

BEST ACHIEVABLE PROTECTION

Seattle WA

21 May 2015

# Subsurface Oil Detection on Shorelines, Shallow Water, and Inland Spills

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# Topics

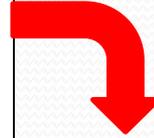
- *API Study: Subsurface Oil Detection and Delineation in Shoreline Sediments*
  - API 2012-2014, Phase 1 and Phase 2: Reports and Recommendations
  - SINTEF Field Trials
  - API 2015, Phase 3: Field Trials and Manual of Practice
- Shallow-Water Case Studies
  - *Lake Wabamun*
  - *Deepwater Horizon*

# Subsurface Oil Detection and Delineation in Shoreline Sediments

Phase 1—Final Report

API TECHNICAL REPORT 1149-1  
SEPTEMBER 2013

1. Review state-of-the-art



# Subsurface Oil Detection and Delineation in Shoreline Sediments

Phase 2—**Field Guide**

API TECHNICAL REPORT 1149-2  
SEPTEMBER 2013

*3 phase  
program*

*all reports are  
available on  
line*

2. Develop  
**recommendations** for  
further studies

# Subsurface Oil Detection and Delineation in Shoreline Sediments

Phase 2—Final Report

API TECHNICAL REPORT 1149-2A  
OCTOBER 2014



**clean sand**

**Oil Residue (OR)**

**Water table at high tide**

**N 29.11741° W 090.16739°**

**12/08/2010 11:01:51 AM**



**Stained sand**



**Anerobic sediment – not oil**

9/4/2010 15:20

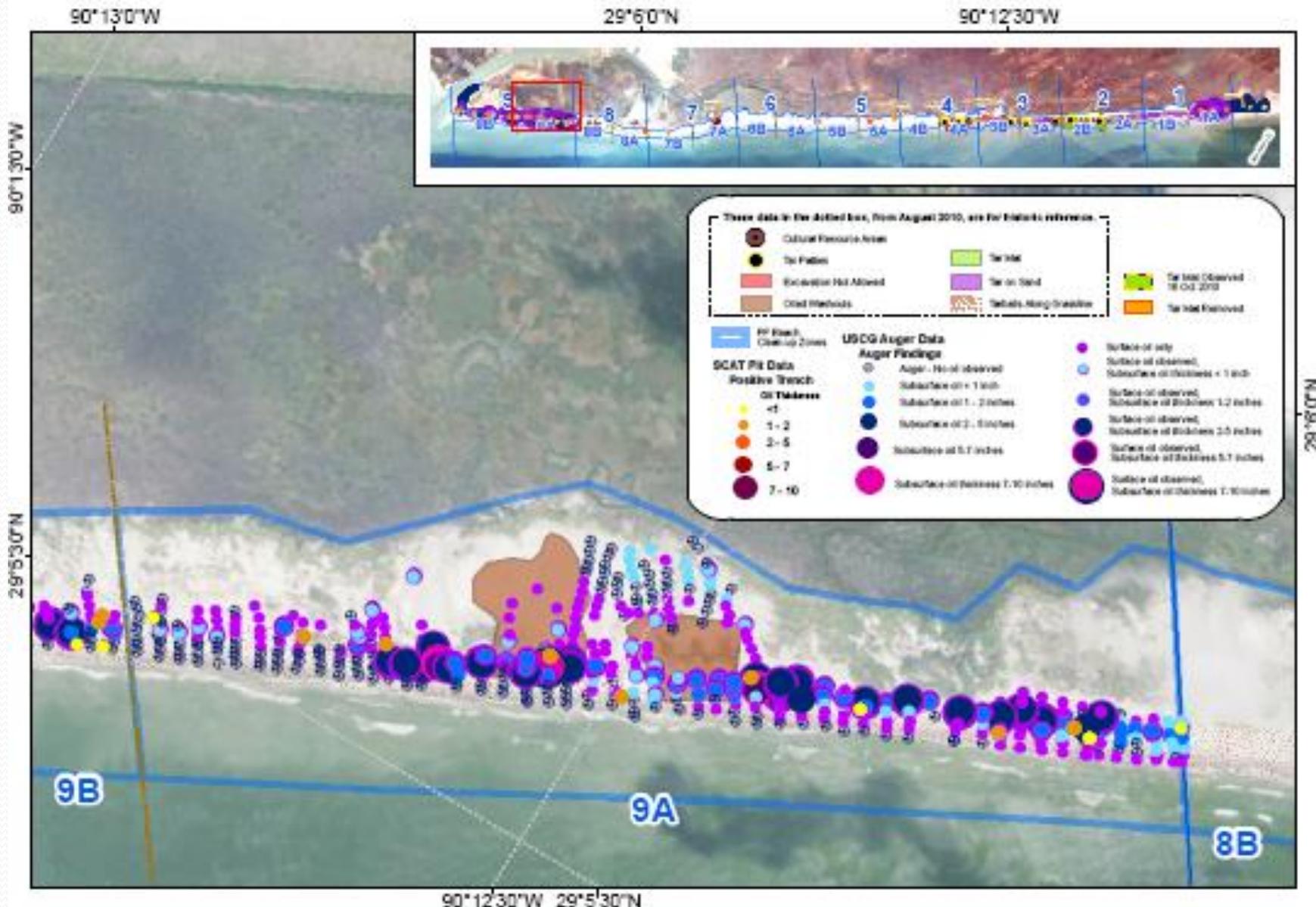
# Current Technology

TACTICAL FEASIBILITY		Manual (Foot Access Only)						Limited Mechanical (Low Surface Pressure Tracks/Flotation Tires)						Unlimited Mechanical (Most Equipment Feasible)														
		Clay/Silt		Sand/Granules		>Granules	Clay/Silt		Sand/Granules		>Granules	Clay/Silt		Sand/Granules		>Granules												
DEPTH (m)		<0.5	0.5-2.0	>2.0	<0.5	0.5-2.0	>2.0	<0.5	0.5-2.0	>2.0	<0.5	0.5-2.0	>2.0	<0.5	0.5-2.0	>2.0	<0.5	0.5-2.0	>2.0									
POTENTIAL TACTIC	Pits/Trenches/Manual *	x	-		x	-		x	-		x	-		-			x	-		x	-		x	-				
	Pits/Trenches/Mechanical *										-	-		-	-		x	x		x	x		x	x				
	Coring Manual	x	x	-	x	x	-				x	x	-				x	x	-	x	x	-	-					
