EnviroEmerg Consulting Services, Duncan, British Columbia, Canada

Shoreline Cleanup Assessment Techniques for Oil Spills in Tropical Marine Environments

SCAT Course Manual

Shoreline Cleanup Assessment Techniques (SCAT)* is a systematic and comprehensive approach used during an oil spill to provide timely information on shore oiling conditions and to determine the best cleanup treatment solution.

* Also referred to as: *Shoreline Cleanup Assessment Team*






January 2010

Emerging environmental issues related to oil and hazardous material spill risk and mitigation

EnviroEmerg Consulting Services

Mailing: 3520 Glenora Road, Duncan, British Columbia, CANADA, V9L 6S2
Tel: 250 732-5515 Skype: Stafford Reid
E-mail: enviroemerg@me.com Web: enviroemerg.ca

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills

Course Preface

Overview:

Shoreline Cleanup Assessment Techniques (SCAT)* is a systematic and comprehensive approach used during an oil spill to provide timely information on shore oiling conditions - whether in coastal, lake or river environments. Within the dynamics of a spill, SCAT brings the field perspective to the Response Team to develop the objectives and strategies for cleanup operations. The SCAT process strives for both *environmentally-sound* and *cost-effective* response activities to achieve an overall *net environmental benefit*. The goal is to maximize the recovery of oiled environments and resources while minimizing the risk of further ecological injury from cleanup. Effective application of SCAT:

✓ Reduces spill response costs and meets the criteria of reasonable cost, and
✓ Meets environmental agency and stakeholder expectations.

SCAT Course:

- **Objective**: to train personnel to be proficient in SCAT from the field to incident management response levels, as well, as to understand the range of shore-based cleanup measures in which SCAT is operationally applied.
- **Approach**: to provide a combination of classroom instruction that includes SCAT concepts, field data collection and command post data management. Course is structured in subject modules. Instruction includes a field tour for SCAT application wherever locating to various shore-types is feasible.
- **Style**: to delivered the course with a style that emphasizes the human relations dynamics of working together and addressing stakeholder/community concerns. Emphasis is placed on participant interaction and dialogue to explore issues and concerns as they arise.
- **Audience**: Government and industry personnel who are either interested in field delivery of SCAT, management/application of SCAT information, or both. Between 8 to 14 people is the optimal class size.
- **Framework**: Course content is according to the *Incident Command System* (ICS) for emergency management and the SCAT standards and process established by *US National Oceans and Atmospheric Administration* and *Environment Canada*. Oil spill response training is focussed on shore cleanup operations in which SCAT is mainly applied. Modules include three environments: 1) marine temperate 2) marine tropical and 3) inland freshwater (lakes/rivers) - selected based on client regional needs..

Module 1 - Course Objectives & Content

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Ducnan, British Columbia

CANADA

EnviroEmerg.ca

SCAT - *course objective*

To train personnel to be conversant in the *Shoreline Cleanup Assessment Techniques* (SCAT)* process from the field to incident management levels.

The objective is to provide timely, standardized information on shore oiling conditions that meets operational, agency, client and stakeholder needs.

** Note: that SCAT is used interchangeably between

- *Shoreline Cleanup Assessment* ***Techniques***
- *Shoreline Cleanup Assessment* ***Team***

SCAT – *course standards*

Course will be in accordance with:

- *Shoreline Cleanup and Assessment Techniques* process as adopted provincially, nationally and internationally, and
- The *Incident Command System* for site (Incident Command Post) emergency management.

SCAT - *audience and course delivery*

The course is primarily intended for government and industry personnel who are either interested in SCAT:

- On-shore delivery - *field members*
- Information management* - *SCAT coordinator*
- Incident management* - *Incident Commanders, Section Chiefs, Branch Directors*

Course delivery is a combination of classroom instruction, field tour and a table-top exercise.

* Undertaken at the Incident Command Post

SCAT – *course outline*

PART 1 – *SCAT framework*

- **Module 2:** Definition, Principles, Benefits & History
- **Module 3:** Net Environmental Benefit
- **Module 4:** SCAT Process

You Will Learn

What is SCAT, and its purpose, benefits and mission.

Fundamentals of *net environmental benefit* to achieve an ecological balance to meet stakeholder interests.

Compare tactical response options with the advantages and disadvantages of natural clean-up.

SCAT tasks and processes during phases of an oil spill.

SCAT – *course outline*

PART 2 – SCAT within the Incident Command System

- **Module 5:** Incident Management
- **Module 6:** Working Relationship with Operations
- **Module 7:** SCAT Job Descriptions

You Will Learn

Basics of the Incident Command System (ICS) for environmental emergency response where SCAT is applied.

The essence of SCAT to guide and work with operational personnel.

SCAT job descriptions as technical specialists within ICS.

SCAT – *course outline*

PART 3 – Case Studies

- **Module 8:** Case studies of oil spills.

You Will Learn

Opportunities for SCAT process to achieve a net environmental benefit in shoreline response activities examined through a photo essay of case studies:

•*M/T Prestige* Oil Tanker No 2 Fuel Spill on November 13th, 2002 in Galicia, Spain

•*M/V Westwood Anette* Freighter Bunker Spill on August 4th 2006 in Squamish, British Columbia

SCAT – *course outline*

PART 4 – Working Environments

- **Module 9:** Environments: tides, waves, winds, and currents
- **Module 10:** Geomorphology Processes, Shoreline Types & Coastal Character
- **Module 11:** Coastal Ecology
- **Module 12:** Sensitive Tropical Ecosystems
- **Module 13:** Coastal Values & Uses
- **Module 14:** Coastal Resource Mapping

You Will Learn

The basics on:

• Tides, winds and currents and how they influence SCAT decisions

• Processes that make and change shorelines

• Coastal ecology with focus on shore zonation and terminology relevant to SCAT, as well as sensitive tropical ecosystems (corals, mangroves, seagrasses)

• About shore resource values uses - public, commercial, marine protection & first nations (Aboriginal)

• How environments (ecology, geomorphology) are mapped.

SCAT – *course outline*

PART 5 – Shore Cleanup Methods

- **Module 15:** Cleanup Methods
- **Module 16:** Shore Characteristics and Cleanup Options

You Will Learn

A wide-range of shoreline cleanup measures - when and where to use, constraints and environmental effects of each option and other factors important to SCAT decision-making.

The fundamental physical and biological characteristics of shores; how oil is likely to behave in each of these characteristic areas, and what are the best options for treating oiled shores that are practical, safe and cost-effective.

SCAT – *course outline*

PART 6 – Shore Cleanup Constraints and End-Points

- **Module 17:** Constraints for Shore Treatment
- **Module 18:** End points for Shore Treatment

You Will Learn

"What not to do" as constraints to cleanup operations by examining examples of pre-established operational constrains for a variety of cleanup options and actual constraints used.

How to establish and to write endpoints as measurable criteria assigned to an oiled segment of to determine the completion of a specific treatment plan.

SCAT – *course outline*

PART 7 – Field Measurement & Documentation

- **Module 19:** Field Measurement Equipment
- **Module 20:** Field Measurement Methods
- **Module 21:** Field Documentation

You Will Learn

About of field equipment such as hip-chains, range-finders, GPS, etc.

How to take measurements of oiling coverage, character, and thickness for each oiled shoreline segment.

How to extract "pre-information" from shoreline coastal resource atlases.

How to complete forms and sketches for each segment to identify specific locations to be cleaned based on field measurements.

SCAT – *course outline*

PART 8 – Field Health & Safety & Field Tour

- **Module 22:** Field Health and Safety
- **Module 23:** Field Application

You Will Learn

What personal protective equipment (PPE) and supplies that should accompany a SCAT field kit.

About SCAT in-the-field by visiting a selection of shore types, habitats and environments in order to foster perspectives of: government agencies, industry (Responsible Party), stakeholders (community) and operations personnel and other matters such as:

- safety issues and communications
- operational constraints
- recommended tactics
- suggested end-points

SCAT – *course outline*

PART 9 – Information Management

- **Module 24:** Automation of SCAT Field Data Collection
- **Module 25:** Information Packaging and Presentation

You Will Learn

The challenges and opportunities to use technology in-the-field, such as using, GPS, photo geo-referencing, and Personal Digital Assistant (PDA)

How to take the field data and compile, analyze and present the information to unified command, operations and stakeholders.

SCAT – *course outline*

PART 10 – Integration Table-top Exercise

- **Module 26:** Table-top Exercise
- **Module 27:** Course Evaluation

You Will Learn

How to integrate the course material *via* a table-top exercise - from arriving at Command Post, for incident briefing, SCAT standardization, safety etc, to going into the field, and returning to manage SCAT field data.

Module 2 – Definition, Principles, Benefits, and History

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
Enviroemerg.ca

SCAT - *definition*

The *Shoreline Cleanup Assessment Techniques* (SCAT)* process is a systematic and comprehensive approach used during an oil spill to provide timely information on shoreline oiling conditions.

"Shoreline" refers to coastal beaches, estuaries and associated wetlands / back-channels

SCAT - *purpose*

The SCAT process provides assessment of stranded oil, geomorphologic features, operational limitations, environmental resources, human uses, and cultural sensitivities to assist in determining:

- Priorities for cleanup;
- Shore-based response objectives and strategies;
- Scope of logistics (people and equipment);
- Constraints to cleanup operations;
- Effectiveness of cleanup operations,and
- When cleanup is completed (end points).

SCAT - *principles*

The SCAT process uses standardized references, procedures and terminology for documenting field information and communicating the results to the Incident Management (Response) Team.

A SCAT objective is for field data to be consistent, comparable, and useful to meet agency, client and stakeholder acceptance.

SCAT - *principles*

Within the dynamics of a spill, SCAT brings the field perspective to the Incident Management (Response) Team.

SCAT - *benefits*

The SCAT process benefits include:

- Ensures field information has been collected and documented;
- Expedites decisions on establishing priorities for cleanup and determining cleanup methods;
- Reduces response costs and supports reasonable cost;
- Mitigates secondary impacts to the environment;
- Lessens amounts of oily waste generation, and
- Fosters agency and stakeholder confidences and acceptance on spill response performance.

SCAT - *mission*

The mission of SCAT is to strive for both *environmentally-sound* and *cost-effective* response activities to achieve an overall "net environmental benefit".**

SCAT MISSION

Maximize the recovery of oiled environments and resources while minimizing the risk of further ecological injury from cleanup efforts

*** Module 3- examines the concept of "net environmental benefit"*

SCAT - *premise of role of government and spiller*

A premise underlying SCAT is that it is generally understood and agreed by the response community that it is government - as the steward/trustee of natural resources (shorelines, fish, birds, mammals *etc*.) - who are responsible for establishing the environmental protection priorities during an oil spill.

Whereas, the Responsible Party* is primarily responsible for the tactical operations of the response, as well as, ancillary activities to support SCAT field work.

**Responsible Party (RP) refers an agency or company taking responsibility for impact mitigation (e.g. cleanup, response management) as a possible consequence of their actions or that of a third party – it does not infer fault.

SCAT - *fundamental structural aspects*

The three "F's of SCAT are:

1. **Functions** within the Incident Management System – both in organization and protocols;
2. **Flexible** in terms of scale of the survey and detail of the data sets collected, and
3. **Facilitates** multi-agency representation and stakeholder interests.

SCAT - *history*

The SCAT process was founded by Environment Canada during the 1988 *Nestucca* barge oil spill of the west coast of Vancouver Island and its procedures refined during the 1989 *Exxon Valdez* tanker spill in Alaska.

The agency custodians of SCAT in the United States and Canada are the *US National Oceans and Atmospheric Administration* and *Environment Canada*, respectively.

SCAT is also used internationally such as in the United Kingdom, Australia and New Zealand.

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *net environmental benefit analysis*

The SCAT process is a form of *Net Environmental Benefit Analysis* (NEBA) that assists in:

- Making decisions about the options available for clean-up so that environmental and socioeconomic impacts are kept to the minimum;
- Getting the correct balance to meet all stakeholder interests in the best practicable manner, and
- Weighing up and comparing tactical response options with the advantages and disadvantages of natural clean-up.

SCAT – *NEBA principles*

Spill response should seek:

- **To minimize** the severity of the environmental damage, and
- **To enhance** the recovery of any damaged ecosystem

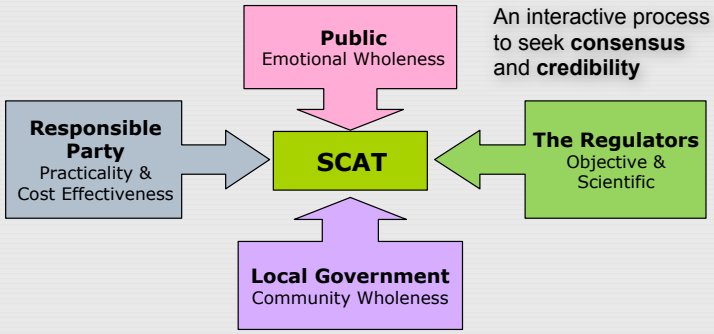
SCAT – *NEBA tenets*

Tenets of NEBA are that the SCAT process is:

- Transparent and equitable to stakeholders;
- Science-based and structured;
- Delivered by qualified people;
- Practical, and
- Fosters reasonable cost.

SCAT –*NEBA drivers*

The SCAT process involves key players and stakeholders within the spill response community as follows:



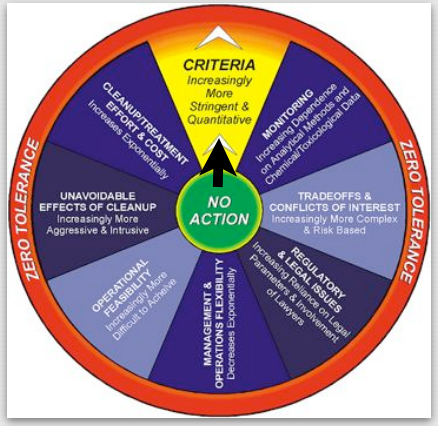
An interactive process to seek **consensus** and **credibility**

SCAT – *NEBA process*

The NEBA process during a spill typically involves:

- **Collecting** information about the spill, the ecology, and human use;
- **Predicting** based on previous case histories and experience the likely environmental/socio-economic impacts, and
- **Comparing** the advantages and disadvantages of response options including natural recovery.

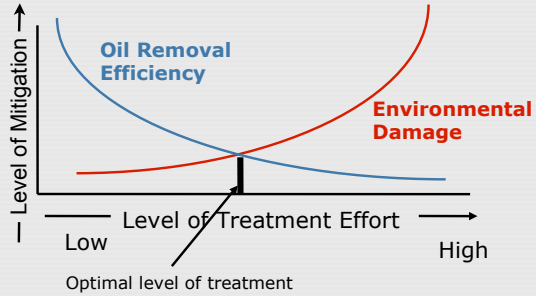
SCAT – *NEBA when moving towards stringent standards*



SCAT – *NEBA limits*

The NEBA process also involves knowing what to do **(response options)**, what not to do **(response constraints)**, defining when the job is done **(end points)**, and determining when the job is done **(sign-off)** by participating agencies.

The Recovery Rule
"The more effort to remove oil, the greater the degree of environmental intrusion"



SCAT – *skill requirements*

To effectively undertake NEBA - and the SCAT process therein - one needs to be conversant in:

- Understanding the fate and effect of different oils within different;
- Using coastal resource inventory and oil sensitivity mapping;
- Knowing the geomorphological and ecological aspects of affected environments (shores, lakes, rivers);
- Understanding shore treatment options and their secondary environmental impacts;
- Recognizing and engaging local stakeholders for their local knowledge and interests, and
- Meeting agency mandated interests.

SCAT - *natural healing*

Shoreline cleaning by natural processes is the fundamental bench-mark to compare environmental impact and cleanup treatment options

SCAT - *natural recovery*

M/V Seledang Ayu incident - December 8, 2004, Skan Bay off Unalaska Island in the Aleutian chain, Alaska

September 2005 to May 2006

SCAT - *natural recovery*

M/V Westwood Anette Bunker spill - August 4th, 2006 in Squamish Estuary & Howe Sound, British Columbia

September 2005 to May 2006

SCAT - *natural recovery*

Exxon Valdez crude oil spill - March 24, 1989 in Bligh Reef in Alaska's Prince William Sound

"Mearns Rock," located in the intertidal zone at Snug Harbor on Knight Island, Prince William Sound, Alaska. The boulder is located on a protected rocky shore that was heavily oiled.

This section of shoreline was not cleaned after the spill.

1990 to 2004 - Mearns Rock Time Series
1st photo 15 months after oiling

SCAT - *a NEBA challenge in the tropics*

The chemically disperse oil within severely oiled mangroves or not?

WHAT IS KNOWN

Floating oil has long-term adverse impacts to mangroves and associated fauna, and relatively minor effects on seagrasses, corals and associated organisms.

Chemically dispersed oil into the water column can cause harm to corals and other reef organisms, but mitigates the oil effects on mangroves.

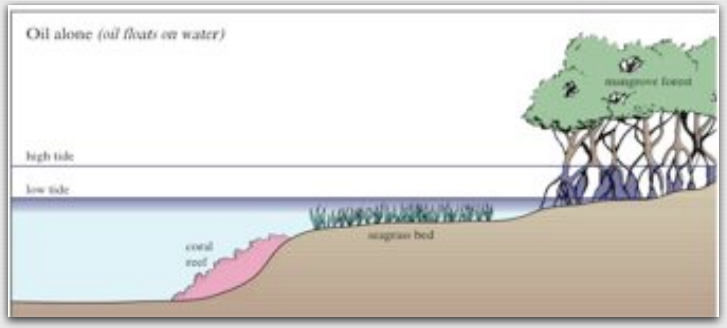
TRADE-OFF DECISION

If one were to take no action, the mangroves and inter-tidal organisms would suffer; the corals would remain healthy.

Using dispersants, mangroves are less affected by the oil, but coral and seagrass incur damage by the dispersed oil in the water column.

SCAT - *a NEBA challenge in the tropics cont..*

To leave alone or to disperse?



SCAT – *NEBA summary*

SCAT members need a plan that **maximizes** the recovery of oiled habitats and resources, while **minimizing** the risk of injury from cleanup efforts. Consideration needs to be given to:

- Potential for human exposure;
- Extent and duration of environmental impacts;
- Potential for remobilized oil to affect other sensitive resources;
- Likelihood of cleanup to cause greater harm than the oil alone, and
- Opportunities to use natural process to hasten recovery.

Rule of "Minimum Regret" of never having to say:
"We should have not done that" or "Sorry"

Module 4 – SCAT Process

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *phases of a spill*

REACTIVE PHASE: Aerial reconnaissance to track oil spread and to determine vulnerable coastal resources/ interests.

Field Observer functions begins with reviewing coastal resource inventory and shore oil sensitivity mapping and imagery to identify resources at risk relative to the oil's anticipated weathering behaviour and modelled trajectory.

Field observations are undertaken by Operations and other personnel experienced in identifying and documenting oil on water.

SCAT – *phases of a spill cont..*

TRANSITION PHASE: Spill response focus becomes on the retrieval of pockets of mobile oil trapped along shoreline recesses to reduce re-oiling of shore areas.

The objective of this phase is to shift the response focus from reactive offshore oil recovery towards a protracted, systematic shore cleanup process.

Generally the start of SCAT process when the trapped oil can be linked to shore units.

SCAT – *phases of a spill cont..*

PROTRACTED SHORELINE CLEANUP PHASE: There is no re-oiling of shores. This phase gathers field data to guide the long-term, protracted cleanup and remediation of oil shores and infrastructures.

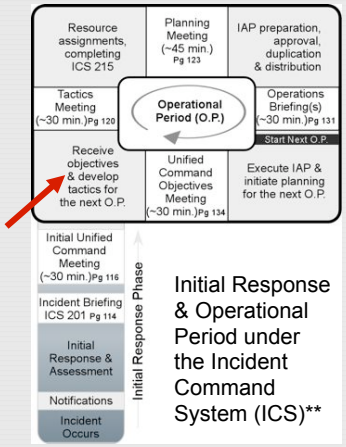
This process is systematic and undertaken on a shore unit-by-unit basis. SCATs are deployed ahead of cleanup work teams to gather information to develop shore work plans.

SCAT personnel and process are fully engaged

SCAT – *the initiation of SCAT process*

The SCAT process is initiated when:

- Field observations of species at risk, oil trajectory are completed;
- Mobile on-water oil stranded along and on shores that can be linked to shoreline units;
- Initial response phase is over;
- Incident objectives are established pursuant to an Incident Action Plan;
- Operational period has been invoked; and/or
- Work assignments for shore-based operations are being considered



Initial Response & Operational Period under the Incident Command System (ICS)**

*** Modules 5 & 6 examines the SCAT process under ICS.*

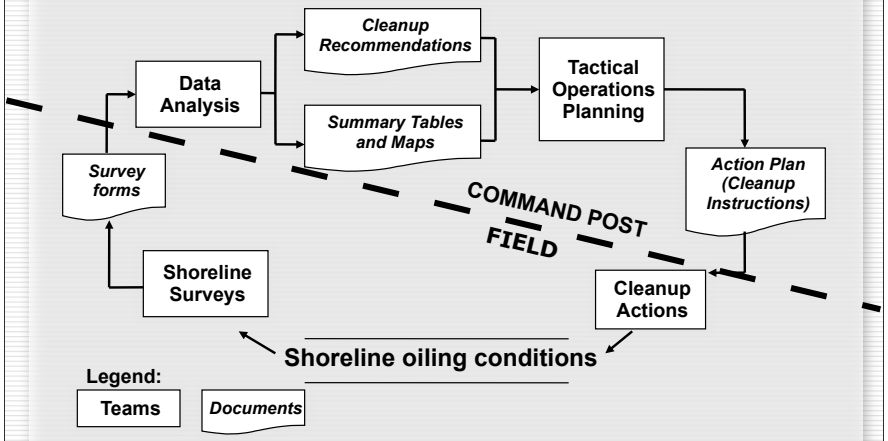
SCAT – *tasks*

The SCAT tasks consist of:

- Identifying sensitive ecological resources at risk;
- Mapping the character of the oiled shores;
- Documenting the nature of the oiling conditions;
- Identifying environmental concerns;
- Making cleanup recommendations, and
- Suggesting operational constraints.

