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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

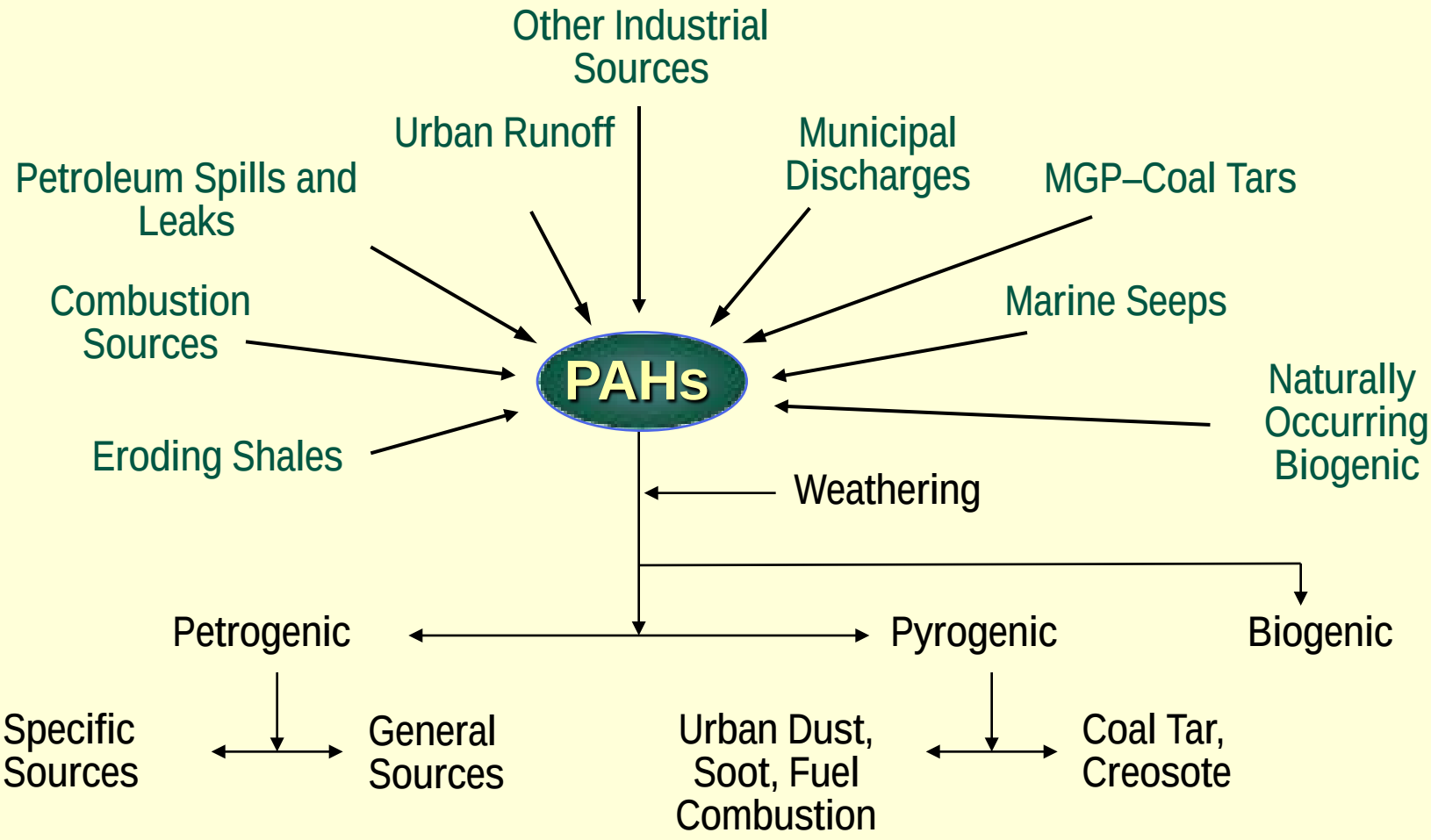
Roles of Forensics in Baseline Determination

- 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 (ΣPAH_{16})