	Coring Mechanical										-	-	-	-	-	-	x	x	x	x	x	x	x	x	x			
	Coring-Vibratory										-	-	-	-	-	-	x	x	x	x	x	x	-	-	-			
	Water Jet	x	x	x	x	x	x				x	x	x	x	x	x				x	x	x	x	x	x	-	-	-

Green: Potential Tactic

Yellow: Potential Tactic under Limited Conditions

# EXAMPLE SUBSURFACE OIL MAP





Team 1 MC-252

N 30° 12.076' W 088° 25.849'

07/21/2010



# Basically.....

- Current practice based on **visual observations** in excavated pits and trenches
- Can be **labor intensive and time consuming**, particularly for large areas or repetitive surveys
- Rely on **small horizontal samples**, may not be adequate to detect or define discontinuous subsurface oil
- Developing technologies have a **real potential** to accelerate the collection of subsurface data and/or allow for continuous horizontal detection and delineation.

# Conclusions

API study identified tactics and technologies which **promise to significantly improve current data collection capabilities**

These techniques can *greatly accelerate the SCAT process*

1. detection **dogs** can locate and delineate: real-time mapping of subsurface oiling;
2. multiple sensor **push probes** can reduce the amount of excavations necessary for subsurface characterization;
3. Non-invasive **geophysical** techniques can delineate the horizontal extent of subsurface oiling; and
4. Near-surface **vapor detection** tactics can provide real time mapping of subsurface oiling (“mechanical sniffing”)

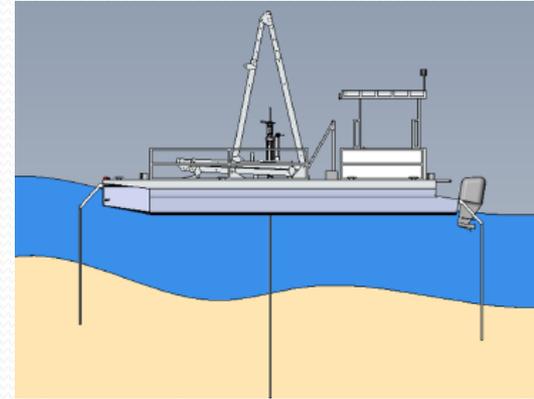


**Filtered  
Detectors**

**Sapphire  
Window**

**Digital  
Electronics**

**Piezocone**



ATTRIBUTES	Existing Procedures			Developing Technology (Potential)			
	Excavation	Cores	Jetting	Push Probes	Service Dogs	Geophysical	Surface Gas
Delineation (Horizontal)	Yellow	Red	Red	Red	Green	Green	Green
Delineation (Vertical)	Green	Green	Yellow	Green	Red	Yellow	Red
Survey Speed	Red	Red	Yellow	Yellow	Green	Green	Green
Oil Character	Green	Green	Yellow	Green	Red	Red	Red
Relative Cost	Yellow	Red	Yellow	Yellow	Yellow	Green	Green

