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# **Comment distinguer un Déversement Nouveau par Rapport à des Pollutions Anciennes?**

## **How to Distinguish New Spills from Old Spills?**

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## Introduction

- Applications of environmental forensics (EF) in the U.S.
- The Environmental Liability Directive (ELD) and potential EF applications
- Evaluating the extent of a spill
- Using other lines of evidence to determine environmental damage
- Conclusion

# Applications of Environmental Forensics in the U.S.

- Commonly used to determine:
  - Liability for cleanup costs
  - Apportionment of cleanup costs among responsible parties
  - Applicability of pollution insurance
  - Liability for exposure and health effects in property damage and toxic tort litigation
  - Liability for damages to natural resources

## Environmental Liability Directive

- Many similarities to the U.S. Natural Resource Damage regulations
- Designed to ensure that damages to environmental assets are prevented or restored
- Focuses on restoration of damaged natural resources (protected species, habitats, surface waters)

## Definitions of Environmental Damage

- Article 2.1

- “Damage to protected species and habitats which has **significant adverse effects** on reaching or maintaining the favourable conservation status of such habitats or species with reference to the **baseline condition**”
- “Any damage that **significantly affects** the ecological, chemical, and/or quantitative status and/or ecological potential of waters”

## Baseline

- Article 2.14:
  - “Baseline condition means the condition at the time of the damage of the natural resources and services that would have existed **had the environmental damage not occurred**, estimated on the basis of the best information available.”

## Importance of Baseline

- For most cases, baseline conditions are not pristine conditions
- Must consider both natural factors and anthropogenic impacts not related to the spill or release



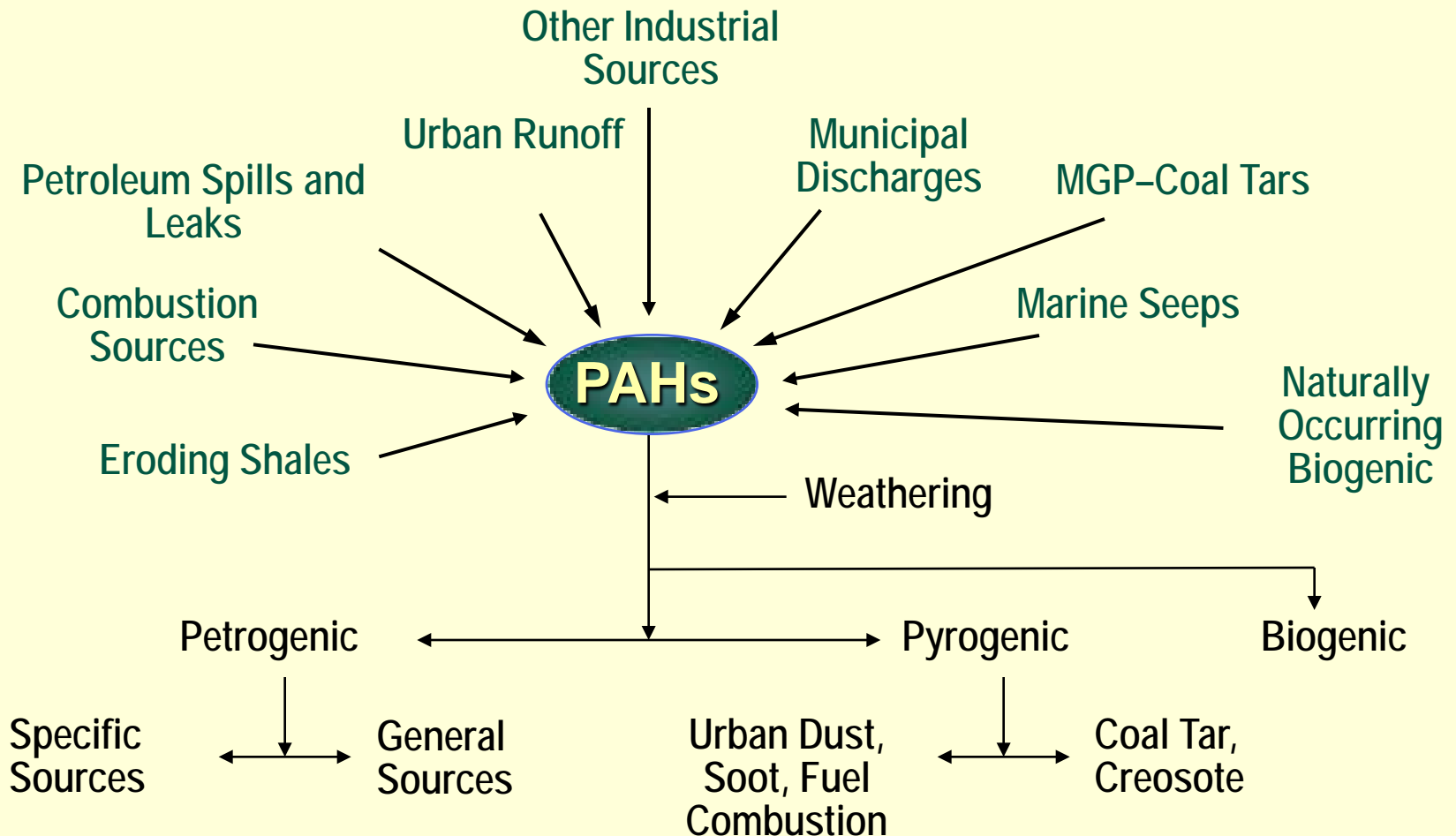
## **Roles of Forensics in Baseline Determination**