This field information must be effectively compiled, analyzed and communicated to incident management so as to guide field tactical operations on the removal of stranded oil on shores.

SCAT – *process schematic*



SCAT – *establishing a SCAT coordinator*

The SCAT coordinator** position is established to scope out field SCAT team and logistics requirements by:

- Reviewing the response objectives and strategies;
- Assessing the level of shoreline oiling and resources affected based on field reconnaissance surveys and oil sensitivity maps;
- Determining responsible party, agency and community needs and interactions.

A SCAT coordinator deliverable is a SCAT plan that provides an understanding of timelines and logistics requirements. This plan should be done BEFORE the first Operational Period requiring SCAT resources.

** SCAT coordinator and other SCAT team positions generally have been involved in the "field observer" reconnaissance surveys.

SCAT – *establishing SCAT field teams*

Two SCAT teams are generally established: 1) a **primary** SCAT and 2) a **stakeholder** SCAT. The first does most of the long-term field work, whereas the latter may be temporarily or permanently established to foster industry, agency and community understanding an acceptance of the SCAT process.

BOTH WORK TOGETHER ON AN INTERIM BASIS

Primary SCAT are qualified (trained and experienced) personnel*:

- A geomorphologist
- A biologist
- A archeologist

Stakeholder SCAT are personnel representing local interests such as:

- First Nations (Aboriginal)
- Local Government
- Parks

* Recommended by primary resource agencies and approved by Command

SCAT – *a stakeholder SCAT*

SCAT – *getting prepared*

The SCAT preparation activities by both the SCAT coordinator and team members include:

- Reviewing coastal resource and oil sensitivity maps;
- Establishing with Operations the need to tactically function according to shore units;
- Determining field SCAT form requirements;
- Scheduling field SCAT standardization meeting;
- Determining and standardizing constraints and end-points;
- Establishing SCAT a data management system;
- Arranging with Logistics for field transportation and meals, and
- Undertaking safety briefings and PPE requirements.

SCAT – *undertaking field SCAT*

The SCAT teams are deployed to:

- Standardize field measurements particularly in oiling characteristics, oil coverage, and biological indicators;
- Work with agency and local stakeholder interests for process clarification and indoctrination, and
- Undertake SCAT data collection on assigned shore units.

Meanwhile, the SCAT coordinator at the Incident Command Post continues to design a field survey presentation and packaging for operations, planning, and command.

SCAT – *manage incoming SCAT data*

The SCAT coordinator and assistants:

- Undertakes quality assurance with field SCAT of their data for accuracy, completeness, and clarity;
- Enters field data into computer systems: (photographs / geo-referenced), SCAT info in data systems (databases or spreadsheets);
- Compiles information into summary maps and documents for command and information officer, and
- Packages information of shore cleanup operations (Division supervisors).

This work is generally done in the evening

*** Module 25 examines SCAT data management*

SCAT – *presenting SCAT data*

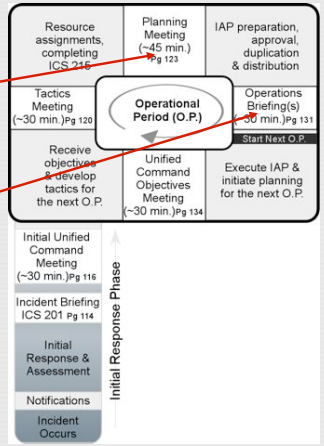
The SCAT coordinator presents:

- The SCAT summary data at *Planning Meeting*,

and

- the SCAT operational data at the *Operations Briefing*.

Start all over again for the next operational period.



Module 5 – SCAT Process within Incident Management

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT– *definition of Incident Command System*

The definition of the Incident Command System - commonly referred to as the ICS:

*The ICS is a standardized incident management organization deployed at the site of an incident to directly supervise field operations. It is an organization that provides a common framework within which people ** can work together effectively.*

**** These people may be drawn from multiple agencies that do not routinely work together - THIS ALSO INCLUDES SCAT PARTICIPANTS.**

SCAT – *Incident Command System*

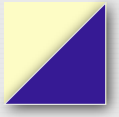
The *Shoreline Cleanup Assessment Techniques* (SCAT) process is often conducted under the Incident Command System (ICS) - particularly in Canada and the United States.

Within the dynamics of a spill, the SCAT members brings the field perspective to the Incident Management (Response) Team so they can develop response objectives and strategies.

SCAT – *incident command post*

The Incident Command Post is where:

1. Communication and supervision of field personnel occurs;
2. Tactical (operational) planning and decisions are undertaken;
3. Unified command is established among multiple participating agencies and Responsible Party (spiller).



Icon for ICP

An ICP may range from:
- **a spot on the ground**
- **vehicle or trailer**
- **board-room**
- **to an gym/auditorium**

SCAT - *field-to-site relationship*

Resources:
Response Equipment
Responders
Field Observers

Field Situation Information →
← Tactical Direction

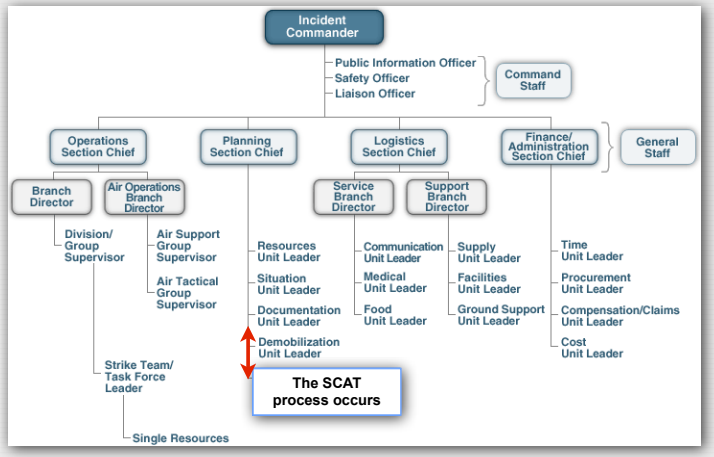
INCIDENT ACTION PLAN

FIELD *– Tactical Operations*

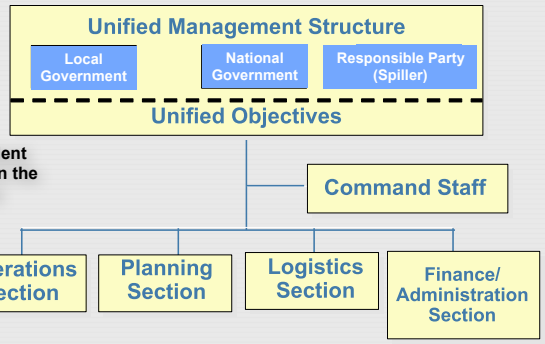
SITE *– Incident Management*

Incident Command Post
Incident Management Team
Incident Command System

SCAT – *Incident Command System organization*



SCAT– *multiple jurisdictions*



An Integrated Incident Management Team in the Command Post

An Integrated SCAT Team in the field

FIELD – Tactical Delivery

SCAT - *unified command*

Under unified command, the Incident Commanders and their respective participating personnel undertake an integrated spill response without abrogating their agency's or corporation's legal responsibilities or mandates - *this also applies to SCAT team member representatives*.

Participating members of the SCAT process should have representation in Command

SCAT – *ICS terminology: field observers*

Both field SCAT members and those at the Incident Command Post managing the data are **"technical specialists"** Other technical specialist include:

- Trajectory
- Historical Cultural Resources
- Wildlife Response
- Weather
- Waste Management

Field SCAT members are "field observers". Other field observers can included:

- Species at Risk (birds and mammals)
- Oil behaviour and trajectory

SCAT – *ICS Terms: Divisions*

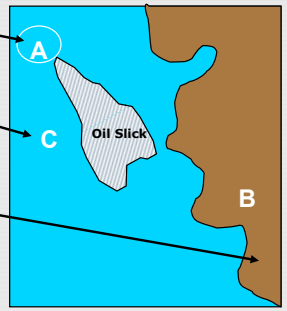
A spill incident may be separated it geographical (area) components called "Divisions" to focus both planning and tactics on specific aspects of an incident.

Each Division has a "supervisor". There can be many divisions.

Division **A** – Vessel Casualty

Division **C** – On-water Response Area

Division **B** – Shoreline Cleanup Area



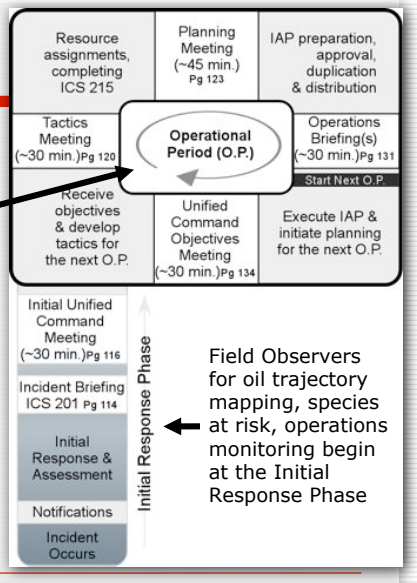
SCAT personnel need to foster a positive and cooperative relationship with shore-based Division Supervisor(s)**

**Module 6 examines the SCAT relationship with operations personnel

SCAT – *operational period*

The SCAT process functions in accordance with an Operational Period which is a scheduled sequence of tasks, deliverables and meetings. Operational Periods for shoreline cleanup phase of a spill are generally 24 hours.

SCAT field data collection and data management must meet the time-lines of an Operational Period – A PERFORMANCE MEASURE



Field Observers for oil trajectory mapping, species at risk, operations monitoring begin at the Initial Response Phase

-Beginning of Response

SCAT - ICS decision framework

Emergency response decisions are framed as:

- **Objectives** (specified response outcomes, defined by response management);
- **Strategies** (plans used to carry out objectives, protect resources at risk);
- **Tactics** (specific actions taken to carry out a strategy)

The ICS decision process is to differentiate between "wishful thinking" and "reality"

SCAT – *objectives*

Objectives

Objectives must be measurable and achievable. They are written as an action such as:

- **prevent** oil from reaching shores
- **remove** oil from shores
- **rescue and rehabilitate** oiled wildlife

Objectives are listed on the front page of an Incident Action Plan as a constant reminder of what direction emergency management is heading. They are developed by unified command.

The "Wish"

SCAT – *strategies*

Strategies

Strategies are the operational "framework" designed to achieve response objectives. Initial spill conditions play a large role in developing effective strategies. As information is gathered, strategies can be developed (and revised) to protect those resources at risk.

Strategies are develop during response planning based on prior-known and real-time information gathered in the field and evaluated - this includes SCAT related information.

"Reality Setting In

SCAT – *tactics*

Tactics

Tactics are site-specific and individual activities. Information on tactics can include details on equipment type, location of deployment, configurations, constraints and endpoints.

They are written as a group of ICS 204 forms that - once discussed with operations (Ops Briefing) - are attached to the Incident Action Plan for command approval.

These instructions are provided to the Operational Group and / or Divisional Supervisor each morning.

The SCAT information is primarily to guide tactics

"The Reality"

SCAT – *environmental unit*

The Environmental Unit**

- Obtains and reviews information about the affected area;
- Compiles public, property and environmental protection priorities based on mapped data and field observations, impact trajectories, and inter-agency/stakeholder consultations, and
- Prepares plans and other decision-supporting documents, maps, analysis for Command.

Products of the Environmental Unit are delivered in established ICS: forms, formats, and time-frames

*** An alternative to the "Technical Specialist Unit"*

Module 6 - SCAT Working Relationship with Operations

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *communication avenues*

Communication is critical to successful spill operations. The SCAT coordinator and field team leaders (as applicable) should:

- Meet with the Operations personnel to ensure they understand cleanup guidelines, what leeway they have in implementing them, and the key issues of concern to the resource agencies;
- Spot-check cleanup operations for compliance with cleanup guidelines and effectiveness toward achieving target cleanup end points; and
- Respond to requests from Operations to resolve problems encountered during cleanup activities.

SCAT – *keep it simple*

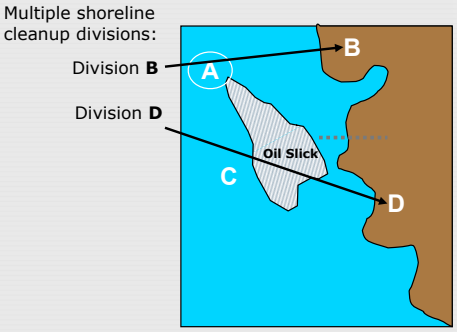
The shoreline assessment process should fit the spill conditions - simple as possible, yet comprehensive enough to address all of the issues and concerns of shore cleanup.

The SCAT process should not keep Operations waiting for information and direction. When delays occur, Operations will get the information it needs on its own and direct itself.

SCAT – *works with division supervisors*

The SCAT assessment process generates site-specific recommendations on resource protection and cleanup methodology for each **shore segment** that are in turn combined within working **divisions**.

Divisions are the responsibility of supervisors to manage all operations therein.

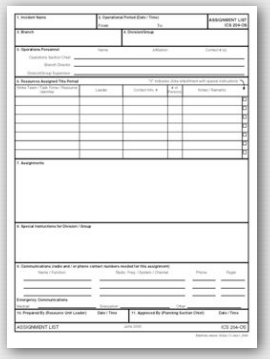


Work according to divisions and get to know the division supervisors

SCAT – *work within the ICS process*

The *Shoreline Assessment Coordinator* must manage the SCAT field personnel and synthesize their field data to support the daily *Incident Action Plan* (IAP).

The IAP includes a bundle of ICS 204 forms** with are the daily work instructions provided to field (Division) supervisors who in turn provides them to their shore workforce personnel.



*** For SCAT the equivalent to an ICS 204 is the Shoreline Treatment Recommendation Transmittal (STRT) form. Module 25 examines data management and transmittal.*

SCAT – *understand the operational mission*

Though the SCAT is functions under the Environmental Unit (Planning Section) of the Incident Command System (ICS), the SCAT field personnel and coordinator are there to serve Operations.

SCAT field personnel need to coordinate their field activities with the operational personnel working in the areas being assessed to ensure important information is exchanged.

SCAT – *reporting problems*

Do not direct operations in the field - this is not the SCAT role. Discuss, evaluate and report shore cleanup effectiveness *via* the SCAT coordinator

Module 7 – SCAT Job Descriptions

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

CANADA

EnviroEmerg.ca

SCAT – *positions & work focus*

SCAT participants consists of a *coordinator* located at the Incident Command post, *team Leaders* and *members* working in the field.

Each participant - by the nature of their profession - has a different work focus.

SCAT – *coordinator*

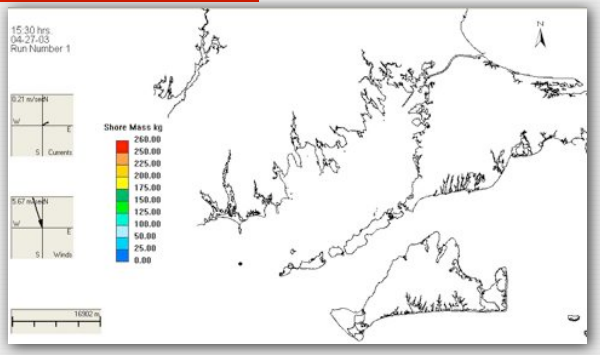
The SCAT *coordinator* leads the development:

1. Of cleanup end points considering shore type, ecological sensitivity, recreational use, and aesthetic requirements, and
2. Of cleanup guidelines for implementing each cleanup method for the impacted shoreline types, based on agency concerns.

SCAT – *generic cleanup guideline*

One of the first activities of the SCAT coordinator is to help write a "generic" cleanup guideline for Operations.

This guide is based on oil trajectory analysis, field observations, and knowledge of affected shoreline types.



Oil Spill Trajectory and Shoreline Oiling Impact Analysis - model
Buzzards Bay Oil Spill April 2003, Westport MA, USA: Bouchard Barge

The objectives are: to determine the number of SCAT teams required, to assess cleanup effort and to get operations active on shoreline cleanup.

SCAT – *coordinator cont..*

As a leader, the SCAT coordinator:

- **Helps** team reach consensus and reports dissenting opinions;
- **Briefs** Planning and Operations chiefs on issues raised by the field;
- **Evaluates** targeted cleanup endpoints and modifies them as necessary, and
- **Recommends** termination of cleanup actions to the Unified Command when:
  - cleanup endpoints have been reached,
  - actions are no longer effective, or
  - further cleanup would cause more harm than good.

SCAT – *the focus of the geomorphologist*

The focus of the geomorphologist is on the physical aspects of the shoreline and oiling conditions – works mainly in the mid and upper intertidal zone. Generally the "team leader"

Tasks:

- Supervises SCAT team in the field;
- Documents oil conditions on applicable *Shoreline Oiling Summary;*
- Undertakes photo-documentation;
- Collects sediment and oil samples;
- Consults with Division supervisor working area being assessed;
- Sketches shore unit information
- Undertakes quality assurance of all SCAT information being submitted.

SCAT – *the focus of the biologist*

The focus of the biologist is on the ecological aspects of the shoreline to determine vulnerabilities and recruitment potential – works mainly in the lower intertidal zone.

Tasks:

- Cross-checks mapped ecological sensitivities;
- Characterizes the overall ecological impact on a shore and recovery potential;
- Recommends operational constraints to mitigate further damages;
- Undertakes photographic documentation for post-treatment comparative analysis.

SCAT – *the focus of the archaeologist*

The focus of the archaeologist is on the cultural and human use aspects of the shoreline. Works mainly in the backshore area.

Tasks:

- Referencing known archaeological, cultural and human use information;
- Assessing potential impacts of operations on cultural/historical sites;
- Recommending constraints on operations such as staging equipment and on shoreline treatment;
- Surveying and marking areas as off-bounds to people and equipment;**
- Collecting and documenting any artifacts found;
- Completes *Cultural Resource Evaluation and Human Use Summary* form.

** demarcating an off-bounds area is done without informing the reason why. All archaeological/cultural sites are confidential.

Module 8 - Case Studies

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *case studies*

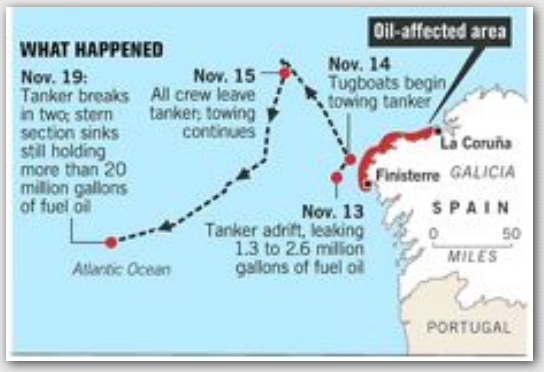
M/T Prestige Oil Tanker No 2 Fuel Spill on November 13th, 2002 in Galicia, Spain

M/V Westwood Anette Freighter Bunker C Spill on August 4th 2006 in Squamish, British Columbia

M/T Prestige Oil Tanker in Spain - November 13th, 2002

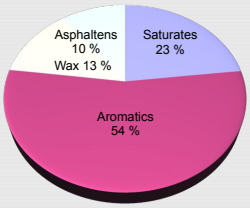
Size: 81,589 Dead Weight tonnes , 243 m length; 34 m width
Cargo: 77,000 tonnes of heavy fuel oil
Age: built in 1976 (26 years old)
Structure: Single Hull
Phase out Date: 11 March 2005

Place of Refuge?



Fuel No 2 - *oil characteristics*

- **Name**: Fuel N°2 (M 100)
- **Specific gravity**: 0.995 kg/l
- **Viscosity**: 30 000 cSt at 10°C
- **Pour point**: 6°C
- **Water in oil emulsion**: 45%



Structural hull failure – No 2 fuel oil

Oil emulsion (mousse)

High oil accumulation in pocket beach

Mobile emulsified oil nearshore

Emulsified oil lifted of rocks

Removal of mobile oil

Removing of mobile oil

Removal of mobile oil

Temporary oily waste management

Oil on sand (foreground) and on boulders (background)

Oil in upper and supratidal area

Typical "bath-tub ring" of oil

Oil on gravel-sand matrix with cobble overlay

Oil turning to asphalt

Oil on rock platform and infrastructure

Oiled marsh

Oiled sandy beach – lower intertidal area

Oil, water and sand interface

M/V Westwood Anette Oil Spill (August 4th 2006 in Squamish BC)

At 3 pm on August 4th, 2006, the *M/V Westwood Anette* departing under tow from the Squamish Terminal during high wind conditions struck a metal pylon and punctured a starboard fuel tank.

An estimated 29,000 liters of Bunker C fuel oil was released – about 2% of its total fuel capacity.

M/V Westwood Anette – *general specifications*

Vessel Type: Forest Product Carrier

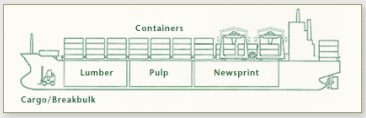
Size: 45,252 Dead Weight Ton

Length Over All: 199.9 meters

Width: 30.59 meters

Cargo: Bulk

Age: built 1987 in Japan



The *M/V Westwood Anette* is constructed and configured as most bulk carriers: single screw, an aft deckhouse, cargo holds, and a double bottom below the cargo holds. **Fuel tanks are located on the centerline in the double bottom below the holds, with wing ballast tanks located outboard of these fuel tanks.**

About Bunker C fuel oil

Bunker C fuel oil is also known as Type 6 heating fuel oil in Canada*.

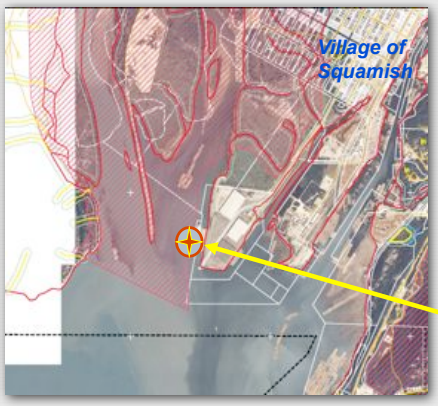
It is a dense, sticky oil produced by blending heavy residual oils with a lighter oil to meet specific needs for viscosity and pour point.