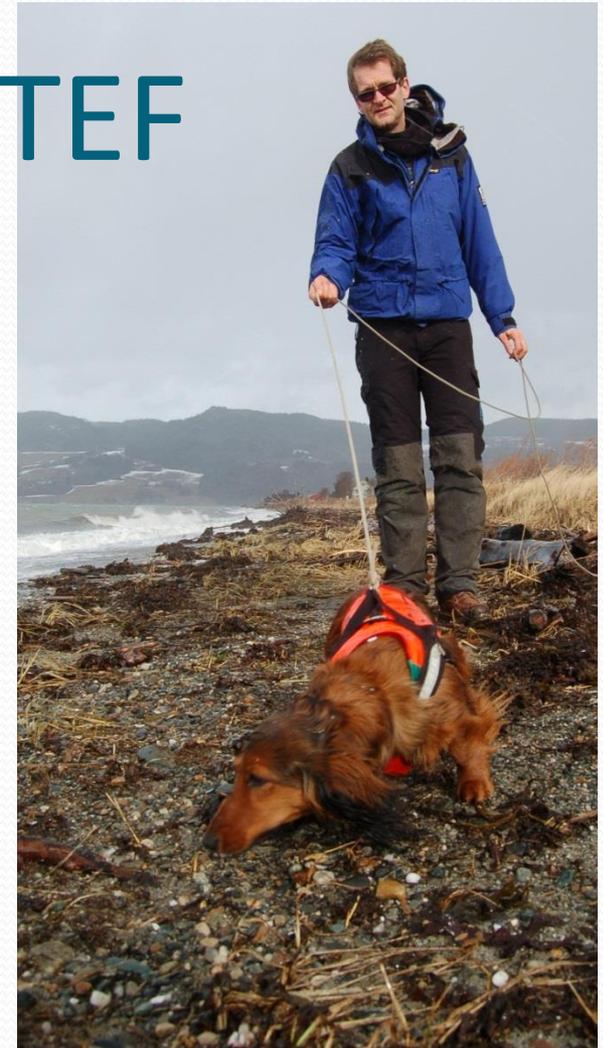
- **Green** indicates a favourable application;
- **Yellow** indicates that the strategy may be effective, depending on circumstances, and
- **Red** indicates important limitations or "not applicable".

# Why Dogs ?

## Proven concept + SPEED + CONTINUOUS COVERAGE

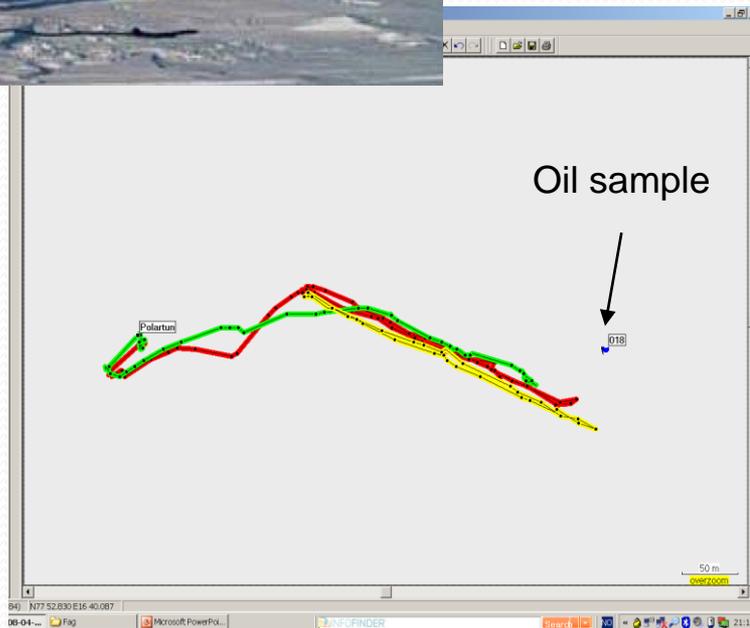
- One day - manual digging - single team - maximum production of 200 pits (*based on MC 252 field operations*)
  - two teams = 3-4 linear miles coverage with 3 pits across-shore per 100 yard interval transect
  - a TOTAL “SAMPLE” OF **100 sq. yds.**
- In one day, a pair of detection dog teams can cover
  - up to 2-3 linear miles of continuous coverage , or
  - a TOTAL “SAMPLE” OF **100,000 sq. yds.**
- Dogs provide virtually **100%** coverage versus **< 0.01%** coverage by manual or auger spot sampling.