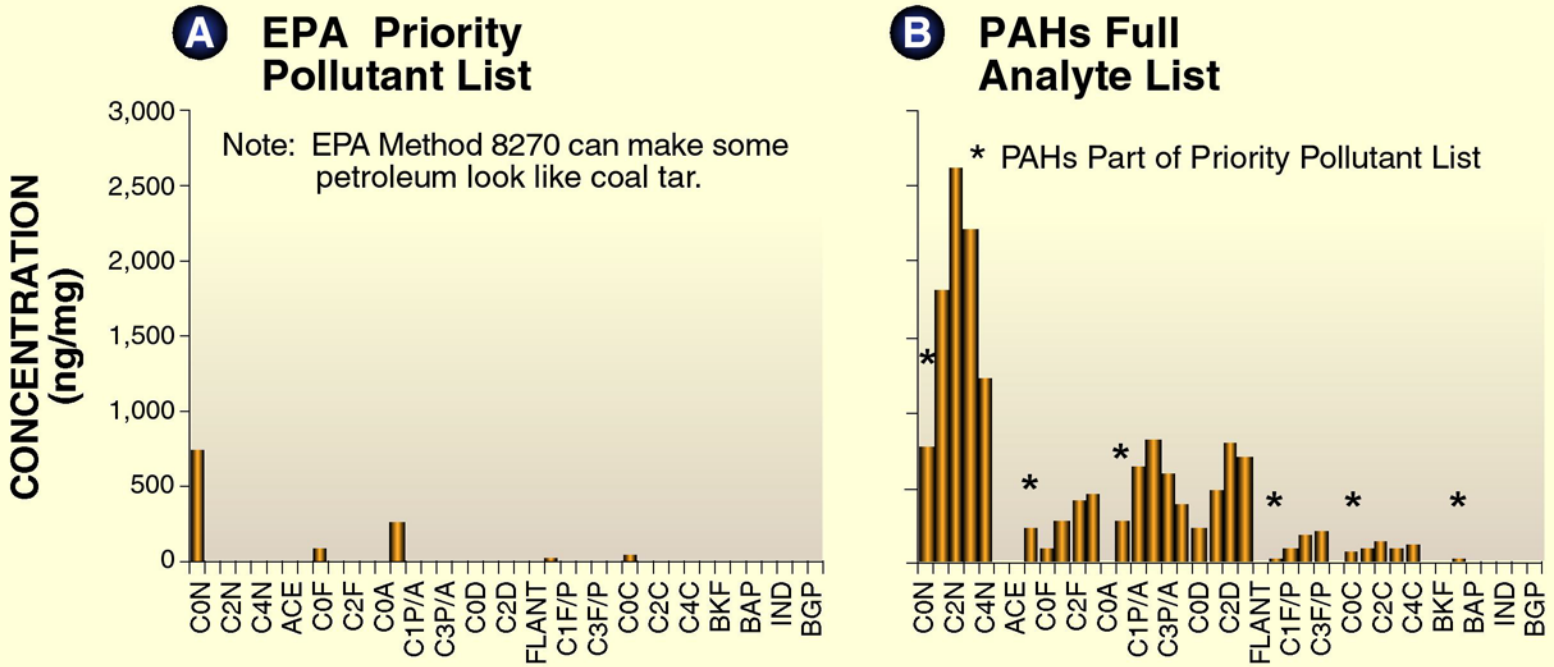
- Naphthalene
- Acenaphthene
- Acenaphthylene
- Fluorene
- Anthracene
- Phenanthrene
- Fluoranthene
- Pyrene
- Benz[a]Anthracene
- Chrysene
- Benzo[b]Fluoranthene
- Benzo[a]Pyrene
- Indeno[1,2,3-c,d]Pyrene
- Dibenz[a,h]Anthracene

Forensics Analyte List (ΣPAH_{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