It is inexpensive to make and is used in industrial burners worldwide including most major marine vessels.

* No. 6 fuel oil in the United States

M/V Westwood Anette – *at terminal (day 1)*

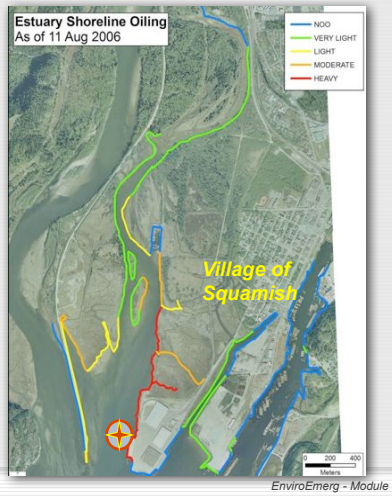
Squamish Estuary – *environmental oil sensitivity map*



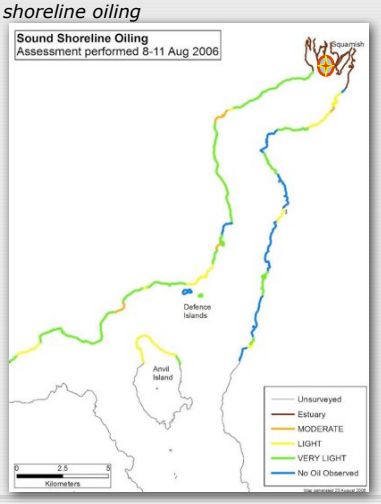
Red – High sensitivity to oil pollution

M/V Westwood Anette at Terminal

Squamish Estuary – *shoreline oiling*



Howe Sound – *shoreline oiling*



On-water Oil Recovery – *boom & skimmer*

Shoreline Protection Boom – *preventing mobile oil entering marsh*

Marsh Oiling – *high tides pushed oil into marsh*

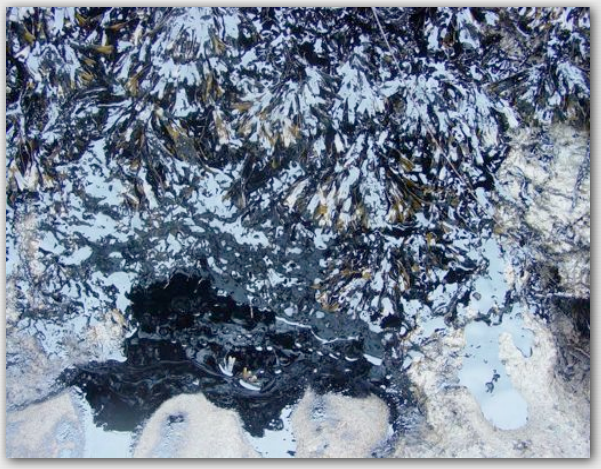
Oiled Marsh – *heaviest oiled marsh ravine*

Oiled Beach front – *little oiling of clay/mud intertidal area*

Oiled Woody Debris – *at clay beach front of marsh area*

Most Heavily Oiled Marsh – *oil contaminated during high tides*

Oiled Rock Weed (*Fucus sp*) – *fully saturated*



Rock Weed – *low oil retention after natural tidal cleanings*

Oiled Marsh Grass – *oiled grasses (yellow ribbons to scare birds)*

Heavily Oiled Marsh Ravine – *mobile oil removed by suction truck*

Manual Removal of Oiled Vegetation – *gas-powered weed cutter*

Moderately Oiled Marsh Vegetation – *spread by high tidal waters*

Life Under the Oiled Vegetation – *no remediation required*

Oiled Vegetation – *natural cleaning by water-borne sediments*

Pom-Pom Pathways – *to reduce trampling impacts on marsh grasses*

Potential Asphalt Layer – *5 to 10 cm of heavy oiled beach gravel*

Oiled Sediment Relocation – *berms readied for natural surf washing*

Oiled Sediment Re-location – *Pom-Poms capture oil as tide rises*

Sediment Re-location by Hand-Raking – *Pom-Poms capture mobile oil*

Manual Sediment Re-location – *silt is a flocculent to capture oil*

Manual Sediment Re-location – *Pom-Poms captures mobile oil*

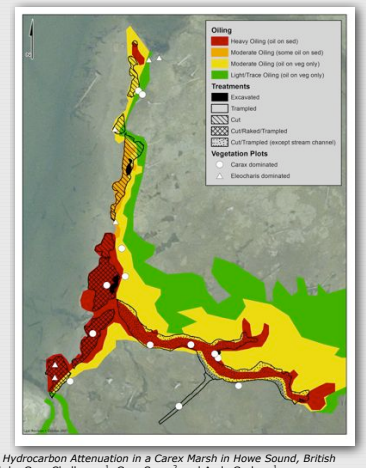
Minor Sporadic Oiling – *Howe Sound: no further cleanup*

Minor Sporadic Oiling – *Howe Sound: no further cleanup*

Post Incident Monitoring

The oiled marsh was subjected to the following types of treatment:

- Natural recovery
- Vegetation cutting & raking
- Low pressure ambient water flushing of sediment
- Shallow excavation of sediment
- Trampling of oiled and unoiled vegetation and sediment



Vegetation Response and Sediment Polycyclic Aromatic Hydrocarbon Attenuation in a Carex Marsh in Howe Sound, British Columbia, Canada Following a Spill of Bunker C Fuel Oil, by Greg Challenger[1], Gary Sergy[2] and Andy Graham[1].
[1]Applied Sciences, Kirkland, WA, USA, Science and Technology, Environment Canada, Edmonton, AB, Canada.

Post Incident Monitoring - *oily vegetation removal*

Vegetation Response and Sediment Polycyclic Aromatic Hydrocarbon Attenuation in a Carex Marsh in Howe Sound, British Columbia, Canada Following a Spill of Bunker C Fuel Oil, by Greg Challenger[1], Gary Sergy[2] and Andy Graham[1].
[1]Applied Sciences, Kirkland, WA, USA, Science and Technology, Environment Canada, Edmonton, AB, Canada.

Post Incident Monitoring - *before and after one year later (August 2006 - 07)*

Untreated oiled marsh vegetation

Cut, raked and removed oiled marsh vegetation

Worker's access pathway through unoiled marsh

Module 9 - Environments: tides, waves, winds, currents

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

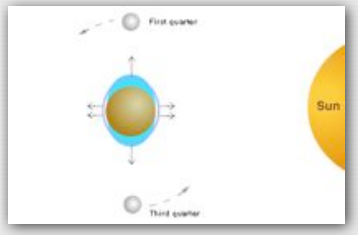
SCAT - *tides*

Tide has two different meanings:

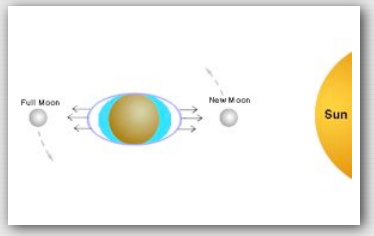
1. *the variation of sea level* at a coastal location, which depends on shoreline topography and nearshore currents (i.e - what you see on shore)
2. *the deformation of land and water of the earth* due to the gravitational forces of the moon and sun (i.e. the "bulge".

The first meaning is of primary relevance to SCAT

SCAT – *Neap and Spring tides*



Neap tides: the moon is in its first or last quarter. The sun's gravitational pull is in perpendicular direction to that of the moon resulting *in lower high tides and higher low tides*.

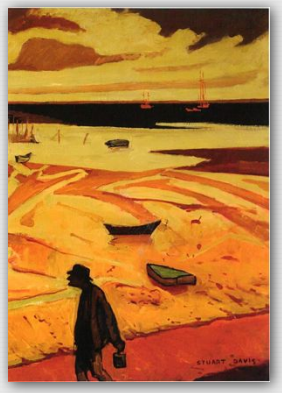


Spring tide: the moon is between the sun and the earth (at new moon). The sun's gravitational pull is in the same direction as the moon's. *The high tides are higher and the low tides are lower*.

SCAT – *tidal period*

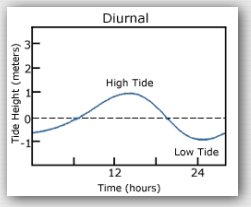
Tides have a periodic variation tied to moon's cycle - about 24 hours 50 minutes that results in alternating:

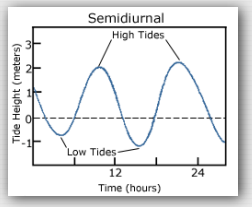
- **Flood tide:** the change from low to high tide
- **Ebb tide:** the change from high tide to low tide

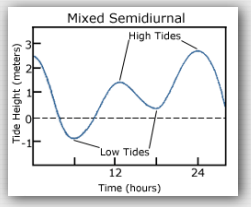


Stuart Davis
EBB TIDE, PROVINCETOWN
(MAN ON THE BEACH)

SCAT – *types of tides*







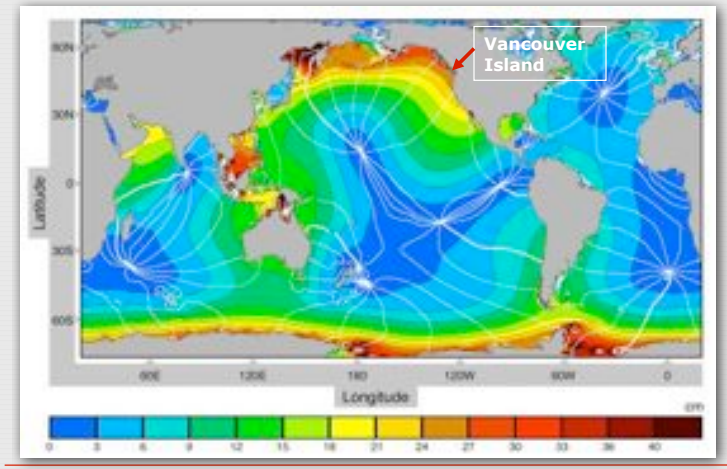
Diurnal tide cycle - one high and one low tide every lunar day.

Semidiurnal tide cycle - two high and two low tides of approximately equal size every lunar day - 12 hrs and 25 minutes between the two peaks or troughs.

Mixed Semidiurnal tide cycle - two high and two low tides of different size every lunar day.

This type is largely responsible for the "bath tub ring" effect of shoreline oiling.

SCAT – *tidal complexity*

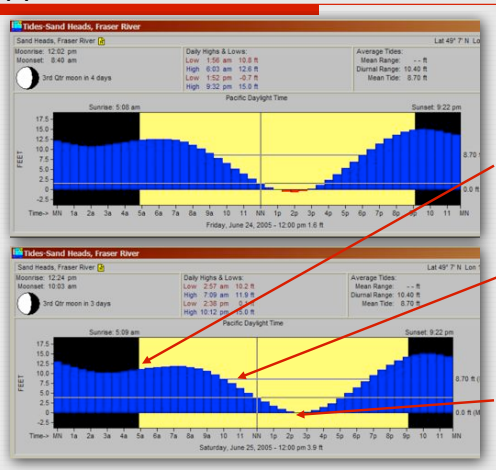


The principal lunar diurnal tide

SCAT – *application of the tidal curve*

June 24th,

June 25th,



1 minute day-light time change

Tidal profile is very important

56 minute day tidal change

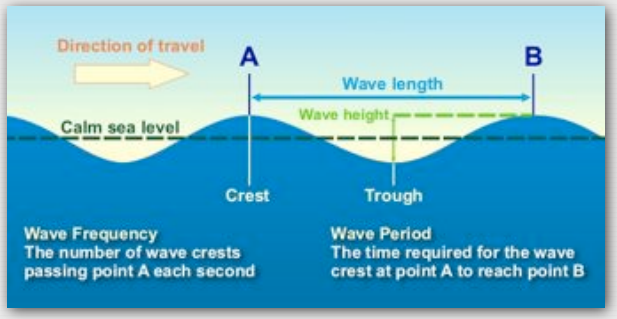
SCAT –*waves*

The majority of waves on an ocean beach result from distant winds. Three factors influence the formation of these **wind waves**:

1. *wind speed*
2. *length of time* the wind has blown over a given area
3. *distance* of open water that the wind has blown over; called *fetch*.

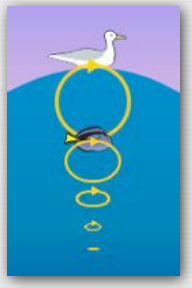
All of these factors work together to determine the size and shape of ocean waves. The greater each of the variables, the larger the waves

SCAT – *anatomy of a wave*



As wind blows across the smooth water surface, the friction or drag makes the surface rougher allowing the wind to intensify the waves

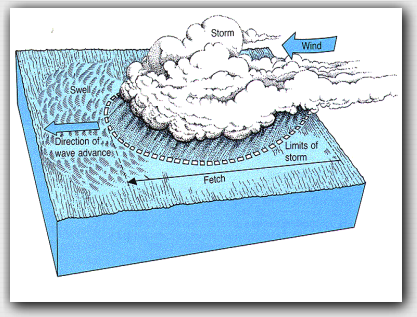
SCAT – *anatomy of a wave* cont…



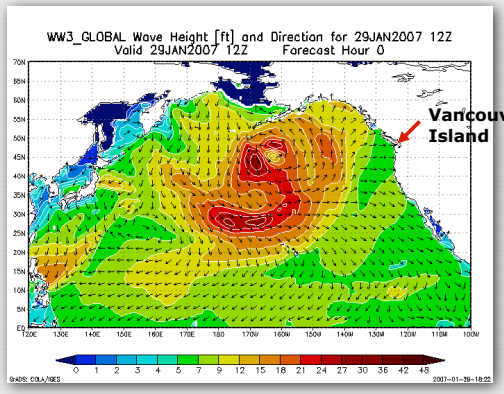
Waves have an *trochoidal* orbital motion that causes an object to bob up and down, forward and backward as waves pass under it.

The water column action has both positive and negative ramifications for shoreline impacts and cleanup options

SCAT – *offshore wave and swell generation*



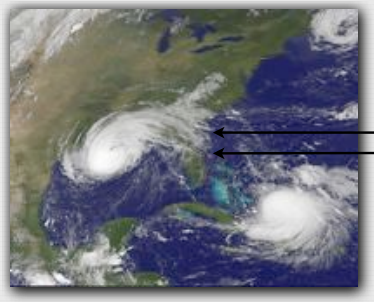
SCAT – *real time global wave height*

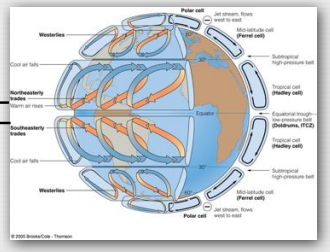


Real-time global wave height modeling has operational utility.

https://www.fnmoc.navy.mil/PUBLIC/WW3/index.html

SCAT – *tropical storms*





SCAT – *types of waves*

Types of waves:

- Ripples
- Seas
- Swells *
- Standing *
- Clapotis *
- Rogue *

From an operational safety aspect, the waves with asters * are of significant concern to SCAT personnel who have to access/egress shores and work near water.

Clapotis from wave reflection back of seawall

A rogue wave 20 meters above average wave height - 2 seconds to full impact

SCAT – *nearshore fetch*

Fetch determines the character of the wave environment both in open seas and nearshore. Wave height can be constrained by the fetch window and distance – regardless of the strength and duration of wind.

Fetch Distance: the length of open water area in the fetch window.

Fetch Window: the angle over which a section of shoreline is open to incoming waves

Fetch Distance	**Fetch Window - Degrees**			
	< 45	45-120	121-180	>180
< 5 km	Low	Low	Low	Low
5-10 km	Low	Medium	Medium	Medium
10–50 km	Medium	Medium	High	High
> 50 km	High	High	High	High

Wave Energy at the Shoreline

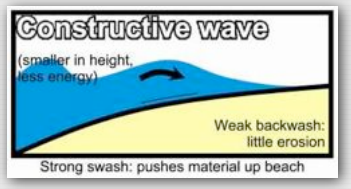
SCAT – *nearshore fetch continued*

Fetch Distance: the length of open water area in the fetch window.

Fetch Window: the angle over which a section of shoreline is open to incoming waves.

Measuring Fetch

SCAT - *waves at the shoreline interface*



Spilling Breaker

Plunging Breaker

When waves reach the shoreline, the dissipate their energy, either constructively (accretion) or destructively (erosion) effect on beaches with mobile sediments. The result is a continuously changing beach profiles.

SCAT – *energy factors in river and lakes*

WIND ENERGY: In rivers and smaller lakes, wind generated wave action is limited. However, boat wakes can be an important factor in increasing shoreline energy.

CURRENT ENERGY: In rivers can be very significant and variable. Spring floods, summer freshets, and controlled rivers can markedly change river dynamics.

ICE ENERGY: In both rivers and lake, ice break up can result in river-bank/shore scouring, as well fixed ice can prevent shore oiling.

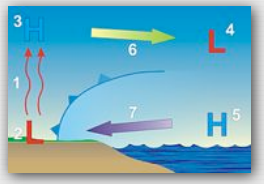
Very large water bodies can be have like an ocean in so far as wave action, and weather.

SCAT – *local winds (sea breeze)*

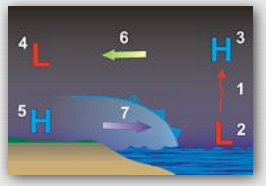
The difference on land and water heating effects local weather by the formation of the sea and land breezes.

The sea breeze circulation is comprised of two opposing flows - *surface* and *aloft*.

These two flows are a result of the *difference* in air pressure between the land and sea generated by the sun's heating (day time) or land cooling (night time).



Sea breeze - daytime



Land breeze - nightime

SCAT – *nearshore currents*

There are two types of nearshore currents: *rip* and *tidal*.

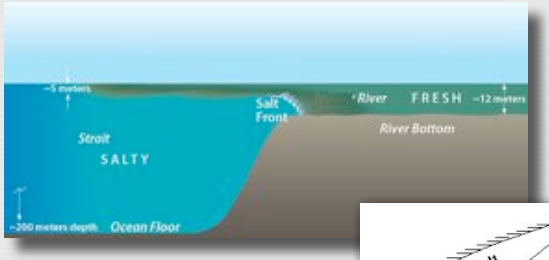
Tidal currents occur in inlets and passages during ebb and flood periods. Velocities can exceed 8 knots in some areas.

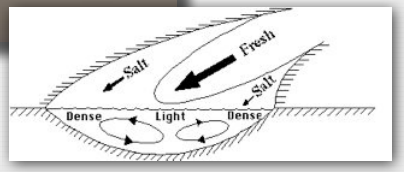
Rip currents are caused by interaction of waves and shore geomorphology. They are the "out currents" common on large sediment beaches.

Both tidal and rip currents are a significant hazard.

SCAT – *density fronts*

Density fronts are where different densities of water meet such as riverine freshwater and saline ocean water.





The interface can become an effective natural barrier to the surface movement of oil.

Module 10 - Coastal Processes, Character and Shoreline Types

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

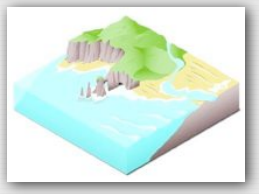
CANADA

EnviroEmerg.ca

SCAT – *the coastal geomorphology cycle*

Coastal Processes such as river flows, waves action, winds, freezing cycles, biological process that erode or accrete on…..

Regional Geology of the coastal zone such as volcanic and sedimentary rocks of mountains, fjords, and plains that provide…



Coastal Character that defines land forms such as spits, deltas, beaches, cliffs, platforms that continues to be affected and changed by...

Shoreline types of substrates (solid and unconsolidated) such as sand, rock, mud, organics that provides ……

SCAT – *coastal process based on waves*

There are two fundamental coastal processes: 1) *wave refraction*, and 2) *substrate transportation*

Wave Refraction: Wave enters coastal water of variable depths such as around islands and headlands, it slows in the shallower depths causing the wave to bend or refract. Over time, this affects the *coastal character (form)* of the coast that includes: *headlands*, *sea stacks, islands*.

Substrate transportation: Waves interact with the shoreline substrates it either moves the substrate from its place (erodes) or deposits it (accretion) that creates various shoreline types as well as changes their profile - *barrier, pocket, spit, tombolo.*

SCAT - *coastal dynamics of wave energy*

Wave energy creates and changes coastal characteristics (forms)

"Jump-off Jack" Sea stack: a 100 year time series

This geological rate of coastal changes is not of particular relevance to SCAT

SCAT – *diversity coastal geomorphology*

The combination of wave refraction and substrate transportation results in a diversity of coastal characteristics (forms).

From erosion of solid forms creates:

Sea stacks, reefs, islets: which are remnants of headlands

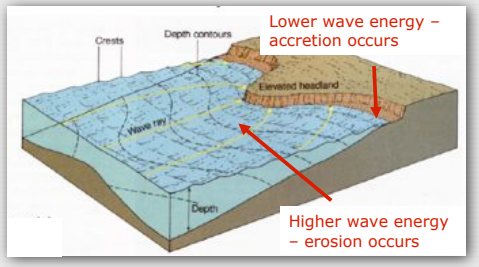
From movement of unconsolidated substrates creates:

Spits: beaches that are attached at one end to their source of sediment.
Tombolos: a strip of sand connection two islands or mainland

SCAT – *wave refraction at a headland*

Along a rocky coast, the coastal irregularities cause waves to refract and focus at shoreline promontories

The waves refract over the shallow submerged ridge to focus on the headland. These converging waves narrow into a smaller volume of water thereby increasing the energy of the wave – *height of wave increases*.



SCAT – *substrate transport*

There are two types of substrate (sediment) movement along beaches:

➡**Longshore Drift:** that defines the coastal character of a beach, such as whether a beach is spit, barrier, or pocket

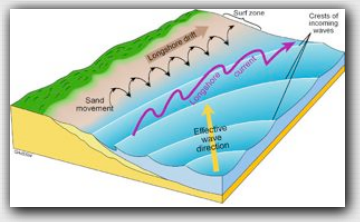
➡**Onshore Deposition:** that defines the profile of a beach

SCAT – *longshore current and drift*

Longshore *Current* and *Drift*:

Waves the approach shores at an angle cause water to move along the beach in a step-like fashion in the direction of wave movement creating a longshore (littoral) current.