# Pioneering Work by SINTEF



# Detecting oil buried in ice/snow

Oil in Ice JIP project - published AMOP 20109



GPS tracks of three dogs, all detecting oil sample drilled down into the sea ice

Oil sample (400 mL) drilled into the ice and left for a week



**SITE 3**

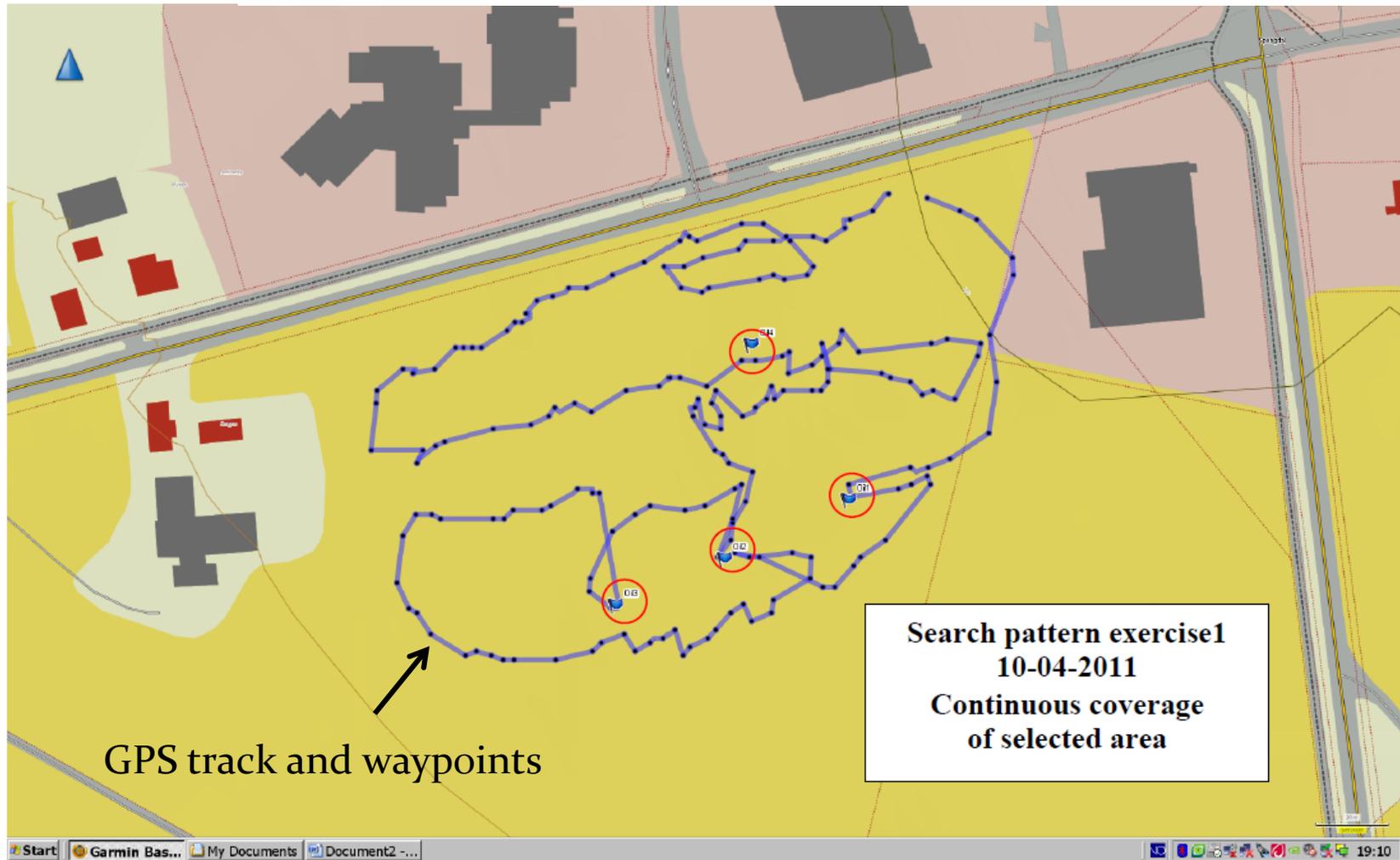
**Svalbard 1997**



**Svalbard 2008**

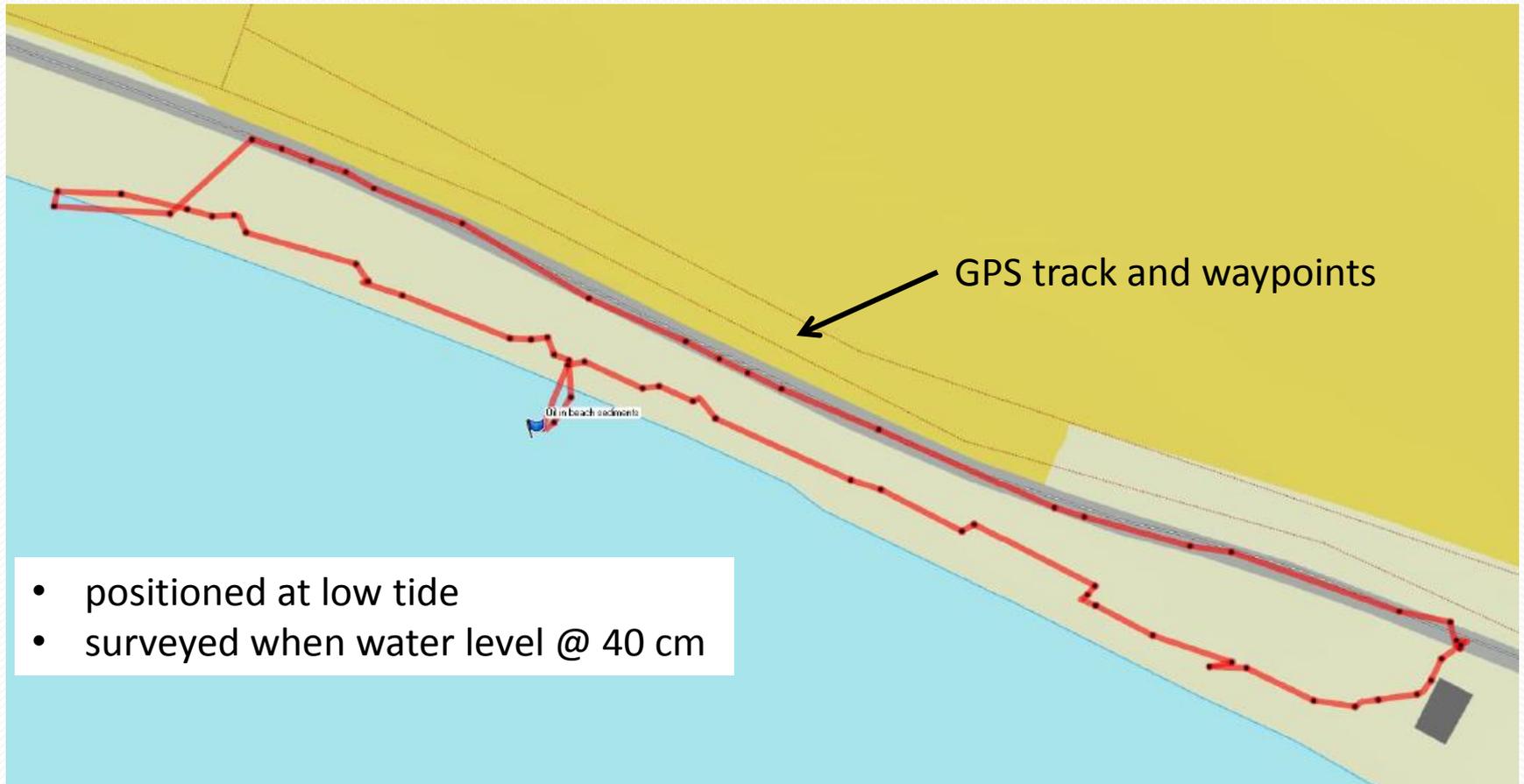
Buried oil layer at 0.8 m

# Wide Area Search – 4 Targets



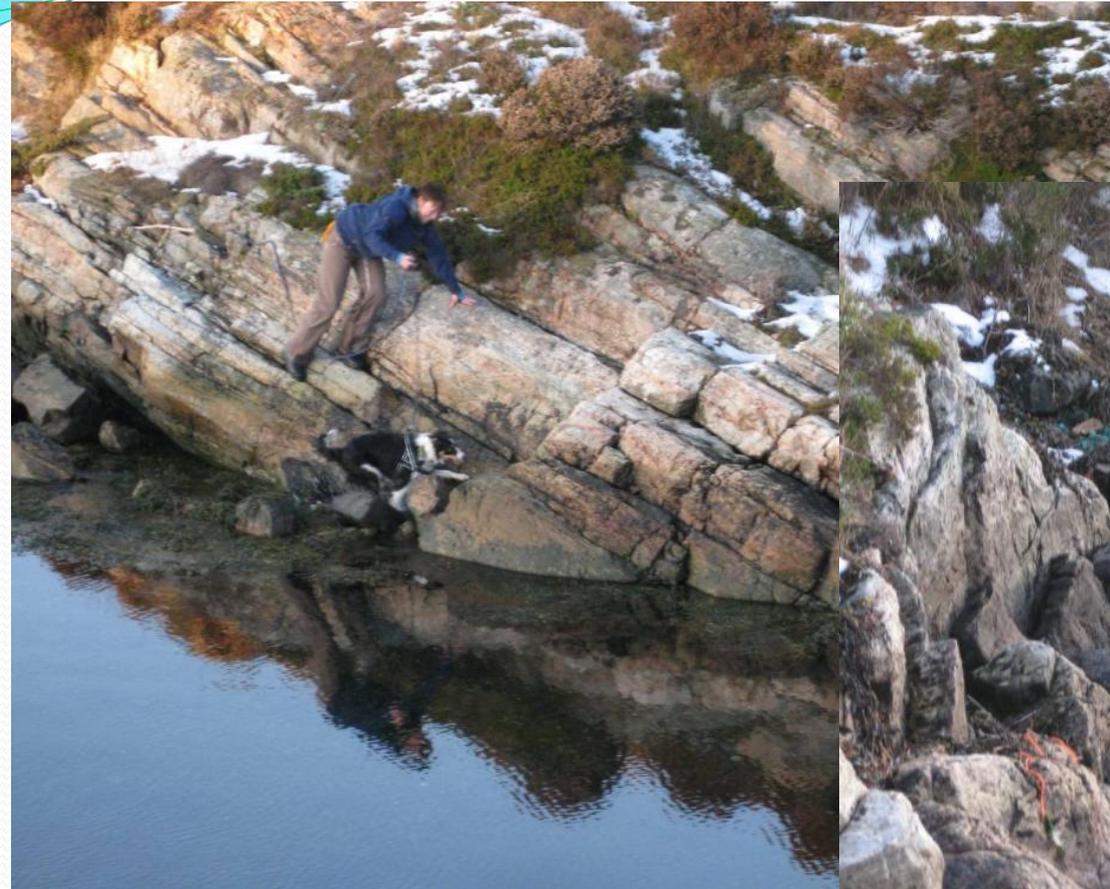
- Weather conditions: 10 °C, 0-2 meters/seconds wind (very variable!)
- Area covered: 220 m x 120 m = 26 400 sqm
- Time used: 46 minutes, average speed 2.3 km/hour
- Equipage: Tara (our smallest/slowest dog) and Per Johan
- All four oil pads (hidden in grass) detected by direct marking (dog sitting and pointing down with nose)

