Non-floating Oil Spills: Structure and Outcomes

- Plenary talks (getting everyone on the same page)
  - Case Studies
  - Submerged Oil Overview
  - Biological Effects/Restoration
Non-floating Oil Spills: Structure and Outcomes

• Breakout Groups
  ♦ Detection and Monitoring
  ♦ Fate and Transport
  ♦ Containment and Recovery
  ♦ Effects and Restoration
  ♦ Protection of Water Intakes
Non-floating Oil Spills: Structure and Outcomes

• Group Reports
  ♦ Research Need
  ♦ Objectives
  ♦ Guidelines
  ♦ Potential Impediments or Enhancements to Research
  ♦ Application to the Decision-Making Process
Non-floating Oil Spills: Structure and Outcomes

- Workshop Report
  - **Tables** generated by each group
  - **Synthesis** into language for the preparation of study plans for future funding mechanisms or research proposals
  - Workshop **Summary** based on discussions at last plenary session
Submerged Oil Overview

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Response Challenges for Non-floating Oil Spills

- Detection of pooled oil on the bottom
- Detection/tracking of mobile oil suspended in the water column
- Predicting fate and transport of submerged oil
- Containment of oil on the bottom
- Containment of suspended oil
Response Challenges for Non-floating Oil Spills

- Protection of water intakes
- Submerged oil recovery
- Submerged oil injury assessment and resource restoration
Non-floating Oil Spills: Detection of Oil on the Bottom

• Needs for detection of pooled oil on the bottom
  ♦ Thickness (generally “thin” 1-10 cm)
  ♦ Dimension of oil accumulations
  ♦ Patch size or percent cover in accumulation
  ♦ Need to estimate volume/area
Non-floating Oil Spills: Detection of Oil on the Bottom

• Visible Surveys
  ♦ Clear water only
  ♦ Need diver validation/thickness measure
  ♦ Rapid turnaround of results
  ♦ Standard spill response method
Morris J. Berman, Puerto Rico
Lake Wabamum, Canada
Non-floating Oil Spills: Detection of Oil on the Bottom

• Diver Observations/Video
  ♦ Water visibility/depth/wx limits
  ♦ Need divers anyway for validation
  ♦ Low areal coverage/poor quantification
  ♦ Contaminated diving expertise limited
Non-floating Oil Spills: Detection of Oil on the Bottom

- ROV Video/Photography
  - Water visibility/wx limits
  - Systems with good GPS tracking of ROV
  - Not much experience in response community on capabilities
  - Need rapid post-processing to produce useful products (georeferenced oil maps)
Non-floating Oil Spills: Detection of Oil on the Bottom

- Sorbent Drops
  - Sorbent material attached to weights, dropped/dragged a short distance, then inspected for oil
  - Embarrassingly crude but simple
  - First used in 1984 at *Mobiloil* spill in Columbia River; latest in 2003 at *Athos 1*
Non-floating Oil Spills: Detection of Oil on the Bottom

- Chain drags/V-SORs
  - Sorbent material attached to chains and dragged some distance, then inspected for oil
  - Used at many submerged oil spills as an initial search strategy
  - Provides data only on relative amounts of oil within drag area
  - Many limitations, but still useful
Non-floating Oil Spills: Detection of Oil on the Bottom

• Acoustic Systems

♦ Lots of good capabilities (no water clarity limits, georeferenced, good areal coverage rates, 2D imagery, available technology)

♦ Lots of limitations (detection limits for oil thickness, patch size; substrate effects; post-processing time; water depth; needs validation)

♦ Little experience in response community
DBL 152 Debris Field and Trench
DBL 152 Oil Patch (?)
Non-floating Oil Spills: Detection of Oil on the Bottom

- Chemical Detection Systems
  - Only experience is with field fluorometers for oil in the water column
  - Potential technologies available
  - Effects of suspended oil (dissolved/particulate), physical processes/transport
  - Correlation of signal with amount of oil?
Non-floating Oil Spills: Detection of Mobile Oil

- Detection of mobile oil suspended in the water column
  - Can be dynamic/episodic at different time-scales
  - Can be along bottom/just under the surface
  - Desperate need for quantification of amount
Non-floating Oil Spills: Detection of Suspended Oil