- Distinguishing “contamination” from background or baseline conditions
- When did the contamination occur?
  - Only contamination since ELD implementation is covered and there is a 30-year maximum period of liability
- Multiple-sources—in some cases there may be multiple sources for contaminants and multiple contaminants
  - Need to apportion costs between parties

## Evaluating the Effects of a Spill: Example PAHs

1. Transport and fate of the spill
  - Persistence
  - Deposition and resuspension
2. Application of EF techniques to determine the extent of contamination
3. Application of other lines of biological evidence to determine environmental damage

# Polycyclic Aromatic Hydrocarbons (PAHs) are Widely Distributed and Have Many Sources



# PAH Target Analytes

## Priority Pollutants ( $\Sigma\text{PAH}_{16}$ )

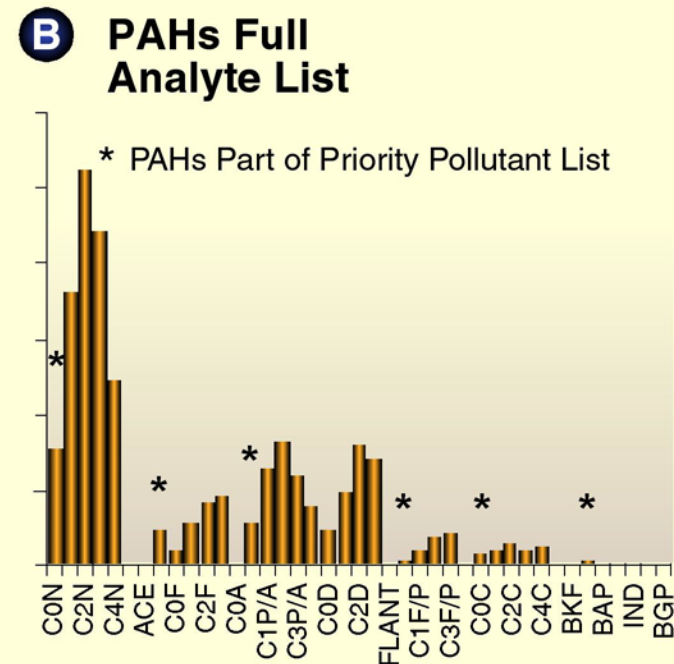
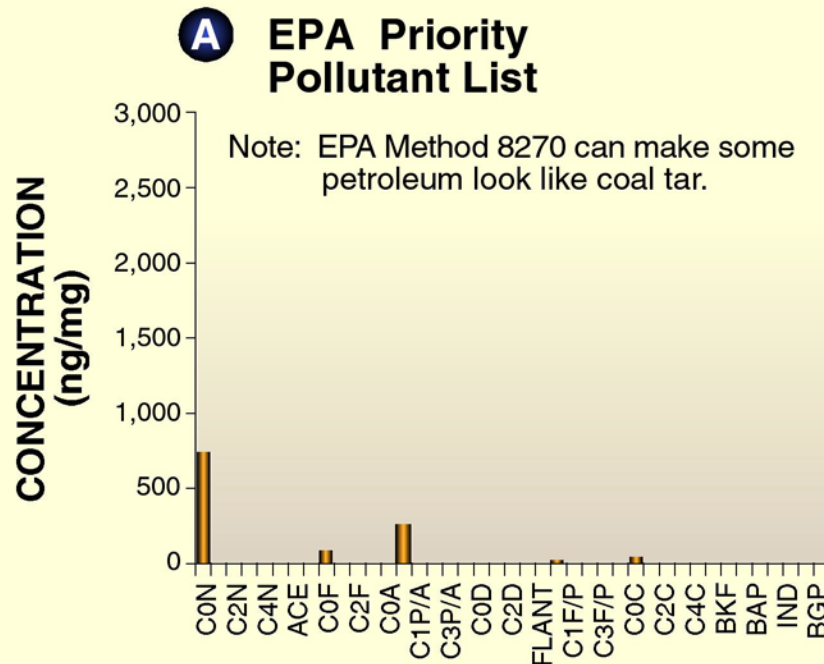
- Naphthalene
- Acenaphthene
- Acenaphthylene
- Fluorene
- Anthracene
- Phenanthrene
- Fluoranthene
- Pyrene
- Benz[a]Anthracene
- Chrysene
- Benzo[b]Fluoranthene
- Benzo[a]Pyrene
- Indeno[1,2,3-c,d]Pyrene
- Dibenz[a,h]Anthracene