# Wide Area Search – Single Target



- positioned at low tide
- surveyed when water level @ 40 cm

## Demanding coastal localities



However, easy access for the dogs

Oil concentrations  
ppm/ppb range



07 May 2012

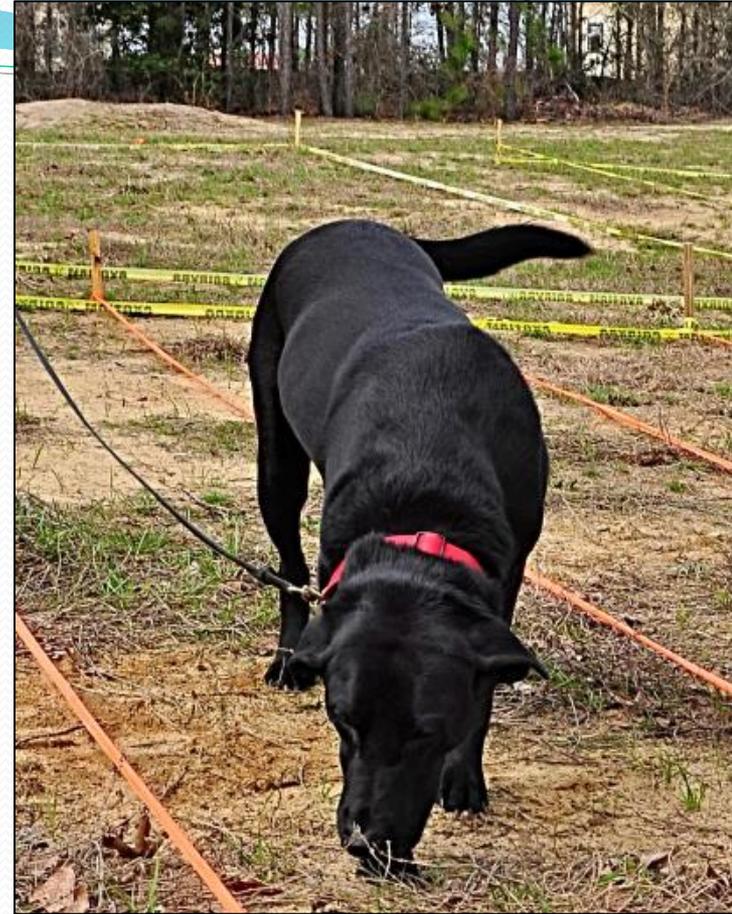
Training...



# API – Phase 3

Field Trials 1<sup>st</sup> - 5<sup>th</sup> June 2015

*Visitor Program 4<sup>th</sup> June*



# Phase 3 - Purpose

- 1. Field Trials** to evaluate the ability:
  - to successfully DETECT subsurface oil during a “Wide Area Search”;
  - to accurately DELINEATE subsurface oil configurations; and
  - to successfully repeat tests and replication with 2 dogs.
- 2. Canine Subsurface Oil Detection Manual** for planners and decision makers to determine appropriate situations for which a Canine Detection Team could usefully support a subsurface oil assessment (SCAT) survey related to:
  - Pipeline spills;
  - River spills;
  - Marine shoreline spills;
  - Lake shoreline spills; or
  - Spills under ice or snow.

# Field Trails Test Design

- All tests “double blind”
- One set of tests - **Wide Area Search** pattern for:
  - DETECTION of a single subsurface oil target(s) in a large area; and
  - “clearance” of a large non-oiled area.
- DELINEATION tests will involve:
  - 50 prepositioned empty bottom-sealed plastic tubes at a 5-m offset spacing (diamond grid pattern) and up to a maximum of 1-m deep;
  - the inner blank and oiled sediment tubes will be inserted into the empty tubes in a series of configurations continuous,
    - discontinuous, and
    - isolated subsurface oiling patterns.

EST #	Design and Dog #	of Targets	Layout Design	Priority	COMMENTS
1	Wide Area Detection #1	2		1	
2	Wide Area Detection #2	2		1	
3	Wide Area Detection #1	2		2	
4	Wide Area Detection #2	2		2	
5	Wide Area Clearance #1	0		1	
6	Wide Area Clearance #2	0		1	
7	Wide Area Clearance #1	0		2	
8	Wide Area Clearance #2	0		2	
9	Delineation – continuous #1	23	A	1	
10	Delineation – continuous #2	23	A	1	
11	Delineation – continuous #1	11	B	2	
12	Delineation – continuous #2	11	B	2	
13	Delineation – continuous #1	10	C	3	
14	Delineation – continuous #2	10	C	3	
15	Delineation – continuous #1	23	D	3	
16	Delineation – continuous #2	23	D	3	
17	Delineation – discontinuous #1	22	E	3	
18	Delineation – discontinuous #2	22	E	3	
19	Delineation – discontinuous #1	13	F	2	
20	Delineation – discontinuous #2	13	F	2	
21	Delineation – discontinuous #1	5	G	1	
22	Delineation – discontinuous #2	5	G	1	
23	Delineation – discontinuous #1	11	H	3	

# Topics

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# Lake Wabamun - Wading Surveys