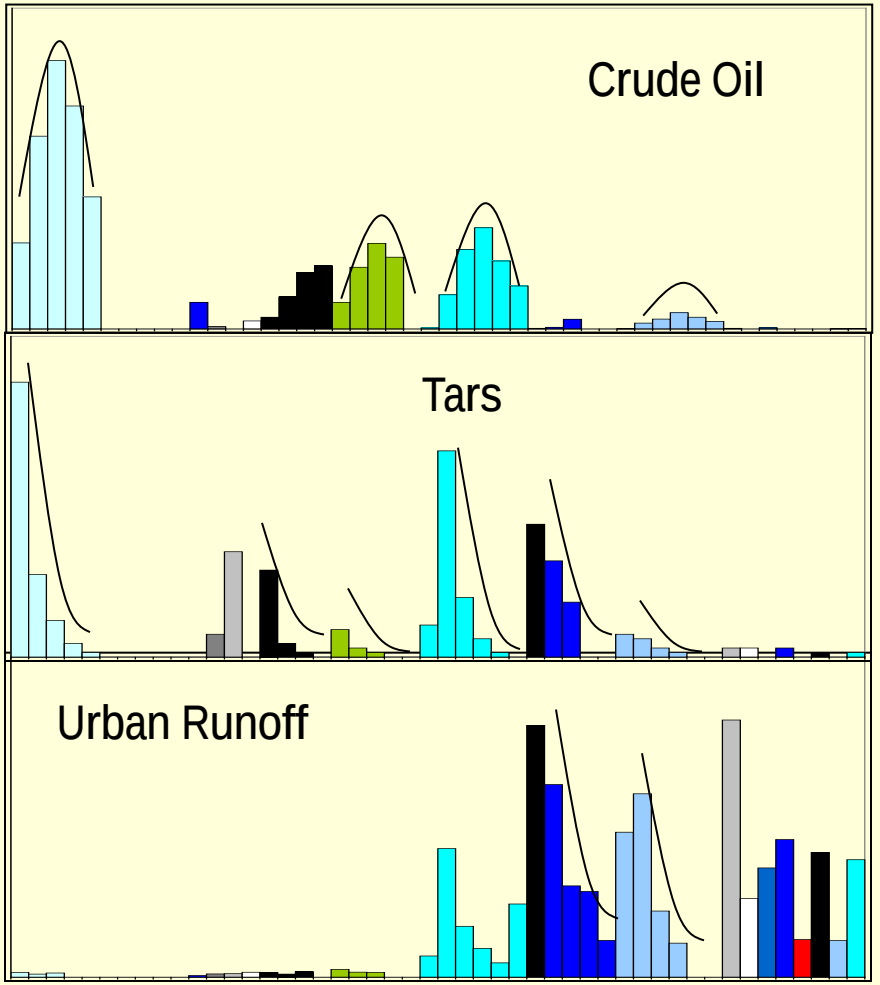
Comparison of PAH Analysis of the Same Oil Using Two Target Lists

- 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)



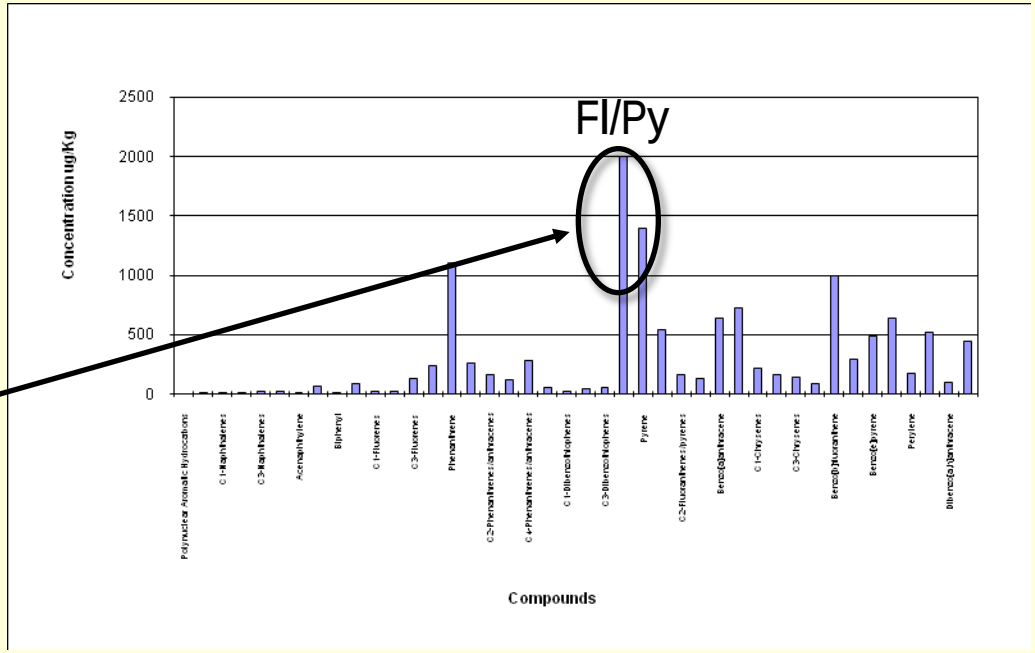
PAH Sources: Distinct Patterns or "Fingerprints" only Revealed with Extended PAH List