## Forensics Analyte List ( $\Sigma\text{PAH}_{50}$ )

- Priority Pollutant List +
- Biphenyl
- Dibenzofuran
- C1-C4 Naphthalenes
- C1-C3 Fluorenes
- C1-C4 Phenanthrenes
- C0-C4 Dibenzothiophenes
- C1-C3 Fl/Py
- C1-C4 Chrysenes
- Benzo[b]Fluoranthene
- Benzo[j,k]Fluoranthene
- Benzo[e]Pyrene
- Perylene
- Benzo[g,h,i]Perylene
- Dibenzopyrenes (4)
- Dibenzo(a,e) fluoranthene

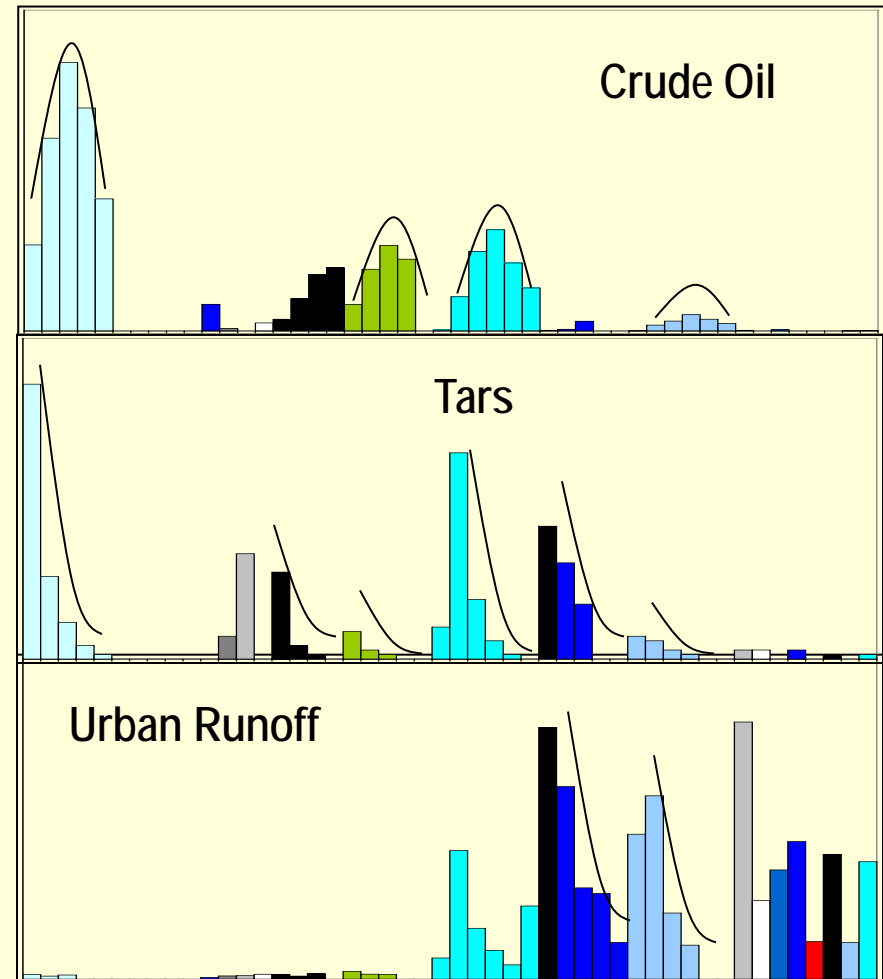
# Comparison of PAH Analysis of the Same Oil Using Two Target Lists