Lake Wabamun Incident  
August 26 Bottom Oil Survey

# ROV Track Lines

272 observation points  
No oil found

0 190380 760 1,140 1,520 1,900  
Meters

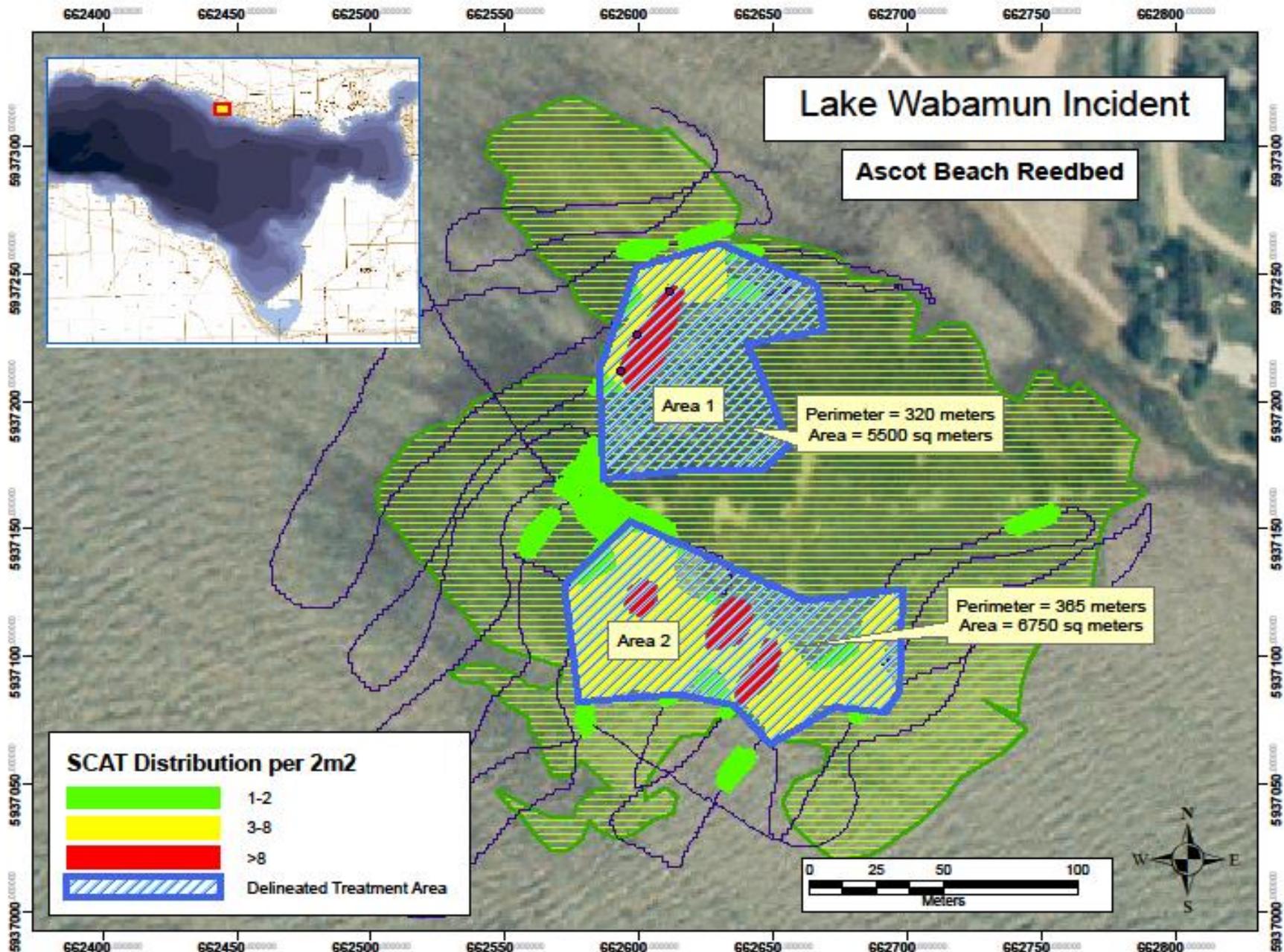


WLB-05-02



# Viewing Tube Surveys





# Deepwater Horizon – “Snorkel SCAT”



# Inland Spills

- In most ways, **no significant difference between inland and shoreline detection and delineation tactics.**
- Pipeline leak detection has used dogs for many years (with an injected odorant)
- Under ice detection work at CRREL (2015) has been funded by the Arctic JIP
- Inland environments less complicated as typically less dynamic

# Conclusions

Current accepted techniques to locate subsurface oil in sediments basically are:

- slow,
- labor intensive, and
- involve low resolution spot sampling.

The same is true for shallow-water sunken oil.

Existing tactics and technologies could **significantly improve detection and delineation:**

- **dogs** for detection, delineation and real time horizontal mapping;
- **push probe** testing;
- **geophysical** techniques; and
- **vapor detection** (“mechanical sniffing”).

Many opportunities exist for technology improvement that have a high probability of success and that could provide a high value, short-term gain.



Sam - Wide Area Search



Patton - delineation