- Stationary sorbent systems
  - Snare on ropes, in pots; on the bottom and in the water column
  - Uses readily available response materials
  - Provide good info on vertical distribution
  - No quantification or calibration of efficiency
Non-floating Oil Spills: Detection of Suspended Oil

- Trawled Systems
  - Mostly fish nets with snare
  - Used as recently as 2004 - Lake Wabamum
  - There are commercial oil recovery nets in the UK, never used in US
  - Better designs could be used for quantification
Non-floating Oil Spills: Detection of Suspended Oil

- Chemical Sensors
  - Only experience is with field fluorometry
  - Can sample different water depths
  - Need better understanding/calibration between dissolved and suspended oil
  - Fouling, contamination issues
Non-floating Oil Spills: Predicting Fate and Transport

• Processes that determine when oil submerges
• Oil/sediment interactions
• Processes that determine submerged oil movement
• Weathering of submerged oil
• Data gaps to provide better predictions
BEHAVIOR OF SPILLS OF HEAVY OILS

Oil-to-Water Density Ratio

- **< 1.0**
  - Majority floats initially
  - Currents: High
  - Sediment Interaction: High
    - **Oil Sinks**
      - after standing onshore and mixing with sand
      - after mixing with sand suspended by wave action
      - oil can refloat after separating from sand

- **> 1.0**
  - Majority does not float initially
  - Currents: High
    - Oil is suspended in water column
    - Sediment Interaction: High
      - **Oil Sinks**
        - after mixing with sand (unsure of effect of mixing with silt/clay)
  - Currents: Low
    - Oil sinks to bottom
    - Sediment Interaction: Low
      - **Oil Disperses**
        - transport and mixing by current and waves
Non-floating Oil Spills:
Protection of Intakes

• What are thresholds for different water uses and treatment systems (always “0”?)
• What detection methods are available?
• How do we communicate effectively with operators?
• Effective protection strategies
Non-floating Oil Spills: Containment/Protection of Intakes

• Filter fences
  ♦ Geotextile fabric - Lake Wabamum
  ♦ “Snare monster” - *Athos 1*
  ♦ Silt curtains

• Air bubble curtains - Lake Wabamum
• Net booms
Non-floating Oil Spills: Oil Containment/Protection of Intakes

• Obvious need for improved technologies
• Need better site assessment/engineering design to improve effectiveness under typical current/flow conditions at intakes
• Need for systems to contain oil suspended during bottom oil recovery operations
Non-floating Oil Spills: Containment of Oil on Bottom

- Bottom booms, in theory
- Permeable barriers to allow water to pass but retain oil
- Bottom currents, oil resuspension processes are poorly understood
- Oil can re-suspended during high-energy events
Non-floating Oil Spills: Recovery of Oil on Bottom

• Diver directed pumping
  ♦ Reduce water/increase oil recovery rates
  ♦ Improve pumping rates
  ♦ Improve oil pickup efficiency (sleds with larger vacuum units, hose management, oil concentration methods)
Athos 1 - Venezuela Crude Oil
Non-floating Oil Spills: Recovery of Oil on Bottom

- ROV directed pumping
  - Deeper water; diver safety
  - Reduce water/increase oil recovery rates
  - Improve pumping rates
  - Improve oil recovery
Non-floating Oil Spills: Recovery of Oil on Bottom

- Dredges
  - Appropriate types/dredge heads
  - Emergency modifications for oil recovery
  - Emergency permitting issues
Non-floating Oil Spills: Recovery of Oil on Bottom

• Decanting systems
  ♦ *Always ad hoc*, under designed, and often fail, lots of trial and error
  ♦ Need guidelines and calculation tools
  ♦ Consider droplet size, flow rates, oil behavior *(float or not)*
  ♦ Still need to use readily available materials
Athos 1 Decanting - Oil Floated
Athos 1 Decant “System”
Lake Wabmum - Tarball Recovery/Decanting
Non-floating Oil Spills: Injury Assessment/Restoration

- What are likely effects based on exposure pathways (smothering, coating, low aquatic toxicity, ingestion)
- Biological assessment and monitoring approaches?
- Methods for scaling of injury?
- Restoration options?
Submerged Oil Summary

• Need new technologies for detecting, tracking, modeling, containing, protecting, recovering, decanting, assessing, restoring

• But, they need to be “emergency” ready

• Your charge next 1.5 days: Identify R&D projects to meet these needs