Mobile substrate – such as sand - is continuously transported along the beach.



Current and drift can move oil and/or cover oil stranded on shores

SCAT – *onshore substrate deposition*

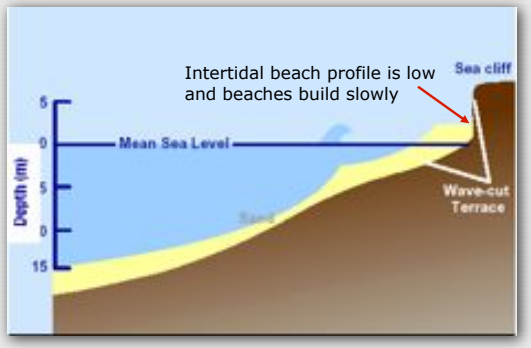
Substrate transportation effects on beach profile

The profiles of beaches change continuously either on seasonal or storm event time-frame. The degree of change depends on its substrates and wave energy levels.

- **During storms**, mobile substrate is carried offshore by waves and beach profiles become steeper.
- **During times of calm**, sediment migrates back toward the beach – beach profiles are low.

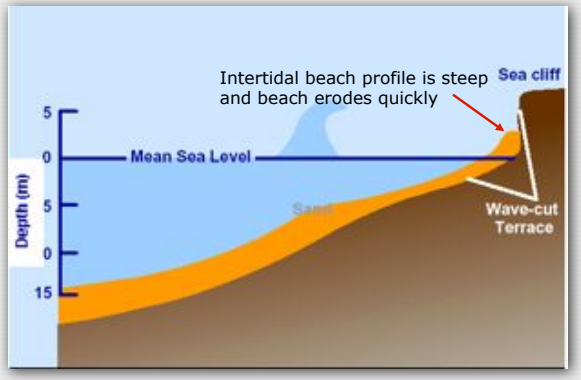
Sediment transportation is a major consideration in the determining the treatment options and timing of shoreline operations.

SCAT – *calm water beach profile*



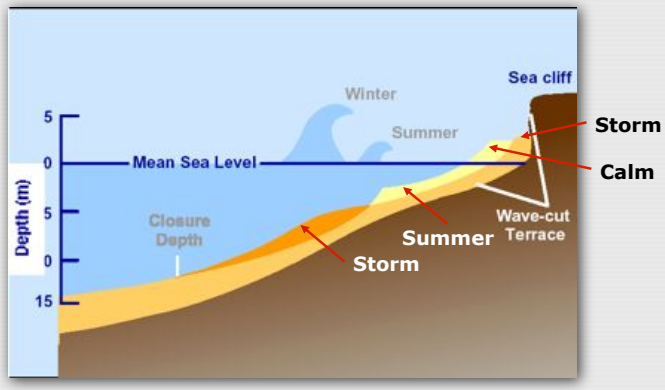
Calm water Beach Profile – beaches build

SCAT – *storm beach profile*



Storm Beach Profile – beaches erode

SCAT – *comparison of beach profiles*



Seasonal Profiles Compared

SCAT – *relevant to SCAT and to operations*

From and SCAT assessment and operational standpoint, changing beach profiles, the ramifications include:

- Not finding oiled substrates because they have been covered with clean substrate;
- Having to segregate clean substrate from contaminated during operations, and
- Re-exposure and re-distribution of oiled substrates.

Substrate movement can also be exploited as a beneficial shoreline treatment options, such as "sediment relocation" to promote natural beach cleaning.

SCAT - *a consequence of sediment transport*

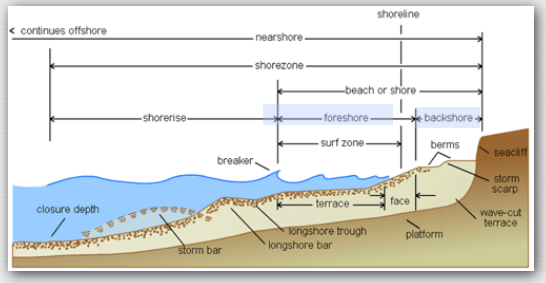
Relevance to SCAT

SCAT – *beach physical zonation*

For SCAT purposes the relevant physical beach terms are:

foreshore:
- *face*
- *terrace*
- *platform*

backshore:
- *berms*
- *storm scarp*



SCAT - *application of geomorphology*

More on Coastal Character (forms) and Shoreline Types

SCAT – *shoreline types & coastal character*

To understand shoreline geomorphology, it is important to differentiate *coastal character* and *shoreline type.*

- **Coastal Character:** is the entire form of the shore zone including upland and seaward areas such as *beach*, *cliff*, *platform*, *delta*, *flat*, and anthropomorphic and subcategories therein.
- **Shoreline Type:** is defined by the materials located in the intertidal zone of a shore of which there are basically two materials: *solid* (rock) or *unconsolidated* (sand, gravel, cobble).

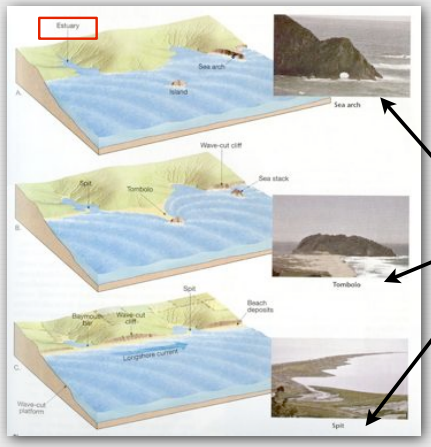
The fate, persistence of stranded oil and treatment options are functions of both coastal character and shoreline type.

SCAT – *treatment and operation implications*

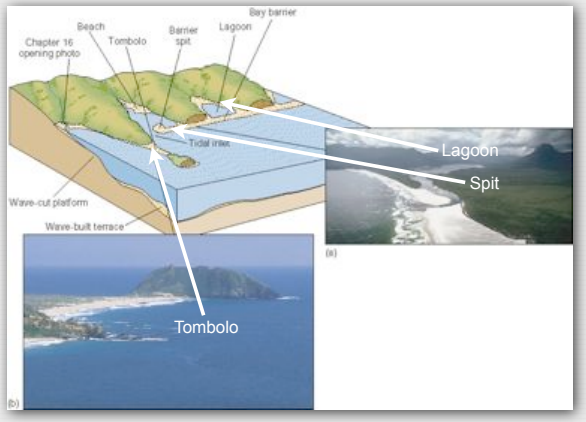
Coastal character (cliff, spit) is where operations activities take place such as equipment staging and assembly and work crew supervision and where there may be access and use constraints.

Shoreline type (sand, gravel, rock, pylons) is where the oil treatment activities take place (raking, sediment relocation, flushing, steam cleaning, *etc*). There may be treatment constraits and end-point determinations.

SCAT – *coastal character*



SCAT – *coastal character cont...*



SCAT - *list of coastal characters*

Coastal character can be delineated whether they are comprised on a **solid** or **unconsolidated** shoreline type.

Cliff/Hill
Sloped
Beach:
- Pocket *
- Tombolo *
- Spit *
- Barrier *

Reef
- Fringe *
- Barrier *

Delta
Dune
Lagoon
River Inlet/Channel
Mangrove
Manmade

Descriptors for Coastal Character

Forested	Bedrock
Vegetated	Unconsolidated
Bare	Boulder
	Cobble
	Pebble
	Granule
	Sand
	Coral
	Mud/Silt/Clay
	Organic/Peat/Soil
	Man-made Solid or Permeable

Descriptors specific for MAN-MADE
Residential
Industrial (landfill, dumps, industry)
Commercial (hotels, beaches, parking)
Agricultural (fields)
Marina/Port
Historic
- Other (name)

SCAT - examples of *coastal characters*


Cliff

Coastal Character is viewed from the 1000 meter perspective based on "regional" geomorphology.

Note: It is important to link Coastal Character is linked to a shore unit.

SCAT - *shoreline types*

Bedrock
- Cliff/vertical
- Sloping/Ramp
- Platform

Man-Made
- Solid
- Permeable

Beach
- Sand
- Coral
- Cobble
- Boulder
- Mixed Sediment

Flat
- Mud
- Sand
- Mixed Sediment
- Pebble/Cobble/Boulder

Wetland
- Mangrove

BEDROCK
Cliff, Slope and Platform reflect the angle or the the bedrock.

MANMADE
Dock
Pier/Wharf
Seawall
Breakwater
Bridge
Causeway
Gabian Basket
_____define

MIXED SEDIMENT BEACH
Fine Mixed (sand or coral/pebble)
Coarse Mixed (sand or coral/pebble/cobble)

Within the two basic types of shoreline types – *solid* or *unconsolidated*. Subdivisions are based on the nature of the substrate materials.

SCAT - examples of *shoreline types*


Bedrock Platform

Shoreline type is viewed from the 10 meter perspective based on local geomorphology.

Note: Shoreline type is directly linked to a shore unit.

SCAT - *primary and secondary shoreline type*

There is only one *primary* shoreline type but can have several *secondary* shoreline types within a shore segment.

The *primary* corresponds to the predominant shoreline generally in the upper intertidal zone, or alternatively the shoreline type most vulnerable to oiling.

Secondary shoreline types can be anywhere along a shoreline segment and its zones

Difference between Primary and Secondary Shoreline Type

SCAT - *primary & secondary shoreline type cont..*

Primary Shoreline Type: There can only be one (overall) primary shoreline type but several secondary shoreline types within a shoreline segment. The Primary Shoreline Type corresponds to the clearly predominant shoreline character located in the Upper Intertidal Zone (UITZ). If there is no clear predominant character in the upper intertidal zone, then it is based on the type most sensitive to oil. By default, if wetlands are predominant in the segment, then these are selected as the primary type.

Difference between Primary and Secondary Shoreline Type

SCAT - *linking coastal character to shoreline type*

Shore Unit 673

Coastal Character: Cliff with mixed sediments

"The Big Picture"

Shoreline Type(s): *Primary* is Cobble, *Secondary* is mixed sediment (sand and gravel)

"The Detailed Image"

Both are linked to a shore Unit

SCAT – *application*

If told that oil is found in front of "cliff" with a "bedrock platform" two operational insights evident when based on:

- **shoreline type (bedrock platform):** little or no oil penetration
- **coastal character (cliff):** no permanent shore access or equipment staging for operations.

If told that oil is found on along a " tombolo" comprised of "sand and pebble" substrates two operational insights evident when based on:

- **shoreline type (mixed sediment):** potentially medium to high oil penetration and need to treat before oil being covered by substrate
- **coastal character (tombolo):** potentially good operational access

Module 11 - Coastal Ecology

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

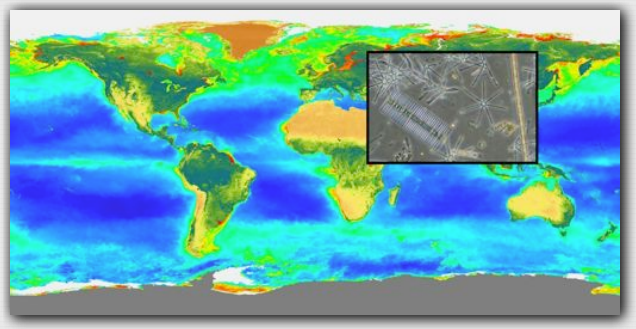
EnviroEmerg Consulting Services

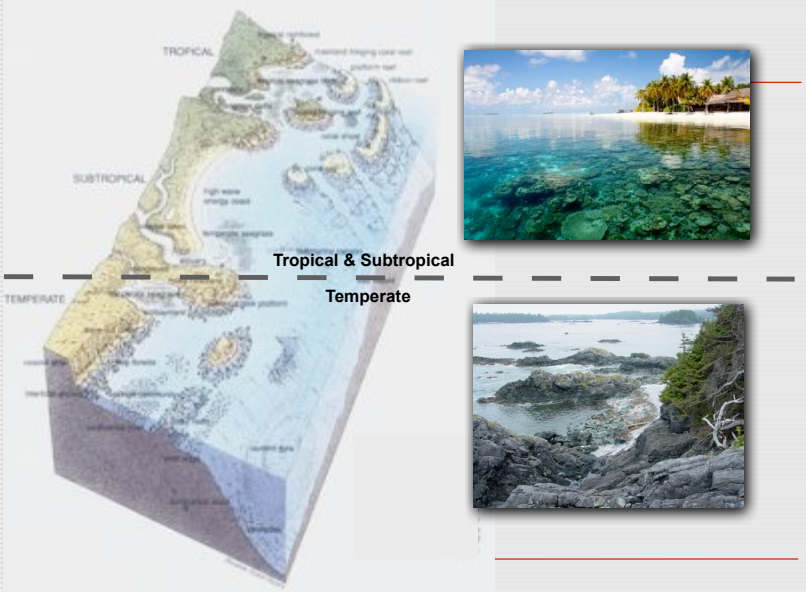
Duncan, British Columbia

CANADA

EnviroEmerg.ca

SCAT – *coastal ecological productivity*

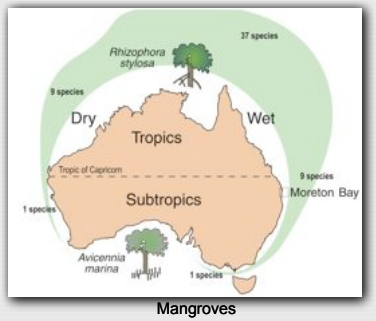




Tropical & Subtropical

Temperate

SCAT – *tropics and subtropic delineation*



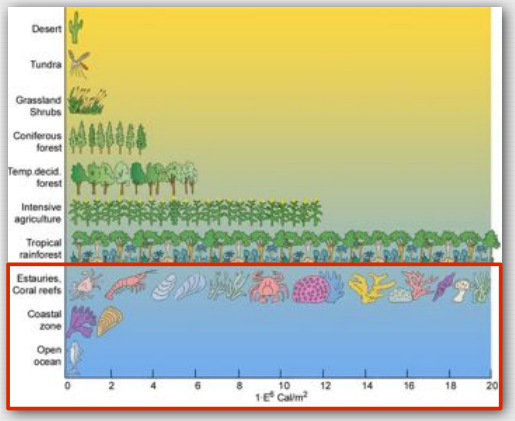
Mangroves

Tropic of Capricorn generally demarcates *tropics* from *subtropics* marine environments, but species representation is a more accurate method.

Source: The University of Queensland, Australia, Centre for Marine Studies, Marine Botany

http://www.cms.uq.edu.au/marbot/index.htm

SCAT – *coastal ecological productivity cont..*



SCAT – *main physical factors of shore ecology*

The major physical factors that determine the types of biotic community (assemblage of organisms) that develops along a shore are:

- *stability of substrate*
- *degree of wave exposure*
- *tidal / current exposure*
- *water salinity*

Therefore, from a SCAT perspective, one needs to be familiar with *shoreline type*, *fetch*, *tidal* and *salinity ranges* and their relevance to shore ecology.

SCAT - *coastal ecology based on wave energy*

Coastal ecology based on wave energy exposure

SCAT – *ecology based on wave energy*

In high wave energy (exposed):

Stable substrate (bed rock, large boulder) environments:

Hardy marine plants and animals cling to substrate, while others hide in sheltered crevices and tide pools.

Unstable substrate (cobbles, pebbles, sand) environments:

Biotic community can be poorly developed or non-existent in constantly mobile sediments, while others burrow deep into stable sediment strata.

Example

SCAT – *ecology based on wave energy cont..*

EXAMPLE: Exposed Outer Coast:

Force of surf is not dissipated. Shores have assemblages of marine plants and animals that either require or tolerate wave shock.

SCAT – *ecology based on wave energy cont..*

In low wave energy (semi-exposed and protected):

Stable substrate (bed rock, large boulder) environments:

Diverse ecological communities (assemblages) with high levels of competition between species.

Unstable substrate (cobbles, pebbles, sand) environments:

Biotic community well developed both on and below the substrate.

Examples

SCAT - *ecology based on wave energy cont..*

EXAMPLE 1: Semi-Exposed Outer Coast:

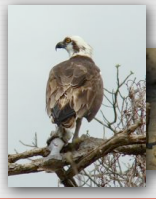
Force of surf is some-what dissipated, often protected by a headland, islets, reefs, and refracted waves.

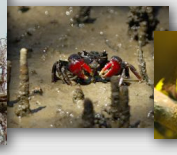
There maybe only be small components of a what appears to be an exposed coast.

SCAT - *ecology based on wave energy*

EXAMPLE 2: Protected Inner Coast:

Enclosed bays, sounds, estuaries where the rise and fall of tides are not complicated by wave energy. Species tend to be different from exposed and protected outer coast.





SCAT – *rule of oil sensitivity based on wave energy*

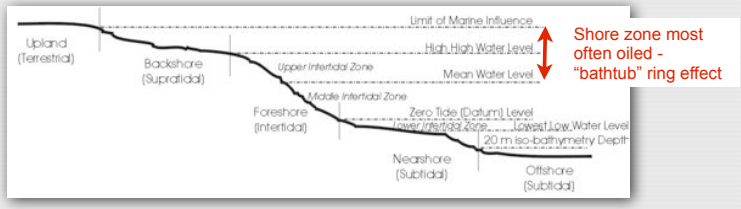
As a general rule... the lower the wave energy and the more unstable the substrate, the higher the environmental sensitivity to both oiling and shoreline cleanup.

SCAT – *coastal ecology based on inter-tidal zone*

SCAT – *shore ecological zones*

Shore zones embraces four distinct components (areas):

1. terrestrial (upland),
2. supratidal (backshore),
3. intertidal (foreshore), and
4. subtidal (nearshore & offshore) areas



Supratidal (spray)

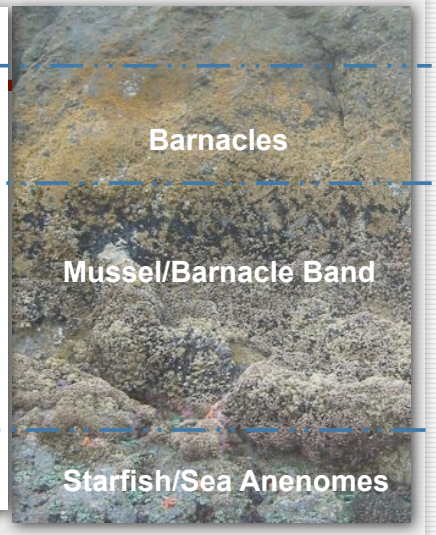
Intertidal (foreshore)

Upper Intertidal

Middle Intertidal

Nearshore

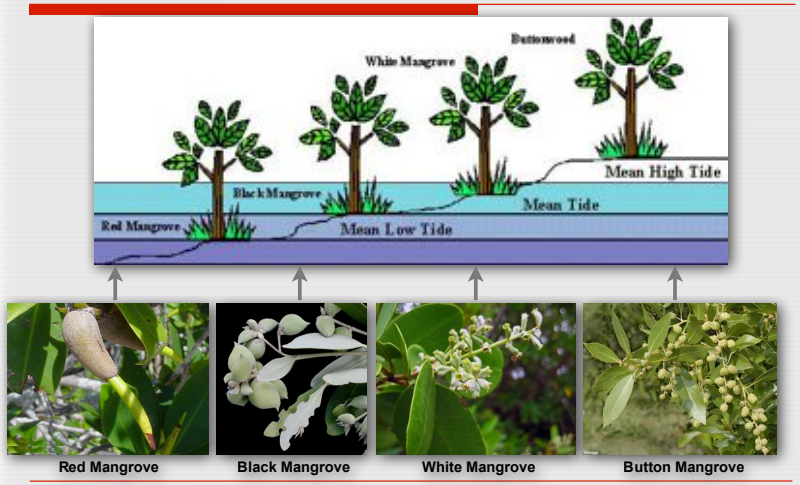
Lower Intertidal



SCAT – *shore zones specific to reefs*

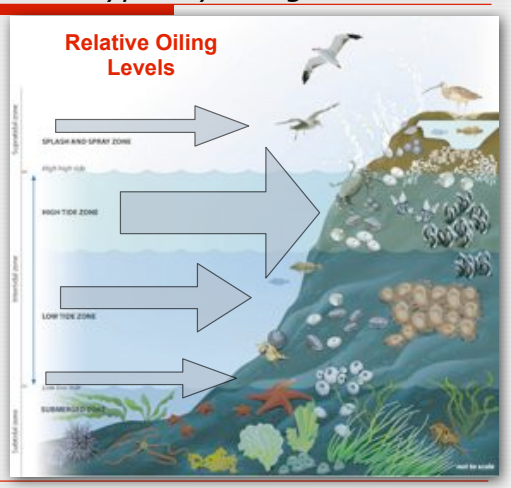
Knowing shore zones is all about "communication" where oiling has occurred and where operations can take place.

SCAT – *shore zones indicators specific to mangroves*



SCAT - *shore zones and typically oiling*

Shore zones and where typically oil resides



SCAT – *the upland shore zone*

The **upland (terrestrial) area** is strictly terrestrial as defined by land-based vegetation.

The upland provides inorganic parent materials for beach creation/maintenance. It can also contribute organic material to support intertidal life, as well as create habitat for marine / coastal dependent wildlife (birds, mammals, reptiles).

The upland does not get oiled unless there is poor oily waste removal practices and monitoring.

SCAT – *the supratidal shore zone*

The **supratidal (backshore) area** is a transitional zone between the upland and intertidal areas.

The upper boundary of this area is the landward limit of marine processes such as storm surges, exceptional high tides and/or wave splash.

The physical evidence of the landward boundary often defined by a storm surge debris-line.

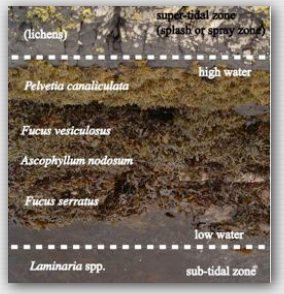
The supratidal area is commonly called the "Splash Zone". This is where oil often gets "trapped" and contaminates logs and infrastructures

SCAT – *intertidal shore zone*

The **intertidal (foreshore) area** is the land subject to daily tidal influence. This area is in between which the tide will seldom fall datum (*i.e.* zero tide) and the higher high water line (HHW) of the mean tides.

