Bioremediation of Diesel Range Organics in the Suisun Marsh

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Region 9 FOSC
Background

- Pipeline spill occurred on April 27, 2004
- Greater than 100,000 gallons of diesel fuel released to a wetland
  - Area is approximately 242 acres in size and is managed as a duck hunting clubs
  - Water levels controlled by levees and gates
  - Responders designated 2 divisions: A (a brood pond) and B (a shooting area)
Incident Command

Unified Command
FOSC – USCG/U.S. EPA
SOSC – CA DFG
RP – Kinder Morgan EP

JIC – KMEP, CA DFG OSPR, EPA

Safety – KMEP, USCG PST

Liaison
KMEP, EPA, OSPR

Finance

Logistics
KMEP, Contractors

Planning
KMEP, Contractors

Operations
KMEP, Contractors

Environmental Unit
CA DFG

Area A Crew

Area B Crew
Response Strategies

• Mechanical
  – Booming, absorbent materials, skimming, and excavation
  – Water level management
    • Tide gate adjustments were utilized to drain Division B
Response Strategies

• An evaluation of cleanup alternatives determined that bioremediation was highly feasible and cost effective
  – Add polyphosphate (Div A) & di-ammonium phosphate (Div B) to affected soils to facilitate biodegradation of diesel in soil
  – Tilling for aeration
Response Coordination

- **State:**
  - Department of Fish & Game and Regional Water Quality Control Board

- **Federal:**
  - NOAA, U.S. Fish & Wildlife Service
    - Endangered Species Issues
  - DOI
    - Cultural and Historic Properties Issues
  - Regional Response Team
    - Approval of nutrient addition
Will bioremediation work.... before winter arrives?

- Heterotrophic plate count and respirometry study (KMEP – lead)
  - High populations of TPH degraders present
  - Populations increase in presence of oxygen
- Bench-scale tests (EPA – lead)
  - Up to 40% degradation observed in bench flasks after 14 days
- Preparations!
  - Construction
  - Mouse catching
Monitoring

• Water and soil samples collected regularly by EPA and KMEP
  – Effectiveness of response measures will be determined by decreases in Total Petroleum Hydrocarbon (TPH analysis) and by “sheen tests”
  – Bioremediation will be measured specifically by Modified GC/MS “fingerprint” analysis
• Biomarker ratios will be derived
  – C17:Pristane
  – C18:Phytane
  – Pristane:Phytane
<table>
<thead>
<tr>
<th>Mean Concentration</th>
<th>T0</th>
<th>T27</th>
<th>T32</th>
<th>T62</th>
<th>T99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Concentration</td>
<td>160000</td>
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<td>8700</td>
<td>1600</td>
<td>860</td>
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<td>Percent Removal</td>
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<td>77.96</td>
<td>84.04</td>
<td>92.99</td>
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<tr>
<td>Time (days)</td>
<td>T0</td>
<td>T27</td>
<td>T32</td>
<td>T62</td>
<td>T99</td>
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<tr>
<td>Mean Concentration</td>
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<td>606</td>
<td>352</td>
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Biomarker Ratio Trends – Division A

Untransformed Biomarker Data - Samples TS-A-10

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>C17:Pr stane TS-A-10</th>
<th>C18:Phytane TS-A-10</th>
<th>R²</th>
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<tbody>
<tr>
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</table>
Biomarker Ratio Trends – Division A

LN-Transformed Biomarker Data

- LN-Transformed Biomarker Data
- LN Ratio
- Sampling Date
- R² = 0.8669
- R² = 0.961

- C17:Pristane TS-A-10
- C18:Phytane TS-A-10
- C17:Pristane TS-A-15
- C18:Phytane TS-A-15
- C17:Pristane TS-A-20
- C18:Phytane TS-A-20
- Linear (C17:Pristane TS-A-10)
- Linear (C18:Phytane TS-A-10)
Biomarker Ratio Trends – Division B

Transformed Biomarker Ratios - Samples ES-1 & ES-4

- R² = 0.7251
- R² = 0.5893

Sampling Dates

LN Ratio

- ln C17/Pristane (ES-4)
- ln C18/Phytane (ES-4)
- ln C17/Pristane (ES-1)
- ln C18/Phytane (ES-1)

Linear (ln C18/Phytane (ES-4))
Linear (ln C17/Pristane (ES-4))
Bioremediation Lessons Learned

• Start early!
  – A more timely application of nutrients in future spills will allow for improved evaluation.

• Response measures achieved interim remediation goals but raise questions
  – Was nutrient addition necessary?

• Consider other lines of evidence prior to crediting the specific approach as clearly successful.
  – TPH data should be normalized to reduce potential errors.
Keep in Touch

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