- Analysis of the 16–18 EPA priority pollutant PAHs (A) yields only a small part of the total PAH content and of the total alkylated PAH petroleum fingerprint (B)

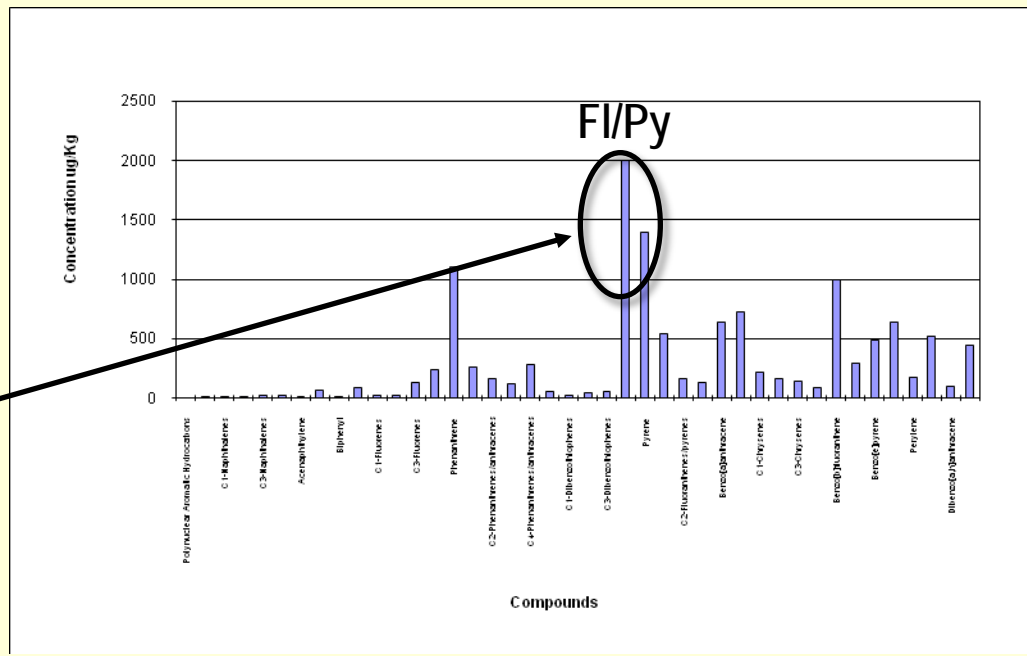


## PAH Sources: Distinct Patterns or “Fingerprints” only Revealed with Extended PAH List

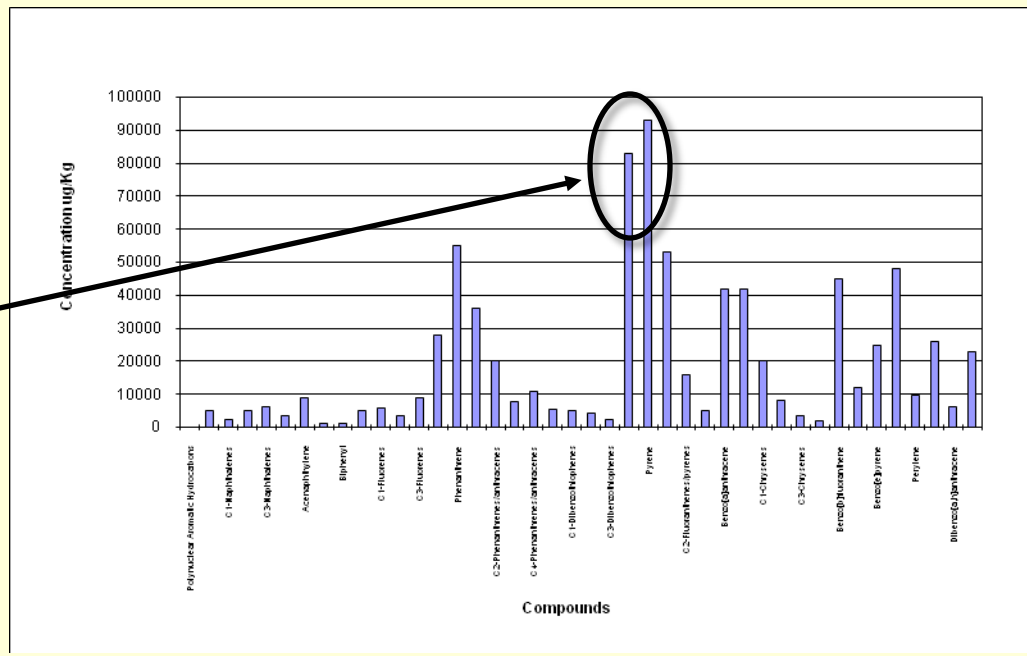
- Petrogenic profile (fresh petroleum)
- Pyrogenic profile (fresh coal tar)
- Pyrogenic profile (urban dust and runoff)