This area has its own "zones" that help predict the types of assemblages of dominant marine life (barnacles, algae, mussels, *etc.*).

These zones – upper, and middle intertidal - are delineated by the duration and frequency of tidal influence and by indicator species.



The upper intertidal is the zone mostly often the heaviest oiled

SCAT – *subtidal shore zone*

The **subtidal (nearshore & offshore) area** is below chart datum (*i.e.* below zero tide). The subtidal area is generally recognized to have distinct zones: a shallow (lower intertidal), nearshore, and deeper offshore zone. The assemblages and biomass of marine organisms can be very complex and extensive.

This zone is where mobile oil generally has bypassed and not adhered, but this is the area where remobilization of shore stranded oil can reappear

Module 12 - Sensitive Coastal Tropical Ecosystems

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *sensitive tropical ecosystems*

The dominant estuarine and nearshore coastal communities in tropical regions are **mangroves, seagrasses**, and **corals**.

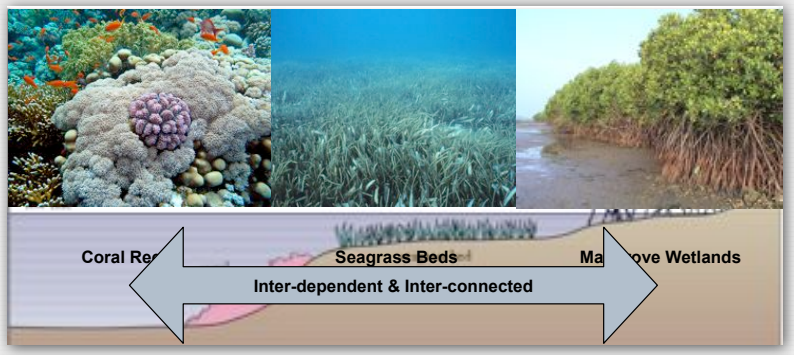
These environments are important to the ecological balance of many marine ecosystems in the tropics.

Like salt marshes of the temperate regions, mangroves, seagrasses and corals serve as nursery habitats and have a high diversity and density of animal and plant species.

Some species are on the threatened or endangered list, such as the Green Sea Turtle and Manatee.

These ecosystems are under stress and hence particularly sensitive to human disturbance.

SCAT - *sensitive tropical ecosystems*



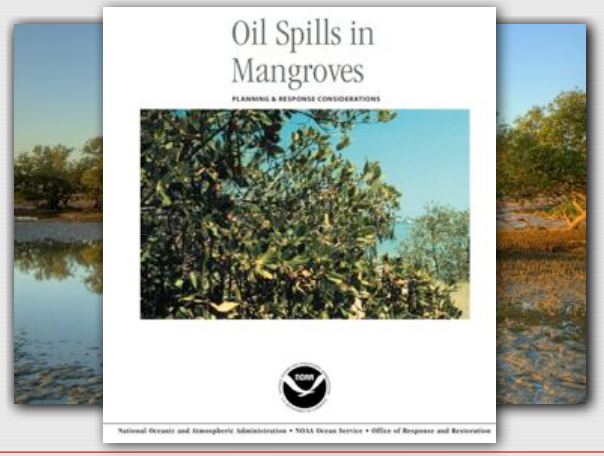
SCAT – *oil toxicity*

Each habitat:

- Presents a unique set of physical, chemical and biological conditions
- Harbours species and community life-stages with varying sensitivities to oil exposure
- Has its own set of economic and cultural values
- Are under different types of natural and anthropogenic stresses.

Where in proximity to each other, each respond option has ramifications that transcend these habitats

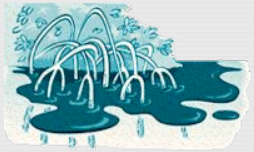
SCAT – *mangroves*



SCAT – *mangroves: definition*

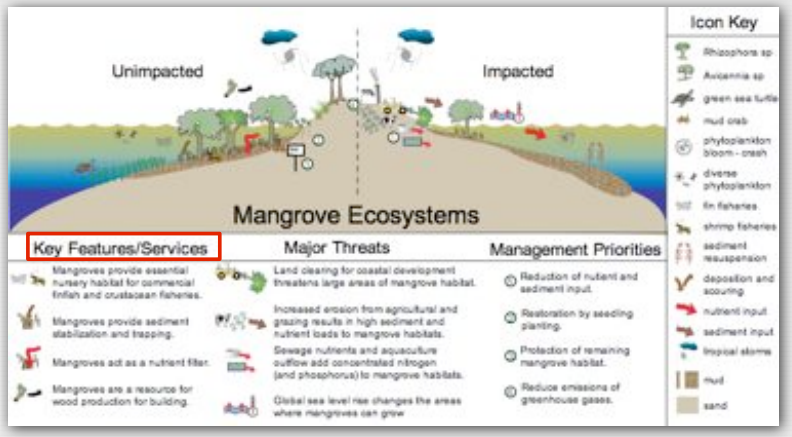
Ecologically, mangroves are an assemblage of tropical trees and shrubs that inhabit the coastal intertidal zone. A mangrove community is composed of plant species whose special adaptions allow them to survive the variable flooding and salinity stress conditions imposed by the coastal environment.**

Mangroves are defined by their "ecology" rather than their "toxonomy".



** *2002, Oil Spills in Mangroves: Planning & Response Considerations*, National Oceans and Atmospheric Administration (NOAA), Office of Response and Restoration

SCAT – *mangroves: ecological & human impacts*



SCAT – *mangroves: features*

SCAT – *mangroves: world distribution*

The largest remaining tract of mangrove forest in the world is found in the **Sundarbans** on the edge of the Bay of Bengal, stretching from SW Bangladesh to SE India

Mangroves worldwide cover approximate 240,000 km^2 of sheltered coastlines. Located between 24ºN and 25ºS - e.g. Tropic of Cancer and Tropic of Capricorn

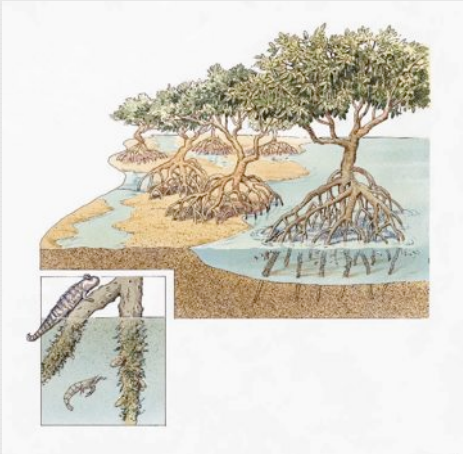
SCAT – *mangroves: ecological & human values*

Ecologically, mangroves function to:

- Stabilize shoreline stabilization
- Provide habitat and food sources for birds, fish and invertebrates
- Improve water quality
- Absorbs carbon

Economically and culturally, mangroves function to:

- Provide construction, fuel and fibre, food, medicinal resources
- Support commercial fisheries and eco-tourism
- Protect coastal communities from storms



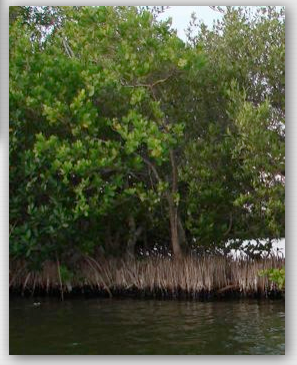
SCAT – *red mangrove (Rhizophora mangle)*

Red mangroves are found closest to the water's edge. They are distinguished by their prop roots which are long and arch-shaped, and which are covered with barnacles, oysters and other marine organisms. Because of these adaptations, the red mangrove survives when exposed to the air at low tide. Because mangroves grow in anaerobic soils, they obtain most of the oxygen needed from the atmosphere.

SCAT – *black mangrove (Avicennia germinans)*

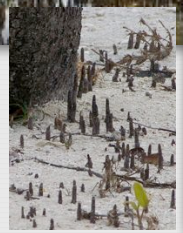
Where both species exist, red mangroves occur in the low- to mid-intertidal zones, whereas black mangroves are more common in the upper intertidal and supratidal zones.

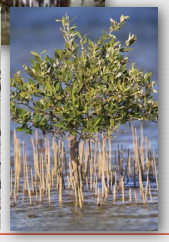
Black mangroves are less tolerant of high salinities, so they grow better where there is less exposure to salt water inundation and some fresh groundwater influence



Black mangroves have a very extensive root system. They are also known as air-breathers, because they have pneumatophores, which extend 20–30 centimeters straight up above the soil from a horizontal root system. Their root systems.

SCAT – *white mangrove (Laguncularia racemosa)*

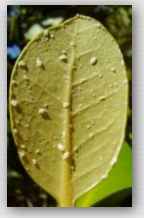




White mangrove has no visible aerial roots, unlike the black mangrove which has pneumatophores and the red mangrove with prop roots. However, when it is found in oxygen-depleted sediments or flooded for extended periods of time, it often develops peg roots.

SCAT – *grey mangrove**

Grey mangrove is one of the most adaptable mangroves, and is distinguished by its ability to withstand extreme weather conditions, high winds, and various pests and diseases. It is a pioneer in muddy soil conditions, but is intolerant of shade.



* Grey mangrove may refer to either of two species of mangrove:
- *Avicennia marina* - occurring around the Indian Ocean and into the western Pacific Ocean as far as New Zealand
- *Conocarpus erectus* (Buttonwood) - occurring on both sides of the Atlantic Ocean, along the eastern edge of the Pacific Ocean and in Melanesia and Polynesia

SCAT – *mangroves: oiling vulnerability*

In many tropical regions, mangrove forests are the defining feature of the coastal environment. Mangrove habitats represent the interface between land and sea and, as such, are one of the principle places where spilled oil and associated impacts converge.

Mangrove communities are both "vulnerable" and "sensitive" environments.

** *2002, Oil Spills in Mangroves: Planning & Response Considerations*, National Oceans and Atmospheric Administration (NOAA), Office of Response and Restoration

SCAT – *oil sensitivity in tropical environments*

The impacts to mangroves other tropical environments from spilled oil is dependent on the amount and type of oil spilled, extent of weathering of the oil prior to landfall, and the physical characteristics of the impacted area (water depth, exposure to waves, nearshore and intertidal topography, sediments, etc.).

There are two responses to oil contamination: *acute* or *chronic*

Acute effects are often immediate and obvious that kills the organism (often referred to as "lethal").

Chronic effects are often delayed and subtle that may or many not kill the organism (often referred to as "sub-lethal"). Nevertheless, chronic effects than compromise the survivability of a single organization or the entire population exposed.

SCAT – *mangrove*: *oil sensitivity*

The line between "acute" and "chronic" impacts can be blurry at times. Visible response to oiling may be immediate such as dying or leaf defoliation (acute). However, a tree may survive but with slowed growth or reproduction capability (chronic)

STAGE	OBSERVED IMPACT
Acute	
0 to 15 days	Death of birds, fish and invertebrates
15 to 30 days	Defoliation and death of small (<1 m) mangroves. Loss of aerial root community
Chronic	
30 days to a year	Defoliation & death of medium (<3 m) mangroves. Tissue damage of aerial roots
1 to 10 years	Death of larger (>3 m) mangroves. Loss of and deformed aerial roots. Recolonization of oiled areas by new seedings. Reduced litter fall, reproduction, seedling survival, resistance to insect damage.
10 to 50 years	Complete Recovery??

Modified from: Lewis, R.R. III. 1983. *Impact of oil spills on mangrove forests*. In: *Tasks for Vegetation Science*, Vol. 8 (Biology and Ecology of Managroves), H.J. Teas, ed. The Haque: Dr. W. Junk Publishers, pp. 171-183

SCAT – *mangrove*: *oil sensitivity cont...*

The type of oil affects the nature and degree of impacts to mangrove ecosystems. Refined petroleum hydrocarbons with water-soluble aromatic compounds (e.g., jet fuels, gasoline) are more acutely toxic to mangroves at lower concentrations than are crude oils ** and heavy refined (residue) products.

Crude Oil/Heavy Refined Products

Light Oils (Gasoline, Jet Fuel, No.2 Fuel Oil)

- Oil spills in the tropics will have less contamination effect at the outer fringe or high-tide line.
- Penetration into the forest is dependent on the amount of oil, forest density, and oil viscosity.
- Light oils penetrate deeply into the forest, stopping only at the high-tide line. Highest impacts are usually in the forest.
- Oil pools on sediment surfaces and accumulates in heavily impacted material such as seagrass wrack.
- Persistence of oil in sediments is short unless there has been physical mixing into the substrate material.
- Toxicity is due to aromatics and sediment contamination; there is little difference in toxicity among the heavier oils and refined products.
- Because of low physical energy in mangrove swamps, oil persistence is great and sheens are generally impossible to physically protect a fringing mangrove forest.
- Booms should be deployed to protect the most sheltered areas where greatest persistence is likely.

SCAT – *mangroves: oiling distribution*

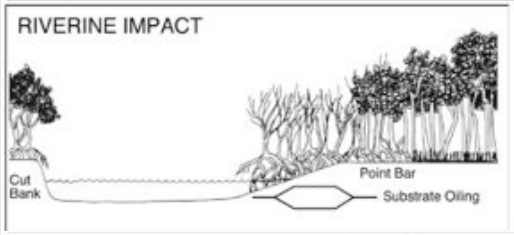
Where mangrove forests occur, water depths are shallow and most of the forest is exposed during low tide on a regular basis. They are frequently fronted by shallow seagrass or coral reef flats.

Topographic elevations in the forest control the location and extent of oiling from floating slicks.

The types of physical impacts likely to occur during oil spills:

1. *Inner fringe* impacts occur when there is a berm behind mangroves growing in the subtidal or low intertidal areas.
2. *Outer fringe* impacts along relatively steep intertidal zones where mangroves commonly occur in a narrow band
3. *Inner basin* impacts occur where there is a low overwash berm in front of a shallow depression or interior basin
4. *Riverine impact* is similar to outer fringe impact, but occurs on river point bars

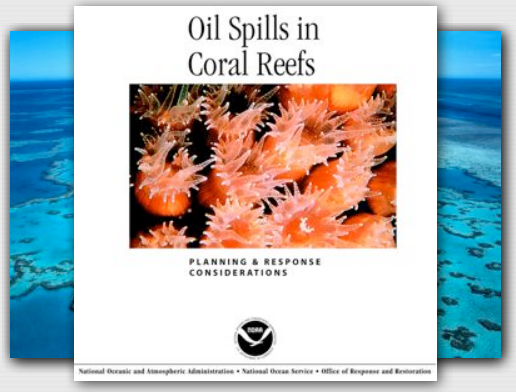
SCAT – *mangroves: oiling distribution cont..*



[illegible]

EnviroEmerg - Module 12: Sensitive Coastal Tropical Ecosystems 20

SCAT – coral reefs

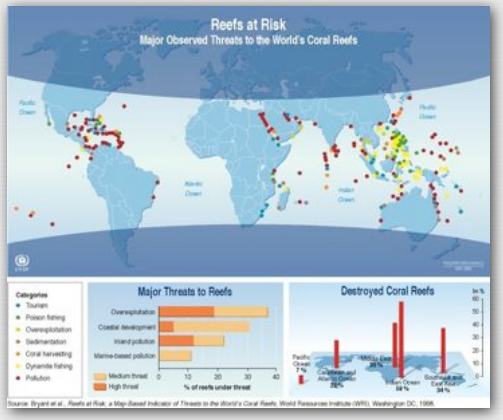


SCAT – coral reefs

Coral reefs building requires high light and oxygen, low turbidity and nutrients, warm water (18-30ºC) and open ocean salinity (33 to 36 ppt).

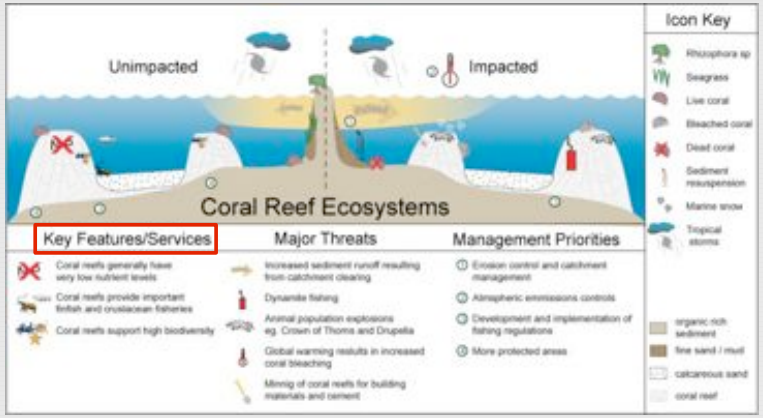
Coral reefs are mostly subtidal; shallow portions of reefs can be exposed during very low tides.**

** Coral "communities" also exist but may not create "reefs" . Coral communities and reefs also occur in deep water.



Much of the World's Coral Reefs are at Risk.

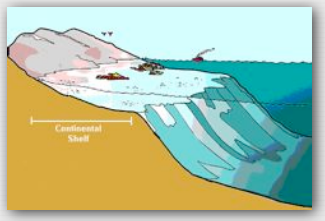
SCAT – *coral reefs: ecological & human impacts*



SCAT – Geographic variability

Different assemblages of dominate coral reef species characterize the "Altantic/Caribbean" versus "Pacific' regions. This also applies to mangroves and seagrass assemblages.

Principle reason is the coastal sub-tidal geomorphology difference where: continental shelf predominate in the Altantic/Caribbean but not as much as in the Pacific regions.



SCAT – value of coral reefs

A variety of corals species contribute to building reefs that provide habitats for countless species of other plant and animal life to create one of the world's most diverse ecosystems

The economies, values, cultures, social framework and other aspects of many human communities benefit from and rely on the products and services of healthy coral reef ecosystems.

The structure and function of coral reefs depends on successful reproduction and survival of corals - the fundamental building blocks of coral reefs.

SCAT – coral reefs: stresses

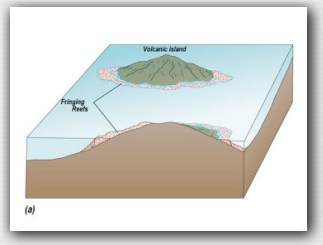
The effects on oil spill and response operations in coral reef environments need to viewed as one of the many anthropogenic and natural impacts that affect coral reefs worldwide.

"Stresses" includes global warming, land-based pollution, sedimentation, overfishing, invasive species, and physical disturbances (vessels, storms)

SCAT – coral reefs

The four major categories of reefs are:

- *Fringing* - bands of coral reefs parallel to and near the shoreline.
- *Barrier* - similar to fringing reefs except that they are further offshore and broader.
- *Atoll* - reefs formed by the buildup of coral on the rim of a subsiding volcano. They are circular forming a sheltered lagoon.
- *Patch* - small, irregularly shaped coral reefs that occur in isolated patches.



Reefs may begin on pre-existing subsea platforms, such as volcanoes and shoal banks, but become coral reefs by the continuous build-up of the remains of bottom-dwelling marine animals and plants.

SCAT – coral reefs: predicted oil impacts

Oil would usually pass over subtidal reefs with no direct contamination. Exceptions where floating oil would potentially coat living reef communities are:

- Landward border of fringing reef platforms which are exposed at low tide.
- Reef-flats which are floored with bedrock and may have high coral heads growing on them, and
- The outer, seaward part of reef-flat platforms that are usually slightly elevated and exposed at low tide and heavily washed by waves.

SCAT – coral reefs: predicted oil impacts cont..

Greatest impacts to the reef would result from spills of light refined products directly into the shallow waters overlying reefs and where high concentrations of water-soluble fractions persist.

Also, large spills during the period of simultaneous spawning could affect the larvae of all coral species, regardless of water depth.

Of concern at most spills are threats to organisms that concentrate around the coral reef habitat.



SCAT – *oil toxicity*

Many corals reproduce through the release of egg and sperm or larvae into the water column during spawning at certain, often predicable times of the year.

A spill occurring at the peak of coral reproductive activity can have both immediate and long-lasting harm.

SCAT – *chronic impact*

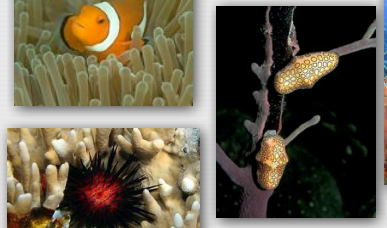
1986 Bahia Las Minas crude oil spill in Panama

- sublethal impacts to reproduction and growth for 5 years and longer
- 76% decrease in coral coverage in heavy oiled areas of 0.5 to 3 meters depth, 56% decrease in depths 3 to 6 meter range.

Oil slicks moving onto coral reefs at Galeta at low tide; Bahia las Minas refinery spill, Panama, April, 1986

SCAT – *impacts to other reef dwellers*

Fish in open waters are able to avoid oil, but many coral fish, crustaceans, echinoderms, sponges, molluscs have small home ranges and therefore are more likely to be harmed. As with coral species, their larva stages are the must sensitivity to oil toxicity.