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



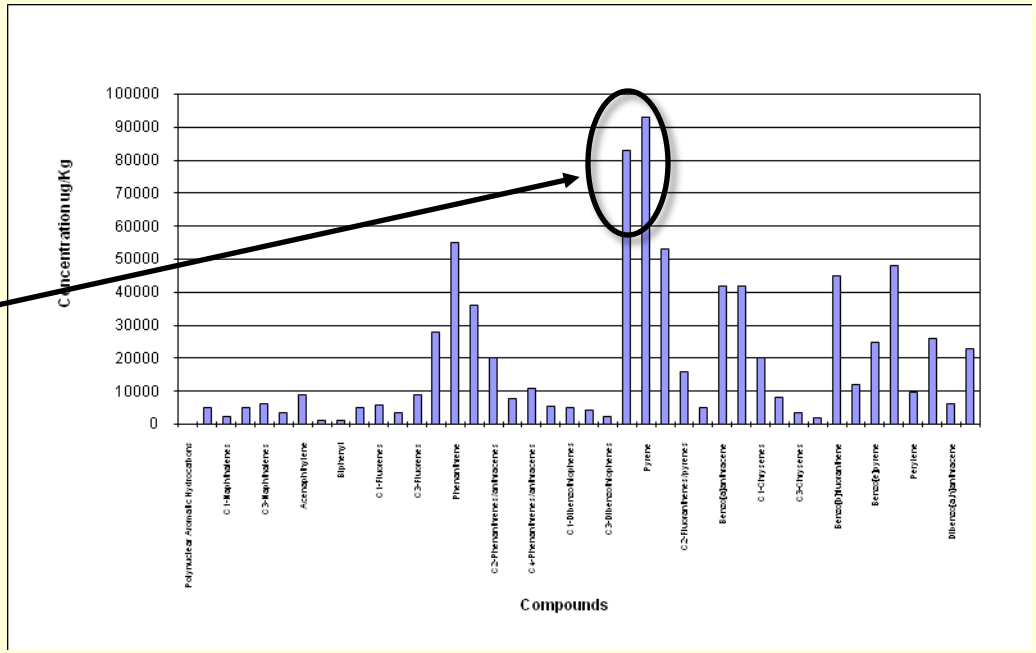
Storm Sewer Sample

Fl/Py >1.2



Coal Tar Impacted Sediment

Fl/Py < 1.0

