OIL DETECTION CANINES

2020 projects to detect subsurface oil

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Humans have Breed Many Types of Working Dogs to Hone Specific K9 Skills

- Companions/therapy
- *Detection dogs - find things*
- Guide dogs
- Herding dogs
- Hunting (hounds, retrievers or terriers)
- Protection (personal or patrol) dogs
- Search and rescue
- Sled dogs
- *Tracking dogs - follow things*

Detection ("Sniffer") Dogs

- Can be trained to find almost any target by the **odor molecules** that a substance emits (easily down to ppb – maybe ppt?)
  - bed bugs, blood, cadavers, cancer, explosives, food, invasive species, mines, narcotics, wildlife, whale poop, Covid-19, etc.
- Trained using positive reinforcement ("Operant Conditioning"): dogs are motivated by rewards so the activity becomes fun.
- For oil detection, the K9 samples **air-borne molecules** at or near the ground-air interface and/or the **ground scent** ("footprint").
- Each nostril separately can determine the target **odor concentration** in milliseconds which allows the dog to instantly move towards a higher concentration.
- Can detect an odor tens or more meters away from the source.
- Unlike tracker dogs, once imprinted to an ordor **do not need a starting point**.

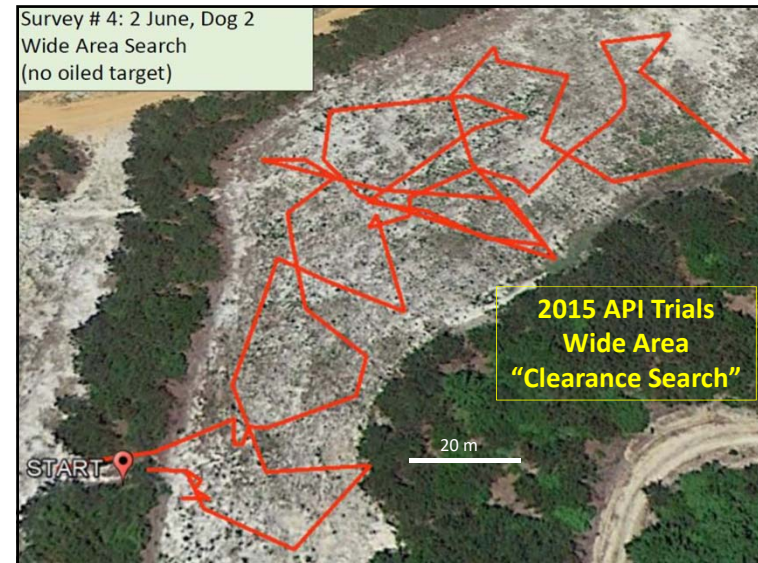*Oil detection began with pioneering work at SINTEF in 2007 ……..*

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Detection Dogs on Svalbard ITOSS/SINTEF

ITOSS Experiment   1997

IFO 30 oil

SINTEF September 2008

oil at 80 cm depth

April 2008 SINTEF

JIP Study   M/V Server oil spill

2015-2020 Field Projects

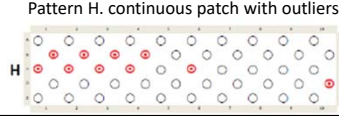| DATE	LOCATION	ASSIGNMENT
2015 June	Jackson Springs NC, USA	**API subsurface oil detection and delineation Field Trials**
2016 June	Chedabucto Bay, Nova Scotia, Canada	T/V *Arrow* spill shoreline survey +1 year post release
2016-2018	N. Saskatchewan River, SK, Canada	pipeline release: real-time spill response SCAT support
2017 June	Prince William Sound AK, USA	search for 28-year old sequestered oil
2020 February	Somerset TX, USA	**API deep target weathered oils Field Trials**

Survey # 4: 2 June, Dog 2
Wide Area Search
(no oiled target)

2015 API Trials Wide Area "Clearance Search"

START

20 m

2015 Delineation Tests

* SCAT - *Shoreline Cleanup Assessment Technique*

- **Objective**: to delineate subsurface oiling identified during a Wide Area Search
  - Slower and more detailed search
  - Results in defining a focused area for a follow up SCAT* subsurface investigation (i.e. pits/trenches)
  - Typically on-leash search pattern directed by handler with support from a K9 SCAT Team Lead

Pattern H. continuous patch with outliers

2020 Field Trials

Three canines for replication: two Labradors with field experience and a young English Springer Spaniel in training

QUESTIONS:

1. Can a canine detect **weathered and "heavy" oil**?
2. Can a canine be used to detect oils to **greater depth**s than previously tested (90 cm)?