SCAT – *field impact studies*

Spill	Amount and type	Reported effect
1968: Witwater spill, Galeta Island, Panama	20,000 barrels diesel oil and Bunker C	Harmful effects on meiofauna, mangroves, fiddler crabs; elimination of algae; reef corals least affected
1970: Pipeline break, Tarut Bay, Saudi Arabia	100,000 barrels of Arabian light crude oil	Mortalities among crabs, bivalves, gastropods, fish; mangrove trees less affected; no detrimental effects on corals and other fauna; good subsequent recovery
1971: M/V Solar Trader, Florida Keys	520 tonnes fuel and lubricating oils	Numerous dead lobsters and clams; survey 8 months later reported large algal growth on corals
1974: Sygma, east coast of Australia	400 tonnes of heavy fuel oil	13 km beaches affected, no reported effect on marine life
1975: MV Lindenbank, Fanning Atoll, Pacific Ocean	10,000 tonnes copra, palm oil, coconut oil	Mortalities in fish, crustacea and molluscs; later, extensive growth of the algae *Enteromorpha* and *Ulva*; reported complete recovery of coralline algae community after 11 months
1969-79, Oil terminals, Gulf of Eilat, Red Sea	Many small scale chronic spills	Decrease in coral and fish diversity, lack of colonization by hermatypic corals in reef areas chronically polluted by oil; damage to reproductive systems of corals

IPIECA REPORT SERIES VOLUME THREE

BIOLOGICAL IMPACTS OF OIL POLLUTION: CORAL REEFS

IPIECA

International Petroleum Industry Environmental Conservation Association

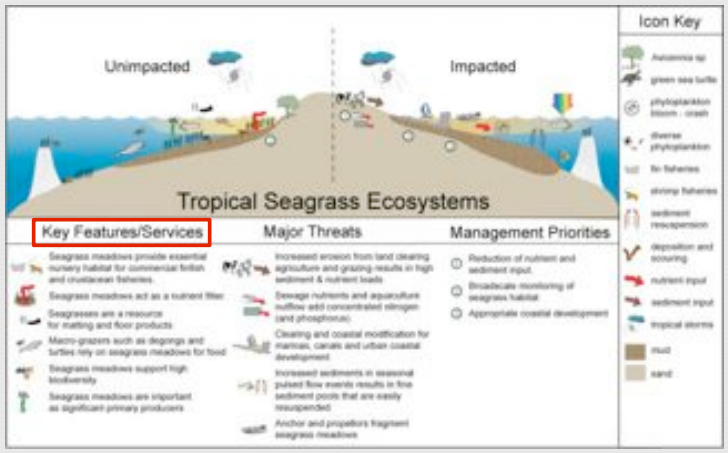
SCAT – *seagrasses*

Seagrasses in tropical environments are commonly turtlegrass (*Thalassia sp.*), manatee grass (*Syringodium sp.*), and shoalgrass (*Halodule sp.* and *Enhalus sp.*).

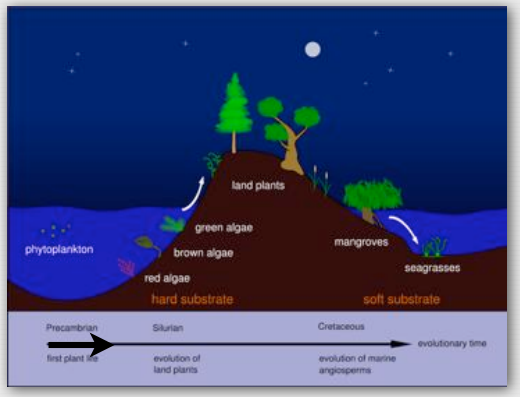
Their distribution is limited by water temperature, light penetration (turbidity and water depth), and salinity.

Seagrass grows mostly on sandy to sandy-muddy sediments from the intertidal zone down to a depth of 20 m or more.

SCAT – *seagrass: ecological & human impacts*



SCAT – *seagrasses: evolution*



SCAT – seagrasses

Turtle grass is a common seagrass in the Caribbean

SCAT – seagrasses: ecological importance

Seagrasses play an important role in shallow coastal marine environments, including:

- Sediment stabilization.
- Detritus production which provides a major basis of food chains, although the bulk of the biomass is in the sediments (rhizomes).
- Substrate for a highly productive epiphytic community, with a total biomass which often approaches or exceeds that of the plants themselves.
- A directly utilized food source such as turtles, who graze on seagrasses.
- Habitat which is utilized by fish and shellfish as nursery areas.
- Key role in nutrient cycling, including nitrogen, phosphorous, and sulfur.

SCAT – vulnerability, sensitivity, & recruitment

Ecological relevance of shore zones to SCAT decisions relates to:

- ➡ vulnerability
- ➡ sensitivity
- ➡ recruitment

SCAT – *ecological assessment factors*

Three ecological assessment factors to understand are:

1. what and where are the *vulnerable* species or assemblages that can harmed by oiling or potentially affected from clean-up efforts;
2. of the vulnerable species or assemblages, which ones are *sensitive* to oil contamination and/or clean-up efforts, and
3. for both vulnerable and sensitive biota, what species need to be protected from treatment efforts so as not to harm future *recruitment* potential.

Vulnerable and sensitive biota and their recruitment potential are often used to "frame" end-points and operational constraints.

SCAT – *vulnerability and sensitivity*

The two SCAT objectives are: 1) to do no more harm and 2) to promote natural healing.

There are two basic intrusions from shore cleanup operations:

1. **moving product from an harmed oiled area to an unharmed area**
2. **physical disturbance from sediment disturbance, equipment/people activities.**

SCAT – *recruitment potential*

Most shore populations are resistant to oil spills - tolerant to the smothering and/or toxic effect of the product. If there is a large population die-off, the natural recruitment from adjacent viable populations then becomes important.

An objective of the ecological assessment is to recognize stressed biological populations and and protect those that can serve as important recruitment sources.

SCAT - *ecological information gathering*

Coastal ecological observations includes coastal birds, mammals, and intertidal habitats. Information is used to develop and support the Ecological Constraints determinations

This field data can be collected on a *Biological Observation Form* and linked to shoreline segment*

Ecological guidelines in the the SCAT process:

For Birds and Mammals:

- Observations should begin on initial approach to beach to record animals fleeing or diving in response to disturbance from the approaching team.
- Document species present in the nearshore zone, along the shoreline, and within the adjacent terrestrial zone.
- Observe and record bird and mammal behavior (i.e. loafing, swimming, feeding, etc.)

* The US has a Biological Observation Form as part of SCAT documentation

SCAT - *Ecological information gathering*

Ecological guidelines in the the SCAT process continued....

For Intertidal Habitats:

- Estimate percent of segment occupied and coverage for the following parameters: Barnacles/seagrass/Kelps/Other algae/ Clams /Mussels/Corals
- Note coverage as: (a) continuous (b) patchy (c) sparse
- Add descriptive notes and additional information as time allows.
- Provide ecological constraints recommendations
- Add descriptive instructions for protection, avoidance, and minimization measures as needed.

SCAT - *intensity of biological data gathering*

The biological data gathering in the SCAT process is at the “marco” level. The biologists assesses ecological resources affected by the oiling or at risk by cleanup .... “standing-up”

This is micro monitoring - not SCAT documentation

SCAT – *summary*

Mangroves, seagrasses, and corals are under ecological stress that provides additional need to protect them and seek the most appropriate treatment option(s) that achieves a net environmental benefit.

Due to current natural and anthropogenic stresses on these systems, both the oil spill and associated response operations will tend to have a greater impact compared to a healthy, more pristine situation.

The notion that coral reefs and seagrass do not suffer from oil floating over them is probably incorrect.

SCAT – *summary cont...*

Oil has both *acute* and *chronic* impacts to these sensitive tropical ecosystems.

Longer exposure to lower levels of oil may cause mortalities, as well as *shorter exposures* to higher concentrations.

Branching corals are more sensitive to oil impacts than are the massive or plate-like corals.

The time of year of a spill is a critical concern, particularly during a coral reef’s reproduction periods.

The animals that depend on these habitats must also so considered (fish, invertebrates, birds, wildlife, etc).

Module 13 - Coastal Uses and Values

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

CANADA

EnviroEmerg.ca

SCAT – *social/economic role*

Recognition and documentation of coastal uses – both past and present - by the public, industry, indigenous people, and scientific community are part of the SCAT process.

It is the SCAT role to very particular in recognizing, appreciating, documenting, communicating and monitoring the social and economic values of coastal resources

SCAT – *socio-economic resources*

Partial list of social/economic uses and interests include:

- **Protected areas:** Marine Protected Areas
- **Marine Transportation Infrastructure:** marinas, breakwaters, wharfs
- **Aquaculture Industry:** salmon farms, shellfish & algae facilities
- **Recreational and Tourism areas:** camping areas, scenic observation points, resorts,
- **Residential areas:** cottages and permanent homes
- **Cultural sites:** archaeological (implements), historic occupation/ use (fish weir, middens, campsites), pictographs/petroglyphs, wrecks, historic industries (canneries)

SCAT – *defining coastal and marine "value"*

Value based on Scientific Interest

- Areas with a substantial record of prior marine research and data gathering
- Significant invertebrate concentration areas
- Significant habitats for marine birds including colonies & environments on which they rely
- Significant marine habitat for waterfowl & shorebirds
- Significant marine mammal habitats (colonies/haul-outs/ breeding grounds etc.)
- Sites significant to rare or endangered species (those not covered by previous categories)
- Ocean Basin: ridges, abyssal plains etc.

SCAT – *defining coastal and marine "value"*

Values Identified in Qualitative Research: Cultural Opportunities

Archaeological sites — places where relics of ancestral activity are found;

Ceremonial and Religious Sites — a location important for ceremonies

Cross-cultural interaction — a place significant to the interaction of two or more cultures (e.g. first contact sites, locations of conflict);

Food harvesting — places significant in the harvesting of marine foods

Material harvesting — a place where important non-food marine items are gathered;

Supernatural beings — a place associated with the past and present occurrence and activity of beings whose existence is not recorded by western science or others from outside the culture

- Anchorages (protection from waves, wind, adequate depth, suitable substrate)

SCAT – *drivers for protection*

It is generally the social-economic values that determines:

- Priority for treatment, and
- End-points

SCAT members are often the ambassadors for understanding and reflecting the concerns and interests of local stakeholders

Note: Ecological impacts general determine operational constraints

SCAT – *tourism*

SCAT – *recreational areas and activities*

SCAT – *infrastructure*

SCAT – *historic cultural activity*

SCAT – *ecological values*

SCAT – *intrinsic values*

Module 14 - Coastal Resource Mapping

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

CANADA

EnviroEmerg.ca

SCAT – *use of coastal resource mapping*

Coastal resource mapping can include: aerial video, still photographs, field sampling data, reference searches, coastal use interviews, GIS mapping, database development, and modeling.

The combined information is used for determining:

- oil residence
- biological sensitivity
- cleanup sensitivity
- logistics information
- cleanup options

Preliminary coastal mapping may have to be done as part of the SCAT process if no prior coastal inventory/maps are available.

SCAT - biophysical shoreline mapping

Coastal video documentation is a three person effort:

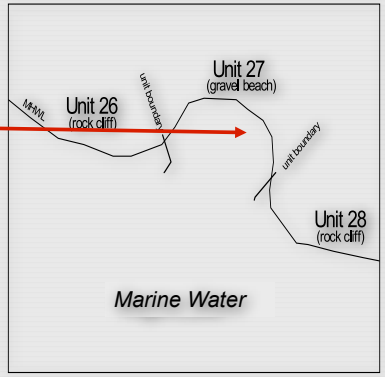
- a **geomorphologist** who operates the camera and narrates shoreline characteristics and up-land features;
- a **biologist** who narrates bio-bands and other ecological features,
- a **navigator** or narrates and charts flight paths and monitors video and GPS systems.

SCAT – *mapping methodology*

Oblique video-taping undertaken generally from helicopter during the lowest tides of the year

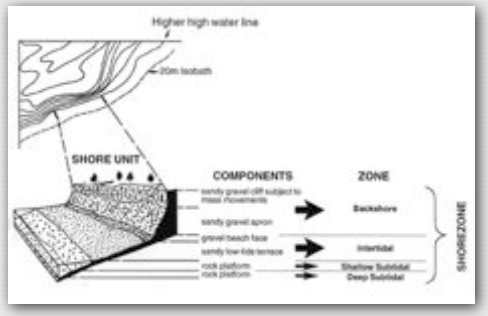
All imagery is geo-referenced

SCAT – *shore units & physical features*



Aerial Video played and information translated to coastal digital map and shore units and physical features recorded – a database is also established

SCAT - *subdivisions of a shore unit*



Across-shore components and shore zones of shore segment (unit)

Each across-shore component is systematically described in terms of physical characteristics such as morphology, texture and dominant processes

SCAT - *field biological data gathering*

SCAT – *biophysical features*

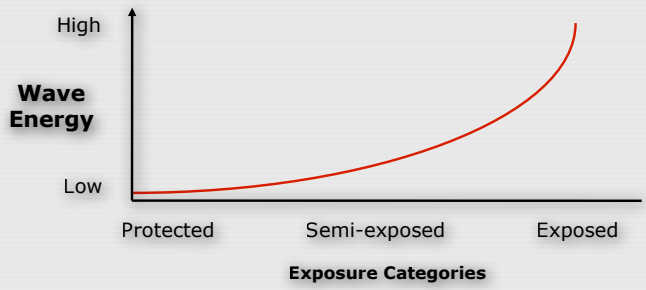
Biobands

- Lichen
- Barnacle
- Mussel
- Barnacle
- Algae

Observed coastal biota is mapped, in particularly the "biobands" such as kelp, barnacle, mussel bands, urchin barrens, eelgrass and other biological assemblages visible from the air

SCAT – *exposure*

Wave exposure category is largely based on observed biota. Information is very useful attribute for habitat modeling and spill response planning



SCAT – *exposure examples*

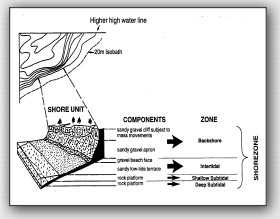
Exposed

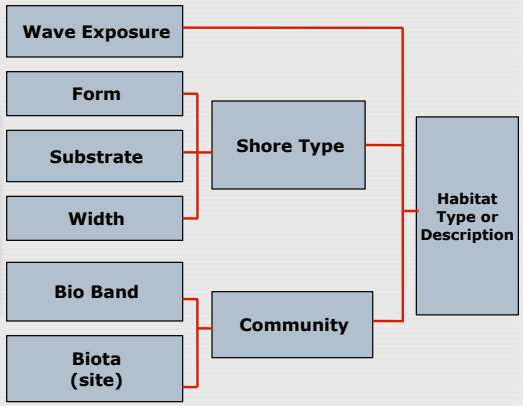
Semi-Exposed

Protected

SCAT – coastal modeling

For a shore unit





SCAT – *habitat type or description*

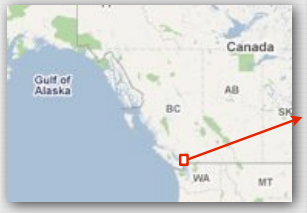
Modeling enables specific description of each shore unit for a multiple of user needs such as oil spill response, recreational hazards, marine threats (tsunami), sediment transport, coastal use planning.

The modeling integrates both the coastal geomorphological and ecological attributes of each shore segment.

SCAT – example coastal resource maps

GeoBC
BC's GEOGRAPHIC GATEWAY

British Columbia
Canada



http://geobc.gov.bc.ca/apps/gga/

SCAT – example coastal resource maps

Coastal Explorer
NIWA
Taihoro Nukurangi

New Zealand

SCAT – web based coastal resource mapping

WASHINGTON STATE
Department of Ecology
Coastal Atlas
https://fortress.wa.gov/ecy/coastalatlas/viewer.htm

BRITISH COLUMBIA
Coastal Resource Information System
http://srmapps.gov.bc.ca/apps/dss_coastal/

Alaska ShoreZone Coastal Mapping and Imagery
http://www.alaskafisheries.noaa.gov/maps/szintro.htm

National Institute of Water & Atmospheric Research
http://wrenz.niwa.co.nz/webmodel/coastal
NIWA
Taihoro Nukurangi
New Zealand

Australian Natural Resources Atlas
For Estuaries
http://www.anra.gov.au/topics/coasts/processes/index.html#process

SCAT – google earth

With Google Earth, you can:

- Demarcate shore units
- Show access routes
- Measure Distances
- Insert images
- Provide instruction
- Tilt and Rotate
- Make a mosaic

In absence of a coastal atlas, google earth provides a valuable resource for coastal resource mapping.

Module 15 – Shoreline Cleanup Methods

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT

Based on: 2001 **Characteristics of Response Strategies:** *A Guide for Spill Response Planning in Marine Environments* prepared by:

- American Petroleum Institute
- National Oceanic and Atmospheric Administration
- U.S. Coast Guard
- U.S. Environmental Protection Agency

SCAT – *response options*

Response Options

- Natural Recovery
- Sediment Reworking/Tilling
- Flood (Deluge)
- Low-pressure, Ambient Water Flushing
- Manual Removal
- Mechanical Removal
- Barriers/Berms
- Sorbents
- Vacuum
- Debris Removal
- Vegetation Cutting/Removal
- In-situ Burning
- High-pressure, Ambient Water Flushing
- Hot Water Cleaning (High & Low Flushing/Steam
- Shoreline Cleanup Agents
- Nutrient Enrichment

Reducing overall environmental consequences in an effective and efficient manner usually requires a combination of response methods

Natural Recovery

Objective: Leave in place stranded oil to minimize impact or because there is no effective method for cleanup.

Description: No action is taken. Oil is left in place to degrade naturally. Monitoring of contaminated areas may be required.

Applicable Habitat Types: All habitat types.

When to Use: When natural removal rates are fast (e.g., gasoline evaporation, high-energy coastlines), when the degree of oiling is light, or when cleanup actions *will do more harm than natural removal*.

Natural Recovery is the "SCAT" decision bench-mark

Sediment Relocation/Tilling

Sediment Relocation/Tilling cont…

Objective: Break up oily sediments increasing contaminated surface area to enhance the natural rate of biological and physical degradation through aeration (tilling) and/or flocculation (surf-washing).

Description: The oiled sediments are roto-tilled, disked, or otherwise mixed using mechanical equipment or manual tools (tilling). Along beaches, oiled sediments may also be pushed to the water's edge to enhance natural cleanup by wave activity (surf washing).

Applicable Habitat Types: On any sedimentary substrate that can support mechanical equipment or foot traffic and hand tilling and that does not have high levels of burrowing organisms such as shellfish, worms, crabs, etc.

When to Use: On cobble, sand to gravel beaches with moderate levels of subsurface oiling. On sand beaches where the sediment is stained or lightly oiled – can be used to "polish" recreational beach sediments. Appropriate for sites where the oil is stranded above the normal high waterline and can be pushed down to enable natural wave washing.

Flooding (deluge)

Flooding (deluge) cont…

Objective: Wash oil stranded on land to the water's edge for collection.

Description: A perforated header pipe or hose is placed above the oiled shore or bank. Ambient-temperature water is pumped through the header pipe at low pressure and flows down-slope to the water where any oil released is trapped by booms and recovered by skimmers or other suitable equipment. On porous sediments, water flows through the substrate, pushing loose oil ahead of it. On saturated, fine-grained sediments, the technique becomes more of a surface flushing.

Applicable Habitat Types: All shoreline types where the equipment can be effectively deployed. Not effective in steep intertidal areas.

When to Use: In heavily oiled areas when the oil is still fluid and adheres loosely to the substrate, and where oil has penetrated into gravel sediments.

Low-pressure, Ambient-Water Flushing

Low-pressure, Ambient-Water Flushing cont…

Objective: Remove fluid oil that has adhered to the substrate or man-made structures, pooled on the surface, or become trapped in vegetation.

Description: Ambient-temperature water is sprayed at low pressures (<10 psi), from hand-held hoses, to lift oil from the substrate and float it to the water's edge for recovery by skimmers, vacuum, or sorbents. Usually used with a flooding (deluge) system.

Applicable Habitat Types: On substrates, riprap, and solid, man-made structures, where the oil is still fluid. In wetlands and along vegetated banks where oil is trapped in vegetation.

When to Use: Where fluid oil is stranded onshore or floating in shallow intertidal areas.

Manual Oil Removal/Cleaning

Manual Oil Removal/Cleaning cont…

Objective: Remove oil with hand tools and manual labour.

Description: Removal of surface oil by hands, rakes, shovels, and buckets.

Applicable Habitat Types: All habitat types.

When to Use: Light to moderate oiling conditions for stranded oil, or heavy oils on water that have formed semi-solid or solid masses and that can be picked up manually.

Mechanical Oil Removal

Mechanical Oil Removal cont..

Objective: Remove oil from shorelines using mechanical equipment.

Description: Oil and oiled sediments are collected and removed using mechanical equipment not specifically designed for pollution response, such as backhoes, graders, bulldozers, dredges, draglines, vacuum trucks etc.

Applicable Habitat Types: On land wherever surface sediments are both amenable to, and accessible by, heavy equipment.

When to Use: When large amounts of oiled materials must be removed.

Barriers/Berms

Barriers/Berms

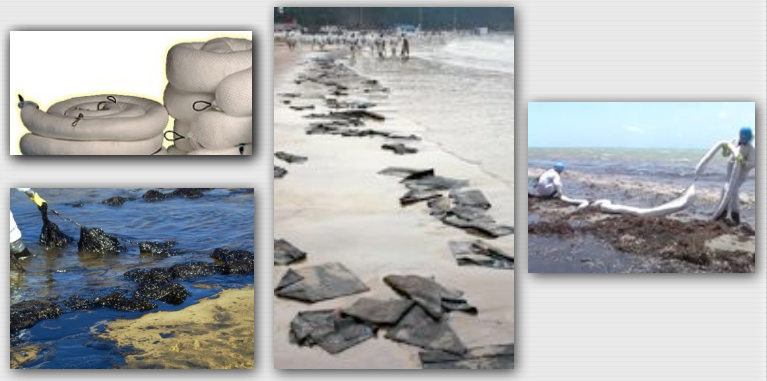
Objective: Prevent entry of oil into a sensitive area or to divert oil to a collection area.

Description: A physical barrier (other than a boom) placed across an area to prevent oil from passing. Barriers can consist of earthen berms, trenching, or filter fences using existing materials. They can serve to contain or divert or create cells for oil recovery.

Applicable Habitat Types: At the mouths of creeks or streams to prevent oil from entering, or to prevent oil in the creek from being released into offshore waters. Also, on beaches where a berm can be built above the high-tide line to prevent oil from overwashing the beach and entering a sensitive back-beach habitat (e.g., lagoon).

When to Use: When the oil threatens sensitive habitats and other barrier options are not feasible.

Sorbent



Sorbent Cont…

Objective: Remove surface oil by using oleophilic (oil-attracting) material placed in water or at the waterline.

Description: Sorbent material is placed on floating oil or used to wipe stranded oil on substrates. Forms include sausage boom, pads, rolls, sweeps, snares, and loose granules or particles. Efficacy depends on the sorbent capacity, wave energy for lifting the oil off the substrate, and oil type and stickiness. All sorbent material must be recovered.

Applicable Habitat Types: Any habitat.