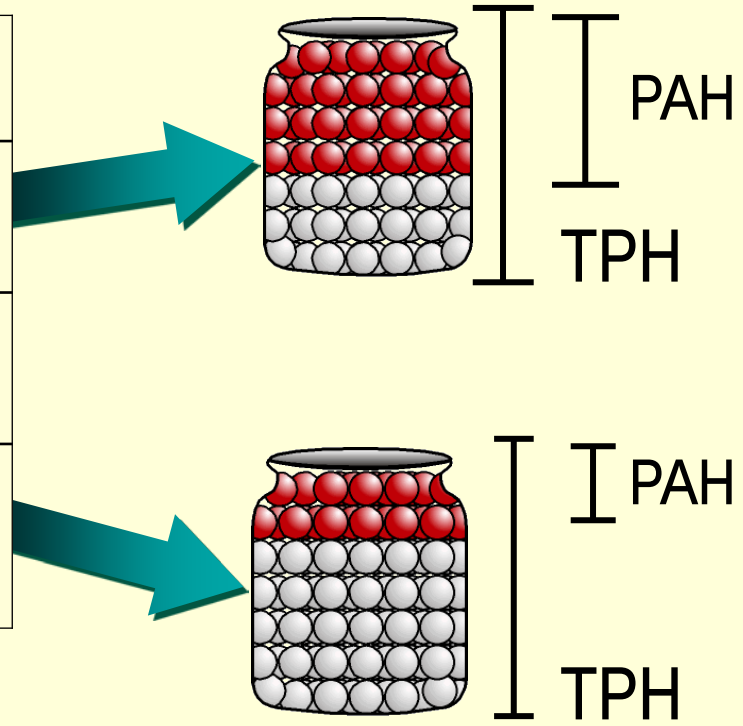


PAH/TPH Ratio Is Used to Differentiate PAH Sources

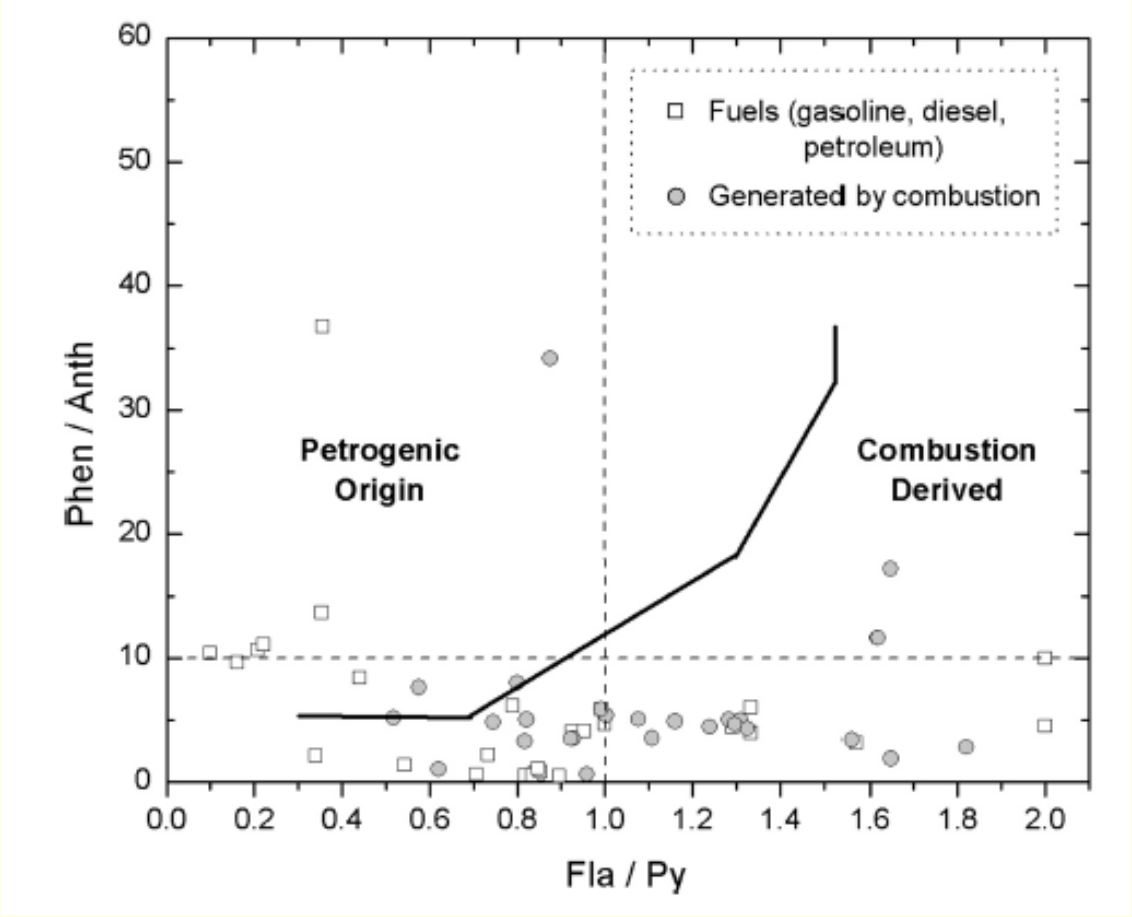
- Higher PAH content indicates that sediments are impacted by coal tar sources