Storm Sewer Sample  
 FI/Py > 1.2

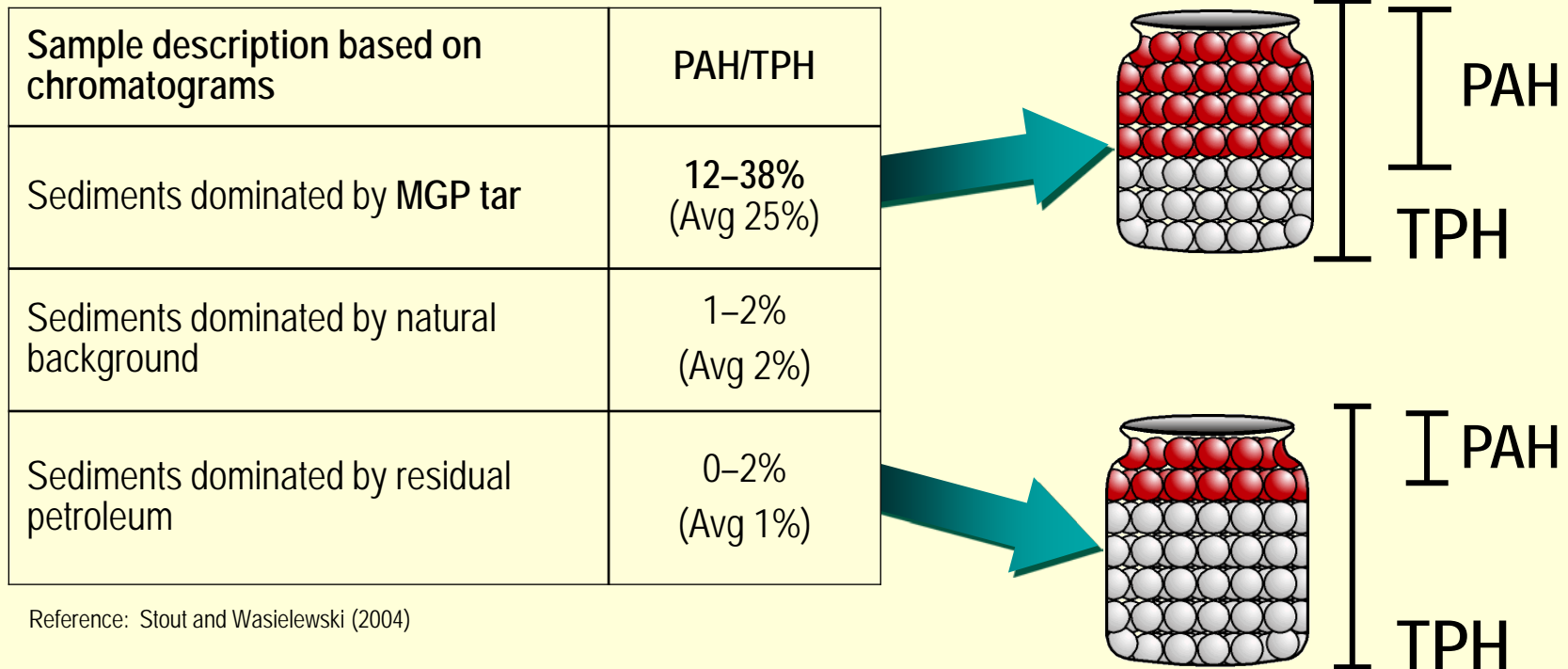


Coal Tar Impacted Sediment  