When to Use: When oil is free-floating close to shore or stranded on shore. The oil must be able to be released from the substrate and be captured by the sorbent. Often used as a secondary treatment method after gross oil removal, and in sensitive areas where access is restricted. Selection of sorbent varies by oil type. Heavy oils coat surfaces, requiring sorbents with high surface areas to be effective (adsorbents); lighter oils penetrates sorbent material (absorbents).

Vacuum

Vacuum cont…

Objective: Remove oil pooled on a substrate or water.

Description: A vacuum unit is attached by a flexible hose to a suction head that recovers free oil. The equipment can range from small, portable units that fill individual drums to large powerful vacuums on trucks. Removal rates from substrates can be carefully controlled, but slow.

Applicable Habitat Types: Any accessible habitat type.

When to Use: When oil is stranded on the substrate, pooled against a shoreline, concentrated in trenches, or trapped in vegetation. Usually requires shoreline access points.

Blower

Blower cont…

Objective: blow and corral mobile oil from vegetation.

Description: A gas powered leaf blower is attached by a flexible hose to a head can blow floating surface oil and oiled debris to a central collection area for pickup.

Applicable Habitat Types: Any accessible habitat type.

When to Use: When oil is stranded or trapped in vegetation such a marshes and mangroves. Usually requires shoreline access points.

Either singular or as an array, blowers can be used to support in-situ burning of oily woody debris.

Debris Removal

Debris Removal cont…

Objective: Remove from the shoreline and water surface debris in path of spill <u>before</u> oiling and any debris <u>after</u> being contaminated.

Description: Manual or mechanical removal of debris (driftwood, seaweed, trash, wreckage) from the shore or water surface. Can include cutting and removal of oiled logs.

Applicable Habitat Types: Can be used on any habitat or environment type where access is safe.

When to Use: When debris is heavily contaminated and provides a potential source of secondary oil release; an aesthetic problem; a source of contamination for other resources in the area is likely to clog skimmers; or likely to cause safety problems for responders. Used in areas of debris accumulation on beaches before oiling to minimize the amount of oiled debris to be handled.

Vegetation Cutting/Removal

Vegetation Cutting/Removal cont…

Objective: Remove portions of oiled vegetation or oil trapped in vegetation to prevent oiling of wildlife or secondary oil releases.

Description: Oiled vegetation is cut with weed trimmers, blades, etc., and picked or raked up and bagged for disposal.

Applicable Habitat Types: Habitats composed of vegetation, such as sedges and grasses.

When to Use: When the risk of oiled vegetation contaminating wildlife is greater than the value of the vegetation that is to be cut, and there is no less-destructive method that removes or reduces the risk to acceptable levels.

In-situ Burning of Oily Vegetation

In-situ Burning of Oily Vegetation

Objective: Burn oil-covered vegetation in place (in-situ) to prevent impacts to wildlife and to speed re-vegetation.

Description: Used to augment mechanical removal of large amounts of oil and may cause less damage to vegetated (marsh) environments than mechanical removal..

Applicable Habitat Types: Wetlands and shores with grasses, sedges and/or shrubs.

When to Use: When oil residue must be removed to prevent oiling of birds and mammals that use the vegetated habitat. It is most effective when ignited as soon as possible after the oil has impacted an area, so that volatile components of the oil can be utilized to sustain the burn

High-pressure, Ambient-Water Flushing

High-pressure, Ambient-Water Flushing cont…

Objective: Remove oil that has adhered to hard substrates or man-made structures.

Description: Similar to low-pressure flushing, except that water pressure is 100-1,000 psi (720-7,200 kpa). High-pressure spray will more effectively remove sticky or viscous oils.

Applicable Habitat Types: On bedrock, boulder, and man-made solid structures.

When to Use: When low-pressure flushing is not effective at removing adhered oil, which must be removed to prevent continued oil release or for aesthetic reasons. When a directed water jet can remove oil from hard-to-reach sites.

High-pressure, Hot Water Flushing

High-pressure, Hot Water Flushing cont…

Objective: Mobilize weathered and viscous oil strongly adhered to surfaces.

Description: Hot water (90°F [32°C] up to 171°F [77°C]) is sprayed with hand-held wands at pressures greater than 100 psi (720 kpa). If used without water flooding, this procedure requires immediate use of vacuum or sorbents to recover the oil/water runoff. When used with a flooding system, the oil is flushed to the water surface for collection by skimmers, vacuum, or sorbents.

Applicable Habitat Types: Gravel substrates, bedrock, and man-made structures.

When to Use: When oil has weathered to the point that warm water at low pressure no longer effectively removes oil. To remove viscous oil from man-made structures for aesthetic reasons.

Steam Cleaning

Steam Cleaning cont…

Objective: Remove heavy residual oil from solid substrates or man-made structures.

Description: Steam or very hot water (171°F [77°C] to 212°F [100°C]) is sprayed with hand-held wands at high pressure (2,000+ psi [14,400 kpa]). Water volumes are very low compared to flushing methods.

Applicable Habitat Types: Man-made structures such as seawalls and riprap.

When to Use: When heavy oil residue must be removed for aesthetic reasons, when hot water flushing is not effective, and no living resources are present.

Shoreline Cleaning/Washing Agents

Objective: To increase the efficiency of oil removal from contaminated substrates.

Description: Special formulations are applied to the substrate, as a presoak and/or flushing solution, to soften or lift weathered or heavy oils from the substrate to enhance flushing methods. The intent is to lower the water temperature and pressure required to mobilize the oil from the substrate during flushing.

Applicable Habitat Types: On any habitat where water flooding and flushing procedures are applicable.

When to Use: When the oil has weathered to the point where it cannot be removed using ambient water temperatures and low pressures.

Nutrient Enrichment (Biostimulation)

Objective: To accelerate the rate of oil hydrocarbon degradation due to natural microbial processes by adding nutrients (generally nitrogen and phosphorus) that stimulate microbial growth.

Description: Water-soluble nutrients applied by a spray irrigation system. These are generally slow-release granular or encapsulated nutrients or oleophilic fertilizer (which adheres to the oil residue on the surface). Time-series monitoring of interstitial pore water nutrient levels is needed to ensure target levels are being maintained.

Applicable Habitat Types: Any shoreline habitat type where access is allowed and nutrients are deficient.

When to Use: On moderate to heavily-oiled substrates, after removal of free product; or on lightly-oiled shorelines. Most effective on light to medium crude oils and fuel oils (asphaltenes tend to inhibit rapid biodegradation). Less effective where oil residues are thick. Not considered for gasoline spills, which evaporate rapidly.

Module 16 – Shoreline Characteristics & Cleanup Options

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *coastal characteristics & response*

The measurement, compilation, and presentation of SCAT information is better served when one understands how oil behaves in a particular *coastal characteristic* and *shoreline type*.

From this knowledge, select the best option(s) for treating the oiled shores.

Though there is a wide variety of shoreline cleanup methods available, BUT it is the type of oil product spilled and the nature of the environmental conditions that determines the best cleanup option(s).

SCAT - *references*

There are references that link oil spill operations (tactics) to specific coastal environments* such as:

- US National Oceans and Atmospheric Administration (NOAA) *Characteristic Coastal Habitats Choosing Spill Response Alternatives*;
- US National Oceans and Atmospheric Administration (NOAA) *Oil Spills in Mangroves: Planning and Response Considerations*;
- US National Oceans and Atmospheric Administration (NOAA) Oil Spills in Coral Reefs: Planning and Response Considerations;
- US National Oceans and Atmospheric Administration (NOAA) Technical Memorandum NOS OR&R 8, 2001, *Toxicity of Oil to Reef-Building Corals: A Spill Response Perspective*;
- Bart Baca, *et al*, 2005 *Net Environmental Benefit Analysis (NEBA) Of Dispersed Oil On Nearshore Tropical Ecosystems Derived From The 20 Year "TROPICS" Field Study*,
- International Petroleum Industry Environmental Conservation Association (IPIECA) REPORT SERIES VOL. 3, *Biological Impacts Of Oil Pollution: Coral Reefs*.

SCAT – *scope*

This module examines the predicted behavour and impacts of various oil types on intertidal (foreshore) habitats of the following coastal characteristics (forms) and shoreline types:

- Rocky Shores
- Solid Man-made Structures
- Wave-cut Platforms
- Tidal Flats
- Sand Beaches
- Mixed Sand and Gravel Beaches
- Pebble and Cobble Beaches
- Marshes
- Mangroves
- Seagrasses
- Reefs

Each of these environments can be markedly different based on their wave energy and therefore their ecologically sensitivity to both oil contamination and shore cleanup activities

SCAT – *oil categories examined*

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products

Suitable options for shore cleanup can vary with the type of oil spilled

SCAT – *treatment evaluation categories*

The treatment evaluation categories used to compare the relative environmental impact of each response option are:

A = Least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = Most adverse habitat impact.
I = Insufficient information- not evaluated.
— = Not applicable.

Rocky shores - exposed

Rocky shores - exposed cont…

Description

- Intertidal zone may a steep cliff, narrow ramp or wide platform, or combinations
- Sediment accumulations are uncommon because wave action
- Strong vertical zonation of intertidal biological communities.
- Species density and diversity vary greatly, but barnacles, snails, mussels, polychaetes and macroalgae can be abundant.

Predicted Oil Behaviour in exposed shores

- Oil is held offshore by waves reflecting off the steep, hard surfaces.
- Any oil that is deposited is rapidly removed from exposed faces.
- Resistant oil often remains as a patchy band at or above the high-tide line.
- Impacts to intertidal communities are expected to be short-term - exception would be exposures of concentrations of a light refined product.

Response Consideration

- Cleanup is usually not required.
- Access can be difficult and dangerous.

Rocky shores - exposed

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Barriers/Berms	–	–	–	–
Manual Oil Removal/Cleaning	–	–	B	B
Mechanical Oil Removal	–	–	–	–
Sorbents	–	B	A	A
Vacuum	–	A	A	A
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–
Flooding (deluge)	–	–	–	–
Low-pressure, Ambient Water Flushing	–	A	A	B
High-pressure, Ambient Water Flushing	–	B	B	B
Low-pressure, Hot Water Flushing	–	–	C	C
High-pressure, Hot Water Flushing	–	–	C	C
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	D	D
Solidifiers	–	–	–	–
Shoreline Cleaning Agents	–	–	C	C
Nutrient Enrichment	–	–	–	–
Natural Microbe Seeding	–	–	–	–
In-situ Burning	–	–	–	–

Level of adverse impact to habitats:
A Least
B Some
C Significant
D Most
I Insufficient info.
— Not applicable

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Rock shores - semi-protected and protected




Semi-protected and protected rock shores cont…

Description

• Sheltered rocky shores are characterized by a rocky substrate that can vary widely in permeability. Of particular concern are rocky shores that have a semi-permeable veneer of angular rubble overlying the bedrock

Predicted oil behaviour in semi-exposed and protected areas

• Oil will adhere readily to dry, rough, rocky surfaces, particularly at the high-tide line, forming a distinct oil band.

• The lower intertidal zone of rocky shores, if algae-covered stays wet preventing oil from adhering.

• Stranded oil will persist because of the low-energy setting.

Semi-protected and protected rocky shores cont…

Response Considerations

• Low-pressure flushing of rocky shores at ambient temperatures is most effective when the oil is fresh.

• Care must be taken during flushing operations in the upper intertidal zone to prevent oily effluents from impacting biologically rich lower tidal levels - especially seagrasses and coral reef habitats.

• Do not cut oiled, attached algae; but use sorbents to recover oil as it is remobilized by tidal action.

Semi-protected and protected rocky shores cont…

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	B	B
Barriers/Berms	–	–	–	–
Manual Oil Removal/Cleaning	–	C	B	C
Mechanical Oil Removal	–	–	–	–
Sorbents	A	A	B	C
Vacuum	–	B	B	B
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	D	D
Flooding (deluge)	–	A	A	B
Low-pressure, Ambient Water Flushing	–	A	A	B
High-pressure, Ambient Water Flushing	–	C	B	B
Low-pressure, Hot Water Flushing	–	–	D	D
High-pressure, Hot Water Flushing	–	–	D	D
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	D	D
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	B	B
Nutrient Enrichment	–	A	B	C
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	B	C	C

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Man-made structures




Man-made structure cont..

Description

- Seawalls, groins, piers, and port facilities constructed of concrete, wood, or metal.
- Often there is no exposed substrate at low tide, but multiple habitats may be present.
- Attached animals and plants are sparse to moderate depending on wave exposure.

Predicted Oil Behaviour

- Oil is held offshore by waves reflecting off the steep, hard surfaces in exposed settings.
- Oil readily adheres to the dry, rough surfaces, but it does not adhere to wet substrates.
- The most resistant oil often remain as a patchy band at or above the high-tide line.

Response Considerations

- Cleanup is usually not required BUT end-points generally determined by the owner of the structure (local government, industry, private person)
- High-pressure water spraying may be conducted to remove risks of contamination of people or vessels or to improve aesthetics.

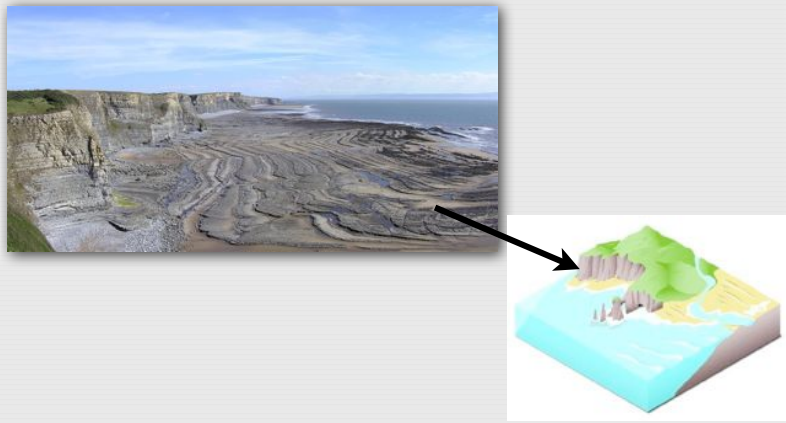
Man-made structure cont..

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Barriers/Berms	–	–	–	–
Manual Oil Removal/Cleaning	–	–	B	B
Mechanical Oil Removal	–	–	–	–
Sorbents	–	B	A	A
Vacuum	–	–	–	–
Debris Removal	–	–	–	–
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–
Flooding (deluge)	–	–	–	–
Low-pressure, Ambient Water Flushing	–	A	A	B
High-pressure, Ambient Water Flushing	–	B	B	B
Low-pressure, Hot Water Flushing	–	–	C	C
High-pressure, Hot Water Flushing	–	–	C	C
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	D	D
Solidifiers	–	–	–	–
Shoreline Cleaning Agents	–	–	B	B
Nutrient Enrichment	–	–	–	–
Natural Microbe Seeding	–	–	–	–
In-situ Burning	–	–	–	–

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Wave-cut platforms - exposed



Wave-cut platforms - exposed cont..

Description

- Bedrock shelf or platform of variable width and very gentle slope.
- Surface of the platform is irregular; tide pools are common.
- Headlands may have only small accumulation of sediments, mostly at high-tide line.
- Often co-occur with gravel beaches; the gravel beach can be either at the upper or the lower half of the intertidal zone, depending on the nature of the bedrock outcrop.
- Species density and diversity vary greatly, but barnacles, snails, mussels, and macroalgae are often abundant.

Predicted Oil Behaviour for exposed and semi-exposed areas

- Oil will not adhere to wet rock surface, but penetrates crevices or sediment veneers.
- Oil persistence is usually short-term, except in wave shadows or where the oil was deposited high above normal wave activity.

Response Considerations

- Cleanup is usually not required.
- Where the high-tide area is accessible, it may be feasible to manually remove heavy oil accumulations and oiled debris.
- Rising tides can quickly inundate the rock platform trapping workforce personnel.

Wave-cut platforms - exposed

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Barriers/Berms	–	–	–	–
Manual Oil Removal/Cleaning	–	B	B	B
Mechanical Oil Removal	–	–	–	–
Sorbents	–	B	A	A
Vacuum	–	A	A	A
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–
Flooding (deluge)	–	A	A	B
Low-pressure, Ambient Water Flushing	–	A	A	B
High-pressure, Ambient Water Flushing	–	B	B	B
Low-pressure, Hot Water Flushing	–	B	C	C
High-pressure, Hot Water Flushing	–	B	C	C
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	D	D
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	C	C
Nutrient Enrichment	–	–	–	–
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	D	D	D

Level of adverse impact to habitats:
- **A** Least
- **B** Some.
- **C** Significant.
- **D** Most
- **I** Insufficient info.
- — Not applicable.

Oil Categories:
- **I** Gasoline
- **II** Diesel/light crudes
- **III** Medium grade crudes / intermediate products
- **IV** Heavy crudes/residual products

Tidal flats - exposed

Tidal flat - exposed cont…

Description

• Exposed tidal flats are broad intertidal areas composed primarily of sand and minor amounts of gravel.

• The presence of sand indicates that tidal currents and waves are strong enough to mobilize the sediments.

• They are usually associated with another shoreline type on the landward side of the flat, though they can occur as separate shoals; they are commonly associated with tidal inlets.

• Biological use can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, and use by foraging fish.

Tidal flat exposed cont…

Predicted Oil Behaviour

• Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line.
• Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
• Oil does not penetrate water-saturated sediments, but may penetrate coarse-grained sand and coat gravel.
• Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators.

Response Considerations

• Currents and waves can be very effective in natural removal of the oil.
• Use of heavy machinery should be restricted to prevent oil mixing into sediments.

Tidal flat exposed cont…

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Barriers/Booms	B	B	B	B
Manual Oil Removal/Cleaning	–	C	B	B
Mechanical Oil Removal	–	D	D	D
Sorbents	–	A	A	B
Vacuum	–	C	B	B
Debris Removal	–	B	B	B
Sediment Reworking/Tilling	–	–	C	C
Vegetation Cutting/Removal	–	D	D	D
Flooding (deluge)	–	A	A	A
Low-pressure, Ambient Water Flushing	–	B	B	C
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	–	–
Nutrient Enrichment	–	I	I	I
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	–	–

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Tidal flats - protected

Tidal flats - protected cont..

Description
- Protected tidal flats are composed primarily of mud with minor amounts of sand and shell.
- Usually present in calm-water habitats, sheltered from major wave activity, and backed by marshes.
- Sediments are very soft and cannot support foot traffic in many areas.
- Large concentrations of bivalves, worms, and other invertebrates
- Heavily used by birds for feeding.

Predicted Oil Behaviour
- Oil does not usually adhere to the surface of sheltered tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur on a falling tide.
- Oil will not penetrate the water-saturated sediments, but could penetrate burrows and desiccation cracks or other crevices in muddy sediments.
- In areas of high suspended sediment concentrations, the oil and sediments could mix, resulting in the deposition of contaminated sediments on the flats.
- Biological impacts may be severe.

Tidal flats - protected cont..

Response Considerations

- Are high-priority areas for protection since cleanup options are limited.
- Cleanup of the flat surface is very difficult because of the soft substrate; many methods may be restricted.
- Low-pressure flushing and deployment of sorbents from shallow-draft boats may be attempted.

Tidal flats - protected cont..

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	B	B
Barriers/Berms	B	B	B	B
Manual Oil Removal/Cleaning	–	D	C	C
Mechanical Oil Removal	–	–	–	–
Sorbents	–	A	A	B
Vacuum	–	C	B	B
Debris Removal	–	B	B	B
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	D	D
Flooding (deluge)	–	B	B	B
Low-pressure, Ambient Water Flushing	–	C	C	D
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	–	–
Nutrient Enrichement	–	I	I	I
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	–	–

Level of adverse impact to habitats:
- **A** Least
- **B** Some.
- **C** Significant.
- **D** Most
- **I** Insufficient info.
- — Not applicable.

Oil Categories:
- **I** Gasoline
- **II** Diesel/light crudes
- **III** Medium grade crudes / intermediate products
- **IV** Heavy crudes/residual products

Sand beaches - exposed

Sand beaches cont…

Description
- Flat to moderately sloping and relatively hard-packed.
- Can be heavy accumulations of sea weed wrack.
- Upper beach fauna include shore crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Predicted Oil Behaviour
- Light oil accumulations deposited as oily swashes or bands along the upper intertidal.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine- to medium-grained sand is about 10-15 cm, up to 25 cm in coarse-grained sand. Maximum penetration of oil into fine to medium-grained sand beaches is about 10-15 cm, and about 25 cm into coarse-grained sand beaches.
- Burial of oiled layers by clean sand can be rapid (within one day), and burial to depths as much as one meter is possible if the oil comes ashore at the beginning of a depositional period.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in infauna, which can affect important shorebird foraging areas.

Sand beaches cont…

Response Considerations

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once most of the oil has come ashore.
- Manual cleanup, rather than road graders and front-end loaders, is advised to minimize volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing vehicular and foot traffic from mixing oil deeper into the sediments.
- Mechanical reworking (sediment relocation) of lightly oiled sediments from the high-tide line to the upper intertidal zone can be effective along exposed beaches.

Sand beaches cont..

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	B	B	C
Barriers/Berms	B	B	B	B
Manual Oil Removal/Cleaning	D	B	A	A
Mechanical Oil Removal	D	B	B	B
Sorbents	–	B	A	A
Vacuum	–	–	B	A
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	D	B	B	B
Vegetation Cutting/Removal	–	C	C	C
Flooding (deluge)	A	A	A	B
Low-pressure, Ambient Water Flushing	B	B	B	B
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	C	C
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	–	B	–
Shoreline Cleaning Agents	–	–	C	C
Nutrient Enrichment	–	A	A	B
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	C	C

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Mixed sand and gravel beaches

Mixed sand and gravel beaches cont…

Description
- On moderately sloping beaches, there may be zones of pure sand, pebbles, or cobbles.
- There can be seasonal changes in the sediment distribution and beach profile due to wave action
- Sediment mobility on exposed beaches cause low densities of attached animals and plants.
- The presence of attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota.