Sample description based on chromatograms	PAH/TPH
Sediments dominated by MGP tar	12–38% (Avg 25%)
Sediments dominated by natural background	1–2% (Avg 2%)
Sediments dominated by residual petroleum	0–2% (Avg 1%)

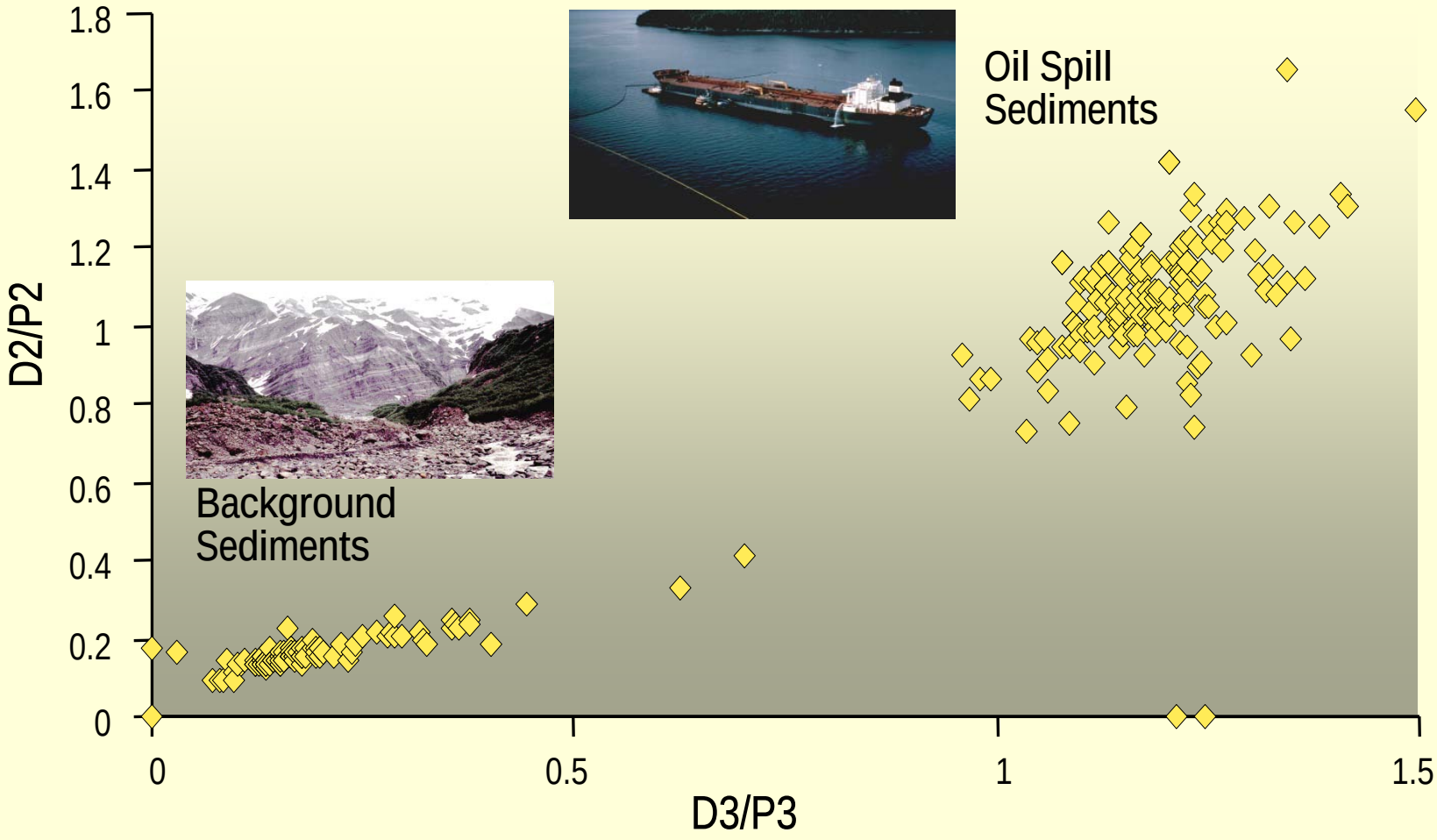
Reference: Stout and Wasielewski (2004)