 FI/Py < 1.0



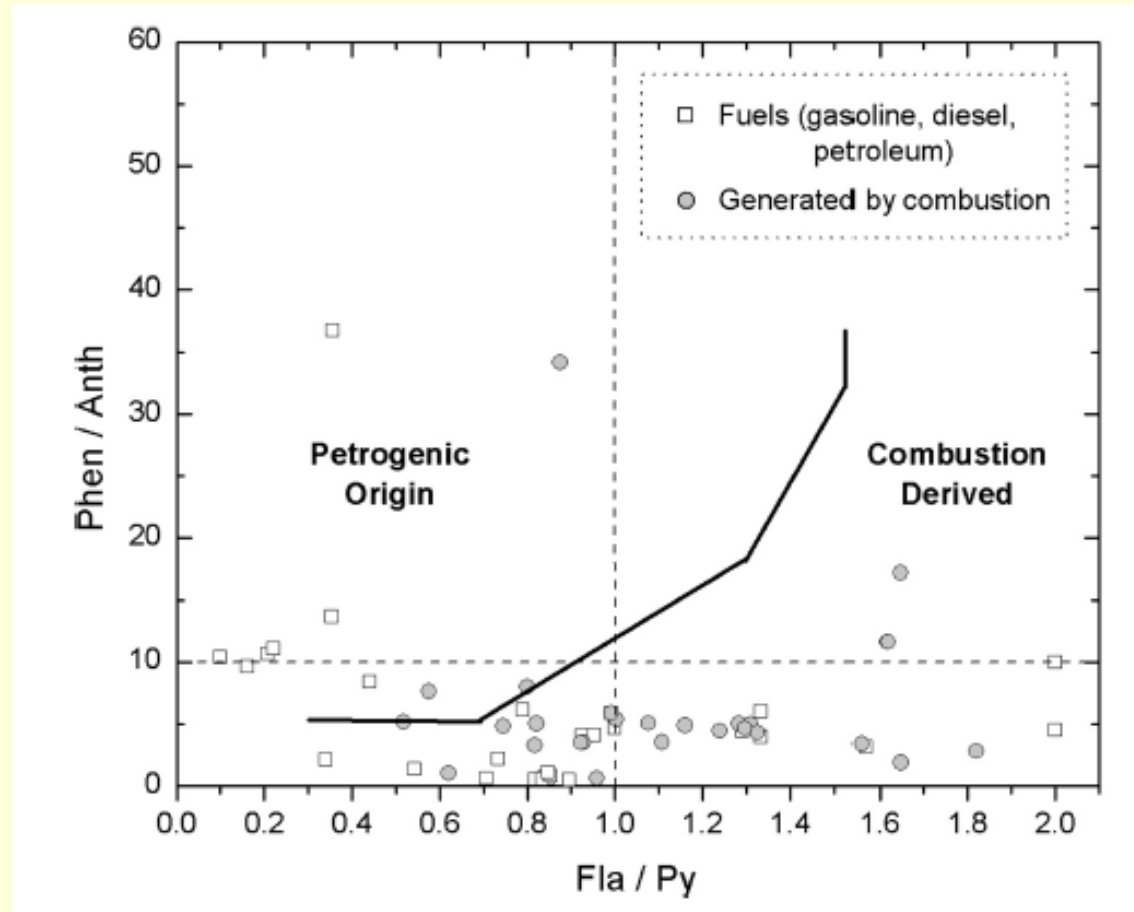
# PAH/TPH Ratio Is Used to Differentiate PAH Sources

