EFFECTS OF SOUTHERN CALIFORNIA WILDFIRES ON STORM WATER CONTAMINANT RUNOFF

Eric D. Stein, Jeff Brown, Terri Hogue, Megan Burke
S. Ca. Coastal Water Research Project & UCLA
Fire in California

- Fire is a regular occurrence in California
- Frequency of fires increasing
- Fire alters runoff patterns
  - Higher flows
  - More sediment
  - More nutrients

Little is known about effect of post-fire runoff on water quality
Post-fire Sources of Pollutants

- Gasses, aerially-deposited particulates
- Fire retardants/fire suppression chemicals
- Sediment
- ASH and partially burned organic matter
Downstream Effects of Fire

- Fires often occur in watersheds with water bodies of concern
  - Impaired waterbodies
  - Sensitive areas
  - Recreational areas
  - Estuaries
  - Ports and harbors
    - Contaminated sediment
Challenges of Data Collection

- Unpredictable
- Numerous potential questions
- Fire does not respect jurisdictional boundaries

Need a coordinated regional plan.
Effects of Post-fire Runoff on Surface Water Quality: Development of a Southern California Regional Monitoring Program with Management Questions and Implementation Recommendations

Eric D. Stein
and
Jeff Brown

Southern California Coastal Water Research Project
Technical Report 598 - August 2006

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Management Questions

1. How does post-fire runoff affect contaminant flux?

2. What is the effect of post-fire runoff on downstream receiving waters?

3. What are the factors that influence how long post fire runoff effects persist?
How Does Fire Affect Flux?

**Direct effects**

**Indirect Effects**
Study Locations

Day Fire (9/2006)
Station Fire (8/2009)
Simi Valley Fire (10/2003)
Santiago Fire (10/2007)

Piru Creek
Dry Canyon
Runkle Canyon
Big Tujunga wash
Arroyo Seco

LOS ANGELES
Ballona Creek
Santiago Creek

Indirect Effects
Sampling Approach

- Continuous flow monitoring
- Pollutograph sampling
- Focus on metals, PAHs, and nutrients
Direct Effects

Dry Creek, Simi Valley, CA
November 2003
Fire Produces Higher Runoff and Sediment

2/25 - 2/26/04

Burned Site
Unburned Site

Flow (cfs)

Dec 25, 2003  Feb 25, 2004  Jan 7, 2005

Total Suspended Solids

Unburned  Burned
Increased Metal Flux (Zinc)
Increased PAH and Nutrient Flux
Persistence of Effects
2007 Santiago Canyon Fire

Santiago Canyon = 17 km²
# Attenuation of Concentrations (Zn)

<table>
<thead>
<tr>
<th>Percent Dissolved</th>
<th>---</th>
<th>37%</th>
<th>1%</th>
<th>4%</th>
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</thead>
<tbody>
<tr>
<td>Fire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct. 2007</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>EMC Zn (μg/L)</th>
<th>Feb 05</th>
<th>Jan 06</th>
<th>Dec 07</th>
<th>Feb 08</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>10</td>
<td>150</td>
<td>20</td>
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</table>
Zinc Concentrations in Ballona Creek

Zinc Concentration

Flow (cfs)

Zinc Conc. (ug/l)

Elapsed Time (hours)

Pre-fire

Post-fire
Indirect Effects of Fire on PAHs

<table>
<thead>
<tr>
<th></th>
<th>Not Influenced by Fire</th>
<th>Influenced by Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA River</td>
<td>3500 ng/L</td>
<td></td>
</tr>
<tr>
<td>Ballona Creek</td>
<td>3000 ng/L</td>
<td>5700 ng/L</td>
</tr>
</tbody>
</table>

Low molecular weight PAHs

High molecular weight PAHs
Persistence & Recovery
2009 Station Fire
Largest Fires in LA County History
Over 160,000 acres burned
Benthic Invertebrate Sampling

- Burned sites
  - Upper Los Angeles River
  - 6 sites
  - Previously sampled in 2008-2009

- Unburned/Control sites
  - Upper San Gabriel River
  - 5 sites
  - Previously sampled in 2005-2008

Sampling June 2010
Persistence & Recovery

- 2003 Cedar Fire (San Diego)
  - Collaboration with CDFG
  - Approximately 60 sites sampled for benthic invertebrates
  - 2003 (pre-fire) - 2009
Conclusions and Next Steps

- Post fire runoff may contribute to increased metals and PAHs
  - Greater than ten-fold increase in mass and concentration in many situations
- Effects appear to be relatively short-live
  - Levels generally return to pre-fire levels within one year
- Indirect effects associated with ashfall can also lead to higher metals and PAHs
- Need additional sampling to better understand biological effects and recovery
QUESTIONS

Eric Stein
714-755-3233
erics@sccwrp.org
www.sccwrp.org
2003 Simi Valley Fire

- Dry Canyon = 4.7 km²
- Runkle Canyon = 2.9 km²
Post Fire Copper Loading

- **Fire October 2003**
  - Unburned: 1.9 cm (0.75”)
  - Burned: 3.3 cm (1.3”)
  - Unburned: 2.8 cm (1.1”)

- **Mass (kg)**
  - Dec 25, 2003: $3 \times 10^{-3}$ kg
  - Feb 25, 2004: 4 kg
  - Jan 7, 2005: 2 kg

The graph shows the mass of copper before and after the fire on different dates.
Post Fire Metals Loading

- Lead
  - Mass (kg): 0, 1, 2, 3, 4, 5, 6

- Nickel
  - Mass (kg): 0, 1, 2, 3, 4, 5, 6

- Zinc
  - Mass (kg): 0, 1, 2, 3, 4, 5, 6

- Copper
  - Mass (kg): 0, 1, 2, 3, 4, 5, 6

October 2003 Fire
Post-Fire Zinc Loading

Fire
Oct. 2007

6.7 cm  5.3 cm  3.5 cm
2.6”   2.1”   1.6”

1.1 cm
0.4”

Feb 05  Jan 06  Dec 07  Feb 08

Mass Zn (kg)
Before and after photos of Rancho Bernardo Community
San Gabriel Dam
August 2004 vs. April 2005
Effect of Rainfall

Rainfall (inches)

EMC (µg/L)

- Post-fire burn areas
- Natural loading
- Developed areas

Rainfall (inches)