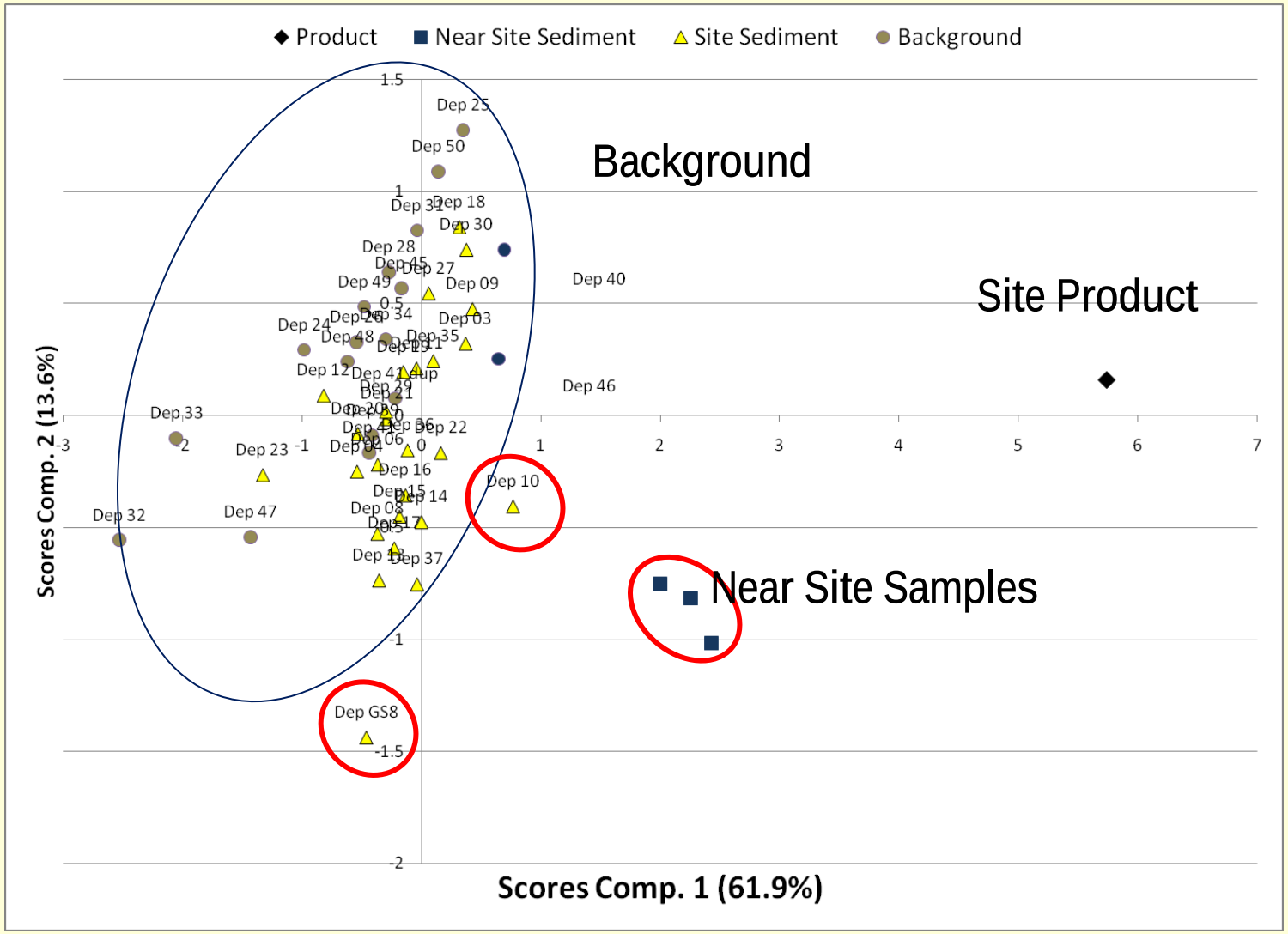
Interpretation of Fla/PY and Phen/Anth Ratios Should Be Done With Care and Multiple Lines of Evidence



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