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Chiron K-9 Training and Testing Facility

co-located with the Global Training Academy, Somerset TX, 30 minutes south of San Antonio

- environmentally controlled room with an industrial exhaust fan, viewing room, storage, and work rooms
- 12-arm carousel
- 3-port Olfactometer
- integrated data and media collection capability

- Wide Area Search open grass field
- Certification grid open grass field

GTA Field Location

5-m deep pipe array

North Field WAS Area

South Field Certification Area

mixed depth pipe array

400 ft

2020 Field Trials Oil Types

By increasing viscosity:

- unweathered dilbit (Cold Lake crude oil blend)
- unweathered Bunker C fuel
- weathered Macondo crude oil ("CTC")(like cold honey)
- very weathered semi-solid Macondo crude oil ("Juniper")
- solid, very weathered <u>marine tar balls</u> collected on Mustang Island TX

Cold Lake dilbit

representative oils

actual oils

n-alkane carbon number

Stage 3 CTC

Bunker C

Stage 3 Juniper

Tar ball

n-Alkane Carbon Number

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Task 1 - Weathered and "Heavy" Oils

- "Carousel" set up in an environmentally controlled room
- All runs "double blind"

Q. Can a canine detect **weathered and "heavy" oils**?
- 5 oils
- 3 canines: 2 experienced with oils - 1 young dog in training
- high-sensitivity (5 ppm) PID (Photo-Ionization Detector)

Task 1 - K9 and PID Results - CAROUSEL

- K9's were **100%** in 38 runs: each run <<1 minute
- PID did not detect any targets with the lids on the pots
  - With the lids removed and the PID sample port held still at ~1" from the pot detected 5 of the 6 targets
  - 4 PID readings ranged from 0.2 to 3.3 ppm: the 5th was 53.5 ppm (the unweathered dilbit)
  - no reading was registered on one of the tar ball targets

Task 2 - DEEP TARGETS (5 m - 15 feet)
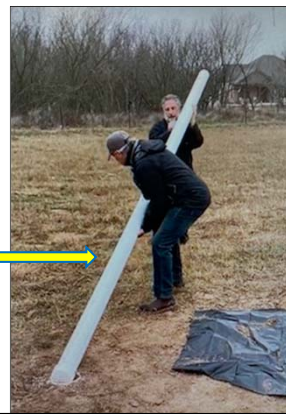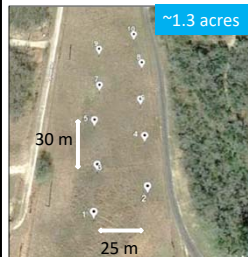
- targets loaded at the base of 15-foot (5-m) pipes
- pipe bottom sealed
- pipes set into preplaced outer pipes and then back filled with the bore hole cuttings
- 3 oils (dilbit, Bunker C and tar ball targets) placed one week prior, the CTC and Juniper targets placed <24 hours prior

Task 2 - Weathered/Heavy Oil Deep Targets

*Q. Can a canine detect oils to **greater depth**s than previously tested (3 feet - 90 cm)?*

- Three K9s, 5 runs over 2 days
- Each K9 had one "double blind" run
- Total: 21 oiled targets, 20 blank targets, 9 empty pipes
- The K9s were not "primed" on the two weathered oils that had been placed <24 hours, both targets were detected successfully

