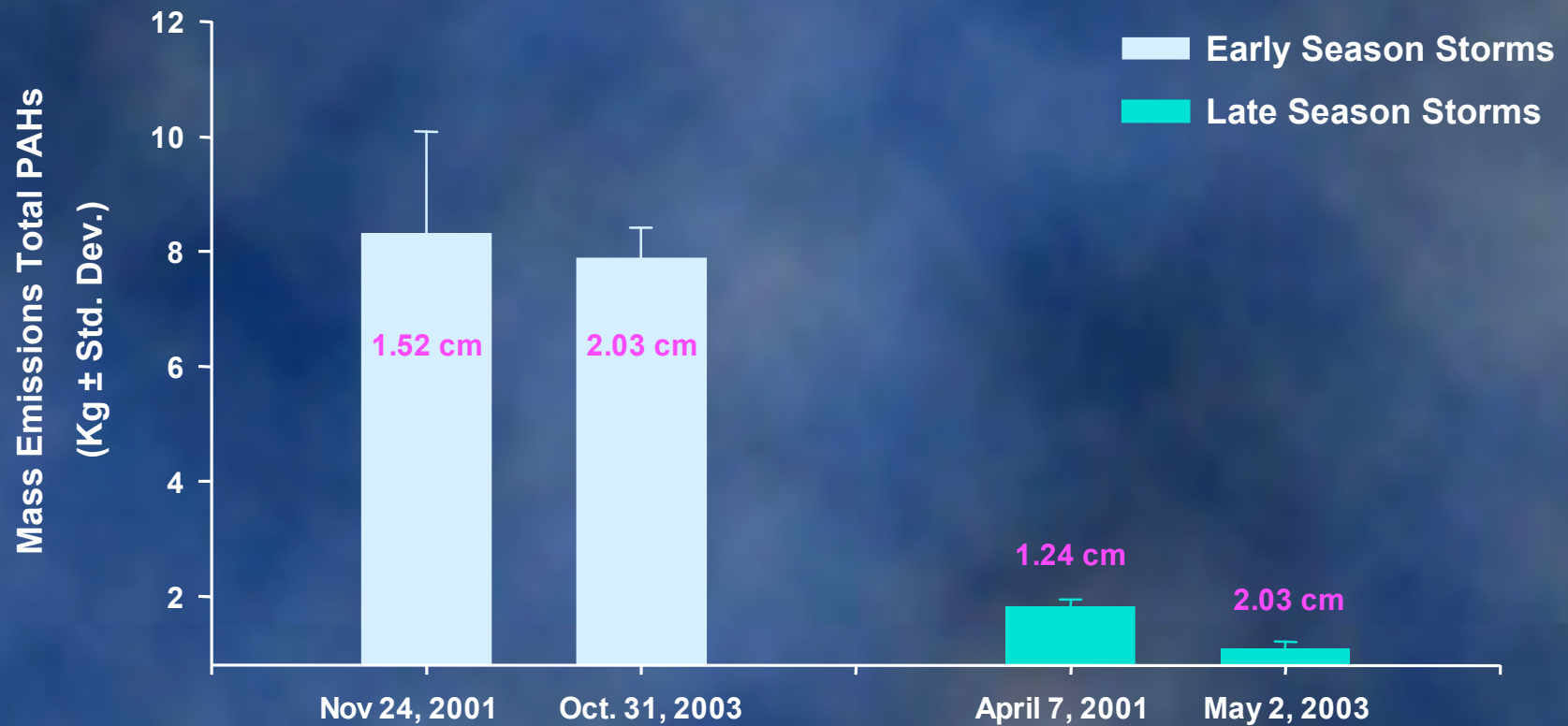


# First Flush of Mass Loading



# Seasonal Flushing

## Ballona Creek Storm Events



# Potential Origins of PAHs

## ◆ “Petrogenic” sources

- **Unburnt petroleum** – asphalt abrasion
- Characterized by LMW compounds
- Methylated derivatives more abundant
- **Phenanthrene / Anthracene (P/A) ratio > 26**  
(Lake *et al.* 1979, Gschwend and Hites 1981)

## ◆ “Pyrogenic” sources

- **Combustion of fossil fuels**
- Characterized by HMW compounds
- Parent compound more abundant
- **Fluoranthene / Pyrene (F/P) ratio < 1.0**  
(Maher and Aislabie, 1992)