- Higher PAH content indicates that sediments are impacted by coal tar sources

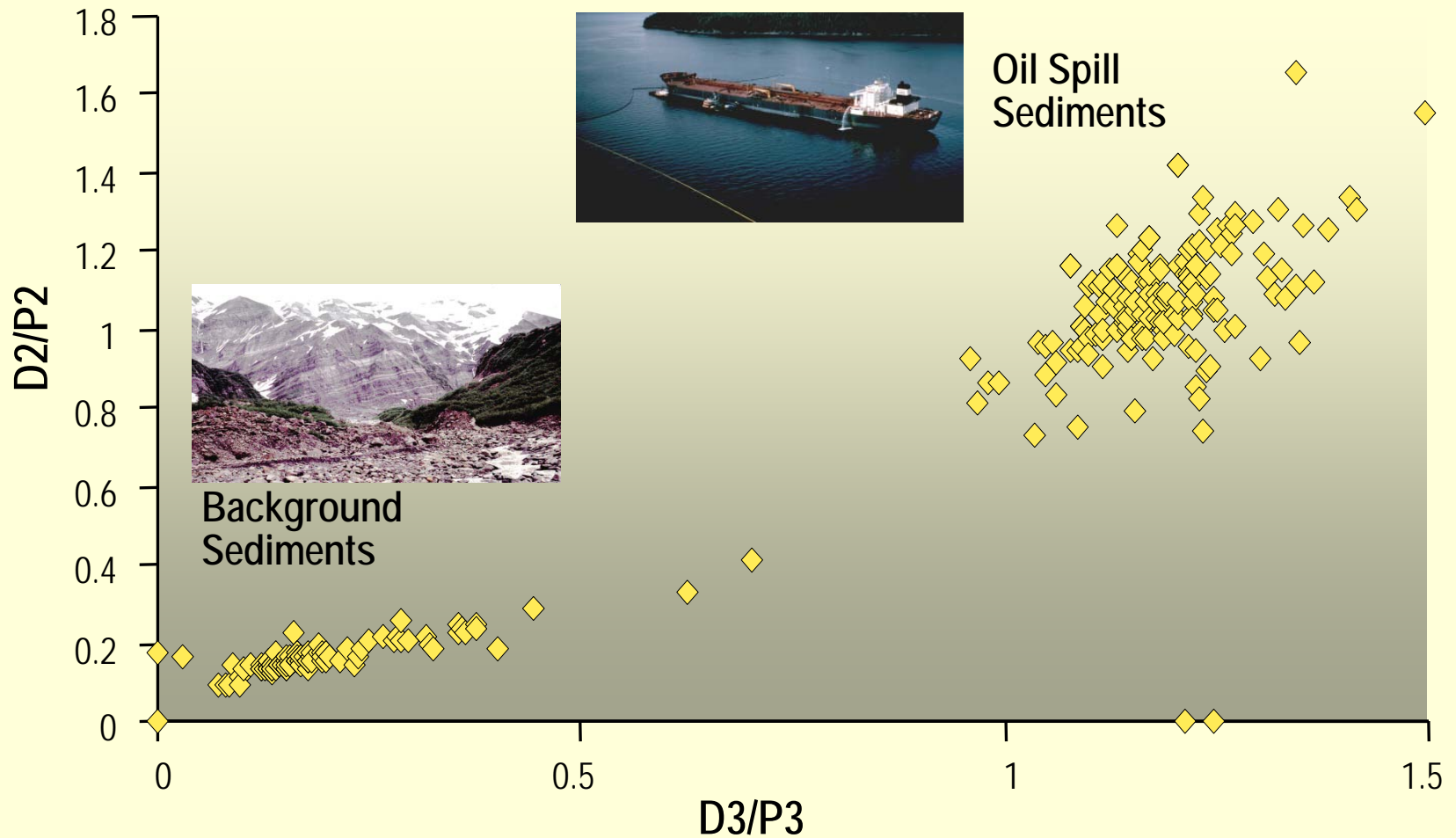




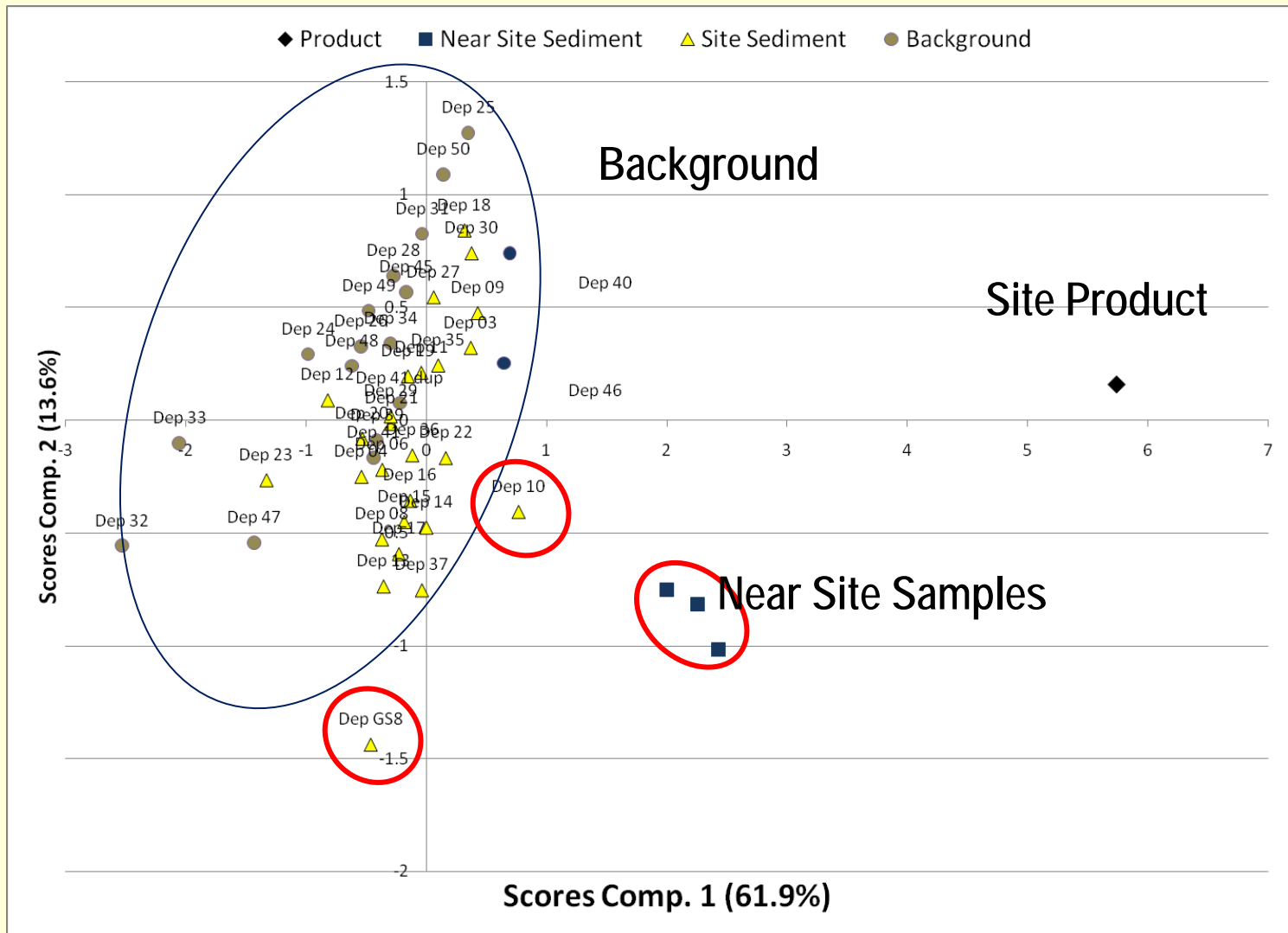
# Interpretation of Fla/PY and Phen/Anth Ratios Should Be Done With Care and Multiple Lines of Evidence



# Differences in PAH Ratios—Key to *Exxon Valdez* PAH Sources in Sediments



# PCA Analysis PAH Data—Grouping by Compositional Similarity



## Methods to Determine Environmental Damages

- Comparison of pre- and post-incident biological data from site
- Comparison with appropriate reference areas
- Toxicity testing
- Site-specific field investigations

## Conclusions

- EF methods can be applied to evaluate spills of persistent contaminants
- EF methods are an important tool for ELD investigations
- Care must be taken to use multiple lines of EF evidence
- EF methods must be combined with biological evidence to determine ecological damage