Wide Area search:
- **49 targets were correctly identified during 5 runs**
- Average run time 4.8 minutes for ~1.1 acres coverage
- Found 20 out of 21 on 15-foot deep targets
- One K9 did not detect "Juniper" – the other 2 K9s did
- Detected the airborne odors on the run up to 40 feet (12 m) away from the pipe working into the wind and 6 feet (2 m) working with the wind
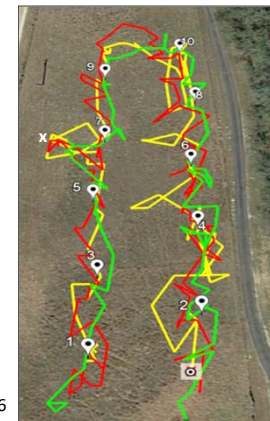
Day 2 track lines – three K9s

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K9 and PID Results - WIDE AREA SEARCH

- K9's were 20 out of 21 on 15-foot deep targets
- detected the airborne odors on the run up to 40 feet (12 m) away from the pipe working into the wind and 6 feet (2 m) working with the wind
- PID did not register on any of the 8 field targets until port held still <1 inch from the pipe surface: then registered on 5 of the 8 targets
- PID readings ranged from 0.2 to 2.5 ppm

Verification

Project	Alerts or Targets	Verified	%	Comments
2015 API Field Trials	**704**	**702**	**99**	3-day program; **strictly controlled design** of oiled and non-oiled targets: very high confidence
2017 PWSSC-OSRI Study	28	18	64	3-day field study; **verification constrained** as very difficult to dig pits in the coarse sediments
2017 North Saskatchewan River Oil Spill Response	8,689	7,748	**89**	4 K9 SCAT teams **deployed continuously for 13 weeks** from May-August; surveyed 690 river shoreline km: verification % **probably low**
2020 API Deep Target Field Trials	**60**	**59**	**98**	3 dogs, very **weathered oils, targets up to 5m** in soils; PID verified 5 of 8 oil targets but only when held steadily right at soil surface

Search Speeds/Coverage

- **subsurface oil search rates** logged for the 2020 API Field Trials translate to an average working speed for a 50-m wide, flat terrain, ROW on the order of **5 km of 100% coverage in one hour or less**
- considerably faster than a normal walking speed with a PID or an ATV visual search speed for surface oil on a zigzag search track similar to that of a K9
- past field spill deployments in similar and rougher terrain conditions have shown can sustain this search rate for 4 to 6 hours at a time, with suitable rest periods, for 5 to 6 days in a row, for weeks on end

Right of Way Detection Survey – November 2020
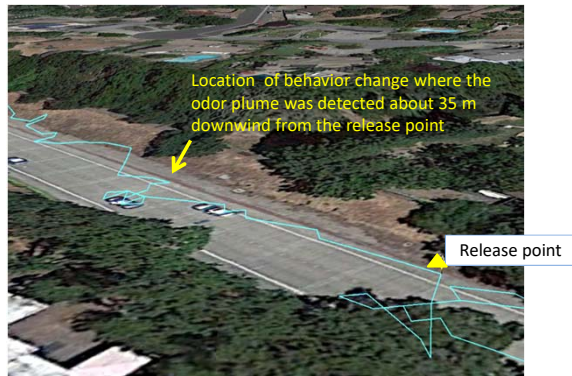

- deployed in a COVID-constrained travel/work environment
- 4-mile section of ROW somewhere west of the Mississippi

- urban, primarily commercial/infrastructure environment
- 2 major road crossings – one confined waterway crossing

- experienced Oil Detection Canine certified under International Canine Spill & Leak Detection Association standards
- professional handler

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Right of Way Detection – November 2020

Location of behavior change where the odor plume was detected about 35 m downwind from the release point

Release point

Survey Statistics

- Deployment
- ROW length
- ODC GPS track line
- Survey manager distance
- Time to completion

- 24 hours to site
- 6.4 km / 4 miles
- 16.6 km / 10.3 miles
- 11.1 km / 6.9 miles
- 4.5 hours