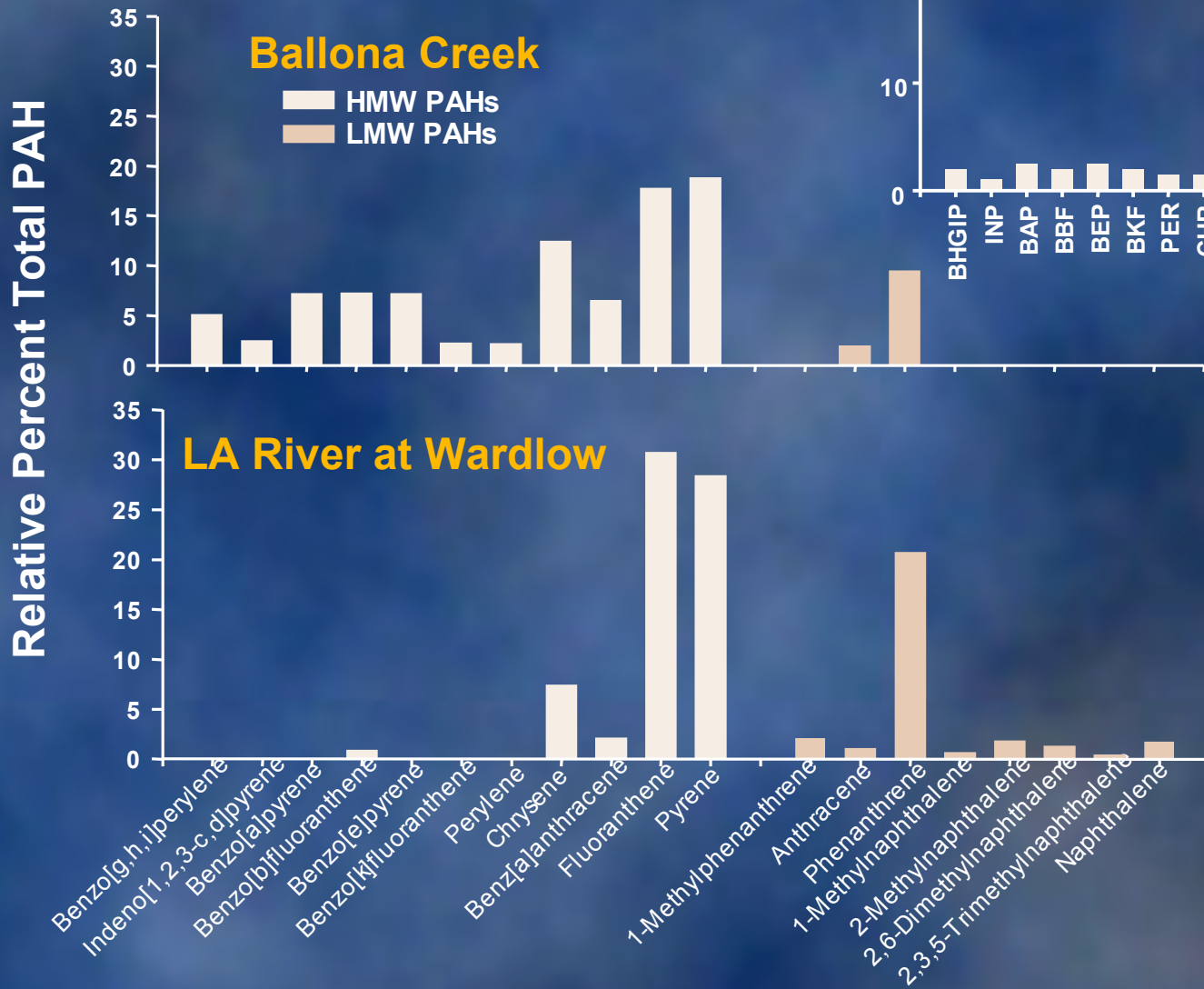
# What Source Information Does this Provide?

|                         | Mass Emission Site               |                                      |  |
|-------------------------|----------------------------------|--------------------------------------|--|
|                         | Ballona<br>Creek<br>May 2-3 2003 | Los Angeles<br>River<br>May 2-3 2003 | Dominguez<br>Channel<br>Feb 21-22 2003 |
| Percent LMW Compounds   | 25.38                            | 30.33                                | 28.8                                   |
| Percent HMW Compounds   | 74.62                            | 69.67                                | 71.2                                   |
| Ratios                  |                                  |                                      |  |
| Phenanthrene/Anthracene | 4.26                             | 20.9                                 | 6.4                                    |
| Fluoranthene/Pyrene     | 1.0                              | 1.1                                  | 1.1                                    |

# PAH Profiles

## May 2-3, 2003

### Aerial Deposition In LA Watershed Particle Phase



# Conclusions

- ◆ PAHs are producing **significant loads** in aquatic receiving environments
  - **Undeveloped watersheds < 2 orders-of-magnitude**
- ◆ **Strong temporal variability**
  - **seasonal flushing**
  - **first flush**
- ◆ **All sites had similar PAH profiles – suggest pyrogenic origin**
  - urban runoff, aerial deposition

# Questions?