- Temperature
- Winds

- 60-65°F
- light breeze (<10 mph) – search conducted into the wind

K9 Support can be a Game Changer for Subsurface Oil Detection and Delineation

RESPONSE / PROJECT	PERIOD	NUMBER OF PITS/TRENCHES	COMMENT
Deepwater Horizon: SCAT	May 2010 - December 2012	>180,000	NOO in 67%
Deepwater Horizon: LAASR	January-June 2013	>32,000	NOO in 5 of the 15 selected target areas (33 %)
Deepwater Horizon: BOP	June-August 2013	>8,000	NOO in 86% of the locations
Bouchard B-155, Tampa Bay FL: SCAT	18-19 August 1993	964	1 team, 2 days: pits at a 1-m interval on 119 transects spaced at 160 m
Refugio, CA: SCAT	15 June 2015	360	4 teams: 1500' x 30' area (4,000m²) with a 10'x10' (3m x 3m) grid in 6 hours

Huge Potential Time and Effort Savings for Shoreline Clearance Surveys

RESPONSE OPERATION	TOTAL SHORELINE LENGTH SURVEYED (km)	LENGTH WITH NO OBSERVED OIL (NOO) (km - %)
Deepwater Horizon	7,057	5,285 - 75%
T/V Exxon Valdez, AK	5,459	3,359 - 62%
M/V Selendang Ayu, AK	763	345 - 45%
M/V Cosco Busan, CA	379	232 - 61%

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Oil Detection Canines (K9 SCAT Support)

A science-based game changer

- Do we need K9 support every time? *NOT NECESSARILY*
  - However, in some situations K9s can help to locate surface oil more quickly and so speed up traditional surveys, particularly in difficult terrain
- ✓ Should we consider their applicability and usefulness to support SCAT? *EVERY TIME*
  - At a minimum always ask whether a K9 support team can be used for subsurface oil detection and/or and clearance surveys?
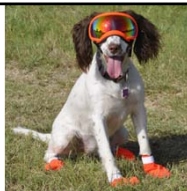

Questions ?

A dog is a tool and is a delicate and sensitive instrument - handle with care and love.

Safety

- A professional handler is responsible for the care, health, and safety of the animal.
- Air intake can go to the lungs or to the olfactory component of the nose – can close the intake instantly (milliseconds) if the odor is undesirable.
- No medical studies on the topic but has not been a problem for arson or explosive detection for decades.
- K9s and humans are constantly exposed to hydrocarbons – e.g. gasoline filling stations.

Potential ODC Studies

1. **Remote Oil Detection** Sample Collection
2. Oil Detection **Technology Comparison**
3. **One Oil Type** Discrimination
4. **Underwater** Oil Detection
5. **Seafood** Taint Detection
6. **Dispersant** Detection and Clearance
7. Texas Coast **Tar Ball Background** Study

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Potential ODC Studies

1. **Remote Oil Detection** Sample Collection
   - Collect air sample and deliver to an ODC
   - Multiple **land-sea-air-ice** potential platform collection options
   - Can support field-based for remote area operations
   - Field trials can be verified by tph or GC analyses

Potential ODC Studies

2. Oil Detection **Technology Comparison**
   - Oil Detection Canine (ODC)
   - Photoionization Detector (PID)
   - Konikore®
   - Smell.Inspector®
   - Electromagnetic (EM) Profilers (Conductivity)
   - Electrical Resistivity (ER) Profilers
   - Ground-Penetrating Radar (GPR)
   - Nuclear Magnetometer Resonance (NMR)
   - ?

Potential ODC Studies

3. **One Oil Type** Discrimination
   - ignore other (background) oils, such as tar balls
4. **Underwater** Oil Detection
   - freshwater and seawater
   - still and moving (currents) water
5. **Seafood** Taint Detection
   - fish and crustaceans/shell fish
   - compare with a human panel
6. **Dispersant** Detection and Clearance
   - onshore or on water

Potential ODC Studies

7. Texas Coast **Tar Ball Background** Study
   - 12 month time series
   - monthly surveys with an ODC
   - monthly beach profiles to understand sediment erosion and deposition cycles
   - ? joint TAM Corpus Christi project

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Potential ODC Studies

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Things to Consider

- Potential for successfully **meeting objective**(s)
- Potential for **practical application**(s)
- Verification/credibility - **acceptance**
- Level of **effort** (cost)
- Multidisciplinary/agency, student involvement

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