Predicted Oil Behaviour
- During small spills, oil will be deposited along and above the high-tide swash.
- Large spills will spread across the entire intertidal area.
- Oil penetration into the beach sediments may be deep but sand sediments underneath (<40%) can limit this penetration
- Burial of oil may be deep at and above the high-tide line, where oil tends to persist, particularly where beaches are only intermittently exposed to waves.
- In sheltered pockets on the beach, pavements of asphalted sediments can form if oil accumulations are not removed, because most of the oil remains on the surface.

Mixed sand and gravel beaches cont…

Response Considerations

- Remove heavy accumulations of pooled oil from the upper beachface.
- All oiled debris should be removed.
- Sediment removal should be limited as much as possible.
- Low-pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents. High-pressure spraying should be avoided because of potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones.
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity. However, oiled sediments should not be relocated below the mid-tide zone.
- In-place tilling may be used to reach deeply buried oil layers in the mid-tide zone on exposed beaches.

Mixed sand and gravel beaches cont…

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	B	B	C
Barriers/Berms	C	C	C	B
Manual Oil Removal/Cleaning	D	C	B	A
Mechanical Oil Removal	D	C	B	B
Sorbents	–	A	A	B
Vacuum	–	–	B	B
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	D	B	B	B
Vegetation Cutting/Removal	–	C	C	C
Flooding (deluge)	A	A	B	C
Low-pressure, Ambient Water Flushing	B	A	A	B
High-pressure, Ambient Water Flushing	–	–	C	D
Low-pressure, Hot Water Flushing	–	–	C	C
High-pressure, Hot Water Flushing	–	–	D	D
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	–	–
Solidifiers	–	–	B	–
Shoreline Cleaning Agents	–	–	C	C
Nutrient Enrichment	–	A	A	B
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	C	C

Level of adverse impact to habitats:
- **A** Least
- **B** Some.
- **C** Significant.
- **D** Most
- **I** Insufficient info.
- — Not applicable.

Oil Categories:
- **I** Gasoline
- **II** Diesel/light crudes
- **III** Medium grade crudes / intermediate products
- **IV** Heavy crudes/residual products

Pebble and Cobble beaches - exposed

Pebble and Cobble beaches - exposed cont…

Description

- Pebble and cobble beaches can be steep, with multiple wave-built berms forming the upper beach.
- The degree of exposure to wave energy can be highly variable.
- Density of animals and plants in the upper intertidal zone is low on exposed beaches, but can be high on sheltered beaches and on the lower intertidal zone of all beaches.

Predicted Oil Behaviour

- Stranded oil is likely to penetrate deeply into pebble and cobbles because of their high permeability - unless there is a rock, sand, or clay foundation beneath.
- Long-term persistence will be controlled by the depth of routine reworking by the waves.
- Along sheltered portions of the shores, chronic sheening and the formation of asphalt pavements is likely where accumulations are heavy.

Pebble and Cobble beaches - exposed cont…

Response Considerations

- Heavy accumulations of pooled oil should be removed quickly from the upper beach.
- All oiled debris should be removed.
- Low-to high-pressure flushing can be effective if all released oil is recovered with skimmers or sorbents.
- Mechanical reworking of oiled sediments from the high-tide line to the lower beachface can be effective in areas regularly exposed to wave activity; the presence of multiple storm berms is evidence of wave activity.
- In-place tilling may be used to reach deeply buried oil layers along the mid-tide zone on exposed beaches.

Pebble and Cobble beaches - exposed cont…

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	B	B
Barriers/Berms	–	B	B	B
Manual Oil Removal/Cleaning	D	C	B	B
Mechanical Oil Removal	D	D	C	C
Sorbents	–	A	A	B
Vacuum	–	–	B	B
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	D	B	B	B
Vegetation Cutting/Removal	–	–	–	–
Flooding (deluge)	A	A	B	C
Low-pressure, Ambient Water Flushing	A	A	A	B
High-pressure, Ambient Water Flushing	–	–	B	B
Low-pressure, Hot Water Flushing	–	–	C	B
High-pressure, Hot Water Flushing	–	–	C	C
Steam Cleaning	–	–	D	D
Sand Blasting	–	–	–	–
Solidifiers	–	–	B	–
Shoreline Cleaning Agents	–	–	B	B
Nutrient Enrichment	–	A	A	B
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	C	C

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/residual products

Marshes (Salt & Brackish Water)

Marshes (Salt & Brackish Water) cont…

Description

- Intertidal wetlands contain emergent, herbaceous vegetation, including both tidal and muted tidal marshes. Depending on location and interannual variations in rainfall and runoff, associated vegetation may include species tolerant or adapted to salt, brackish, or even tidal freshwater conditions.
- The marsh width may vary from a narrow fringe to extensive areas.
- Sediments are composed of organic muds except where sand is abundant on the margins of exposed areas.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Abundant resident flora and fauna with numerous species and high use by birds, fish, and shellfish.

Marshes (Salt & Brackish Water) cont…

Predicted Oil Behavior

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending upon the water level at the time of oiling.
- Large slicks will persist through multiple tidal cycles and will coat the entire stem from the high-tide line to the base.
- Heavy oil coating will be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in animal burrows and root cavities.
- Light oils can penetrate the top few centimeters of sediment; under some circumstances oil can penetrate burrows and cracks up to one meter.

Marshes (Salt & Brackish Water) cont…

Response Considerations

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated before conducting cleanup.
- Heavily pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid damaging vegetation.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the plants and disturbance of soft sediments must be minimized.
- Aggressive cleanup methods should only be considered when other resources (migratory birds, endangered species) are at greater risk from oiled vegetation left in place.

Marshes (Salt & Brackish Water) cont…

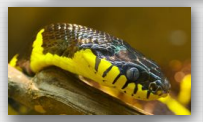
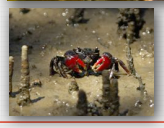
Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	B	B
Barriers/Booms	B	B	B	B
Manual Oil Removal/Cleaning	D	D	C	C
Mechanical Oil Removal	D	D	D	D
Sorbents	–	A	A	A
Vacuum	–	B	B	B
Debris Removal	–	B	B	B
Sediment Reworking/Tilling	D	D	D	D
Vegetation Cutting/Removal	D	D	C	C
Flooding (deluge)	B	B	B	B
Low-pressure, Ambient Water Flushing	B	B	B	B
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	B	B
Nutrient Enrichment	–	A	B	B
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	B	B	B

Level of adverse impact to habitats:
- **A** Least
- **B** Some.
- **C** Significant.
- **D** Most
- **I** Insufficient info.
- — Not applicable.

Oil Categories:
- **I** Gasoline
- **II** Diesel/light crudes
- **III** Medium grade crudes / intermediate products
- **IV** Heavy crudes/residual products

Mangroves




Mangroves cont…

Description

- The roots and trunks are intertidal, with only the lowest leaves inundated by high tide.
- The width of the forest can range from one tree, to many kilometers.
- The substrate can be sand, mud, leaf litter, or peat, often as a veneer over bedrock.
- Wrack accumulations can be very heavy.
- They are highly productive, serve as nursery habitat, and support a great diversity and abundance of animal and plant species.

Predicted Oil Behavior

- Oil can wash through mangroves if oil comes ashore at high tide.
- If there is a berm or shoreline present, oil tends to concentrate and penetrate into the berm sediments or accumulated wrack/litter.
- Heavy and emulsified oil can be trapped in thickets of red mangrove prop roots.
- Oil readily adheres to prop roots, tree trunks, and pneumatophores.
- Re-oiling from resuspended or released oil residues may cause additional injury over time including any adjacent seagrass and coral reef habitats.
- Oiled trees start to show evidence of effects (leaf yellowing) weeks after oiling; tree mortality may take months, especially for heavy oils.

Mangroves cont…

Response Considerations

- Oiled wrack can be removed once the threat of oiling has passed. Wrack can actually protect the trees from direct oil contact.
- Sorbent boom can be placed in front of oiled forests to recover oil released naturally.
- In most cases, no other cleanup activities are recommended.
- Where thick oil accumulations are not being naturally removed, low-pressure flushing or vacuum may be attempted at the outer fringe.
- No attempt should be made to clean interior mangroves, except where access to the oil is possible from terrestrial areas.
- It is extremely important to prevent disturbance of the substrate by foot traffic; thus most activities should be conducted from boats.

Mangroves cont…

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Barriers/Berms	B	B	B	B
Manual Oil Removal/Cleaning	–	D	C	C
Mechanical Oil Removal	–	–	–	–
Sorbents	–	A	A	A
Vacuum	–	B	B	B
Debris Removal	–	A	A	A
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–
Flooding (deluge)	–	B	B	B
Low-pressure, Ambient Water Flushing	–	B	C	C
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	I	I
Nutrient Enrichment	–	I	I	I
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	–	–

Level of adverse impact to habitats:
- **A** Least
- **B** Some.
- **C** Significant.
- **D** Most
- **I** Insufficient info.
- — Not applicable.

Oil Categories:
- **I** Gasoline
- **II** Diesel/light crudes
- **III** Medium grade crudes / intermediate products
- **IV** Heavy crudes/ residual products

Seagrasses

Seagrasses cont..

Description

• Seagrasses are highly productive habitats that occur on intertidal flats and in shallow coastal waters worldwide from arctic to tropical climates.
• Water temperature, light penetration, sediment type, salinity, and wave or current energy control seagrass distribution.
• Seagrasses provide a food source for green turtles, manatees, and waterfowl, who graze on seagrasses.
• Seagrasses are used by fish and shellfish as nursery areas.

Predicted Oil Behavior

• Oil will usually pass over subtidal seagrass beds, with no direct contamination.
• Oil that is heavier than seawater can become trapped in the beds, coating the leaves and sediments.
• Oil readily adheres to the vegetation, and the oiled blades are quickly defoliated when intertidal beds are oiled.
• Floating oil stranded on adjacent beaches can pick up sediment and then get eroded and deposited in adjacent beds.

Seagrasses cont...

Response Considerations

• Be careful when deploying and anchoring booms to prevent physical damage to seagrass beds.

• Be careful to prevent sediment suspension and mixing with the oil, and disturbance of roots and vegetation by foot traffic and boat activity.

• Do not cut seagrass unless species like sea turtles, manatees, or waterfowl are at significant risk of contacting or ingesting oil.

• Dispersant use directly over subtidal seagrass beds may impact the highly sensitive communities. However, use in offshore areas can reduce impacts to highly sensitive intertidal environments.

• In situ burning can be considered outside the immediate vicinity of seagrass beds to protect sensitive intertidal environments. Burn residues can sink;

the potential effects of residues will depend on the composition and amount of the oil to be burned.

Seagrasses cont...

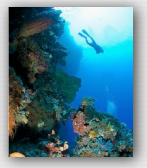
Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	B
Booming	B	B	B	B
Skimming	–	B	B	B
Physical Herding	–	B	B	B
Manual Oil Removal/Cleaning	–	–	B	B
Mechanical Oil Removal	–	–	D	D
Sorbents	–	A	A	A
Vacuum	–	–	B	B
Debris Removal	–	–	B	B
Vegetation Cutting/Removal	–	–	C	C
Low-pressure, Ambient Water Flushing	–	–	–	–
Dispersants	–	C	C	C
In-situ Burning	–	B	B	B

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/ residual products

Coral Reefs



Coral Reefs cont....

Description

- Coral reefs are structures created and maintained by the establishment and growth of populations of stony coral and coralline algae.
- Coral reefs are mostly subtidal in nature, although the most shallow portions of some reefs can be exposed during very low tides.
- Broad, pavement-like platforms formed by reefs when they reach sea level are a special concern.
- Many coral species spawn simultaneously over a very short time period (days), a behavior that makes the entire recruitment class very vulnerable.

Predicted Oil Behavior

- Coral reefs vary widely in sensitivity to spilled oil, depending on the water depth, oil type, and duration of exposure.
- There are three primary exposure pathways: direct contact with floating oil; exposure to dissolved and dispersed oil in the water column; and contamination of the substrate by oil deposited on the seafloor.
- Reef-associated community of fish, crustaceans, sea urchins, etc. can experience significant mortality.

Coral Reefs cont....

Response Considerations

- Caution is needed when deploying and anchoring booms near reefs to prevent physical damage to the reef.
- Foot and vehicular traffic should not be allowed across a reef flat; access must be from the seaward side via boats.
- The use of dispersants directly over shallow reefs is likely to have significant impacts to the reef community. Their use in offshore areas can reduce impacts to highly sensitive intertidal environments.
- In situ burning outside of the immediate vicinity of reefs can protect sensitive intertidal environments. Burn residues can sink; the potential effects of these residues will depend on the composition and amount of oil.

Coral Reefs cont..

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	A
Booming	–	B	B	B
Skimming	–	B	B	B
Physical Herding	–	–	–	–
Manual Oil Removal/Cleaning	–	–	B	B
Mechanical Oil Removal	–	–	–	D
Sorbents	–	A	A	A
Vacuum	–	–	B	B
Debris Removal	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–
Low-pressure, Ambient Water	B	B	B	C
Dispersants	–	C	C	C
In-situ Burning	–	B	B	B

Level of adverse impact to habitats:
A Least
B Some.
C Significant.
D Most
I Insufficient info.
— Not applicable.

Oil Categories:
I Gasoline
II Diesel/light crudes
III Medium grade crudes / intermediate products
IV Heavy crudes/ residual products

SCAT - *some concluding statements*

A SCAT view towards shore clean-up options:

- ☑ think "no-treatment" and natural shoreline remediation as the bench-mark. **Don't make a project out of nothing and expose worker to more risks than they have to be.**
- ☑ think water-flush (deluge) for oil stranded on coarse sediments. **Get the oil to the surface for removal.**
- ☑ think sediment relocation (manual/mechanical) for cleaning - in particular for final polish of shores - even in low wave energy environments. **Take advantage of clay-oil flocculation processes.**
- ☑ think oily waste mitigation in the SCAT process such as natural cleaning, sediment relocation, advanced debris removal, priorities to reduce oil remobilization/spread, realistic end-points. **Less is often better.**

Module 17 – Cleanup Constraints

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *standard constraint categories*

Standard constraint categories "red-flag" whether a shore segment needs either **no** or **special** consideration for cleanup.

SCAT - *ecological treatment constraint categories*

Ecologists on the SCAT team may define treatment constraints. Typically most shore segments are provided the following three designations:

DEFERRED – applied to segments where no oil is present and/or no treatment is planned

(DO NOTHING)

STANDARD – applied if standard (planned) treatment is sufficient to safeguard the ecological community.

(CLEAN SEGMENT AS AGREED ON BY OPERATIONS)

HOLDING – applied as a temporary measure for sites where treatment is planned, but where the ecological survey is incomplete and/or further survey work is considered necessary.

(WAIT FOR FUTHER INSTRUCTIONS)

SCAT - *ecological constraints categories cont...*

Some segments are targeted for special constraints/consideration as follows:

SPECIAL CONSIDERATION – when treatment measures are recommended for segments in vicinity of sensitive habitats or populations(i.e. seabird nesting colony, seal haulout). Written instructions are provided on how to avoid or minimize disturbance during the cleanup operation.

CONSULTATION – applied where the standard (planned) treatment could adversely affect the ecological community and consultation between ecologists and Operations Supervisor(s) is appropriate to prevent or minimize potential adverse effects.

ON-SITE MONITORING – applied where high sensitivity or highly vulnerable areas require the presence of an on-site ecological monitor during cleanup

The last two categories involve a site-specific discussion regarding what is acceptable regarding a particular treatment technique, timing, or level of effort. Instruction is provided in the Shoreline Treatment Recommendation Transmittal (STRT) form

SCAT - *cultural resource constraints categories*

Cultural resource data are available for use only by qualified individuals on a "need to know" basis - only generic data such as a segment's cultural resource constraint is made public. Each segment is assigned one of the following treatment constraints by the SCAT's archaeologist:

REPORT any cultural resources found during operations to the Historic Properties Specialist or to the Environmental Unit Leader in the Command Post."

INSPECT area prior to operations. *The Historic Properties Specialist, or someone he/she designates, undertakes an field evaluation and make demarquate and area as "out-of-bounds" or collect artifiact.*

MONITOR on-site operations." *The Historic Properties Specialist, or someone he/she designates, should be on-site monitoring response operations.*

Example Cultural Constraint is: *Cultural resources found during response operations or a SCAT undertaking must be left in place and location marked. No cleanup allowed within the vicinity surrounding the site. Inform the Historic Properties Specialist at the Incident Command Post.*

SCAT - *examples of operational constraints*

Examples of detailed operational constraints that can be applied to:

- a standard "generic" cleanup plan, or
- for each segment.

SCAT – *constraints related to response options*

Constraints can be applied to all physical pesponse options

- Sediment Reworking/Tilling
- Flood (Deluge)
- Low-pressure, Ambient Water Flushing
- Manual Removal
- Mechanical Removal
- Barriers/Berms
- Sorbents
- Vacuum
- Debris Removal
- Vegetation Cutting/Removal
- In-situ Burning
- High-pressure, Ambient Water Flushing
- Hot Water Cleaning (High & Low Flushing/Steam
- Shoreline Cleanup Agents
- Nutrient Enrichment

Constraints reduce overall environmental consequences from the actual shore treatment method recommended by SCAT

Sediment Relocation/Tilling

Constraint: Do not be use on sediments with high levels of biological productivity such as shellfish beds and other burrowing organisms.

Use only after removal of mobile oil

Low-pressure, Ambient-Water Flushing

Constraints: Do not contaminate previously unoiled marine environments.

Operations restricted to lower-intertidal submerged periods (specify times).

Do not flush muddy or fine grain substrates.

Flushed oil must be contained and recovered to prevent further oiling of adjacent areas

Manual Oil Removal/Cleaning

Constraints: Restrict or prevent workforce access over sensitive areas (wetlands, tidal pools, etc.) by use of barrier tape and signage.

Remove oily sediment only to depth of oil penetration.

Mechanical Oil Removal

Constraints: No equipment use in restricted or sensitive habitats.

Operational noise mitigation requires work begin after 0800 hours and to cease after 1700 hours.

Remove sediments only to the depth of oil penetration.

No off-site contamination allow.

No large debris removal or disturbance to mitigate shore erosion.

Barriers/Berms

Constraints: No placement of dams and filter fences in wetlands or know cultural site - as marked by barrier tape.

No placement of barriers or berms within the natural shore profile to mitigate oiled sediment transportation.

Segregate all oiled filter fence materials

Sorbent

Constraints: Minimize use of sorbents to final "polish" and "cleanup" use only.

Securely anchor all Pom-Poms and other sorbents that have ropes with them.

Remove and segregate all sorbents within (specified time) before they break apart.

Vacuum

Constraints: Restrictions access from areas where foot traffic and equipment operation may be damaging to soft substrates.

Collected oil and or oil/water mix to be stored temporarily in approved and designed containers.

Oil/Water separation on-site not allowed.

Debris Removal

Constraints: Do not remove debris identified as wildlife habitat, for erosion control or of recreational values - as indicated by signage and flagging tap.

Do not physically disturb substrate when using mechanized equipment to remove large woody debris.

Chain-saw the oiled sections of large oily debris for removal and leave the rest on-shore.

Temporarily store oily debris on non-permeable substrate.

Vegetation Cutting/Removal

Constraints: Minimize the degree of root destruction by cutting only the oiled portions of the plants.

Remove only oil "saturated" vegetation (oil sticks to hands or clothing).

Access in active bird-nesting areas is restricted.

Cut portions of oiled plants to be collected, bagged and disposed of in accordance with *Waste Management Plan*.

In-situ Burning of Oily Vegetation

Constraints: Minimize excessive heat to roots and substrate by ensuring continuous movement of torch

Do not burn where trees and building are at risk of ignition.

Burn only during off-shore wind conditions when near residential areas to mitigate Air quality impacts.

High-pressure, Ambient-Water or Hot-water Flushing

Constraints: Use only on anthropogenic solid structures (pilings, rip-rap) or boulder/ bedrock substrates.

Not be used directly on attached algae nor rich, intertidal areas.

Do not disturb mobile substrates

Restrict flushing so that the oil does not drain across sensitive habitats.

Flushed oil must be recovered to prevent further oiling of adjacent areas.

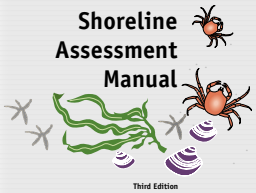
Staging Areas

Constraints can be applied to staging areas, access routes and other operational activities as well.

SCAT - *incident examples*

Examples of operational constraints used in incidents

SCAT - *sample constraints (Julie N Spill)*



GUIDELINES FOR HOT-WASH OF OILED RIPRAP/BULKHEADS
Julie N Spill, Portland, Maine
October 4, 1996

- Water temperature of hot wash not to exceed 40°C.
- Spray nozzle will be held at a distance of 6 inches or greater from the surface.
- All spraying/flushing will be into water for collection.
- No attached seaweed will be sprayed with hot water.
- Once the water level reaches the seaweed, hot-water washing will be terminated.
- Once hot-water washing is terminated, all released oil will be recovered immediately.
- Cold-water flushing of the seaweed is allowed when oil has accumulated in it.
- Removal of heavily oiled seaweed will be allowed in specified areas identified by the Shoreline Assessment Team.
- If seaweed is to be cut, the root attachment and a 12-inch stem will be left.
- Cold-water flushing will be conducted until no more oil is mobilized.
- Hot wash will be repeated until no free oil is released by the hot wash and no more than a stain (can't be scraped off with a finger- nail) remains on the surface.
- Sorbents will be deployed along areas where sheens are being released from the shoreline.

Module 18 – End Points for Shoreline Treatment

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *end points*

Module based on *2003 Treatment Criteria and End Point Standards for Oiled Shorelines and Riverbanks* by Ed Owens (Polaris Applied Sciences, WA USA) and Gary Sergy (Environment Canada, Calgary, Canada).

SCAT – *who determines end points*

Government - as the steward/trustee of natural resources (shorelines, fish, birds, mammals *etc*.) is responsible for establishing when oiled shore "treatment is completed" – the "*end points".*

Stakeholders – those that use or rely on a clean shore influence the final cleanup recommendations.

Responsible Party* - is primarily responsible for the tactical operations of the response to achieve the defined endpoint(s).

**Responsible Party (RP) refers an agency or company taking responsibility for impact mitigation (e.g. cleanup, response management). The term does not infer responsibility for the incident.

SCAT – *what are end points*

End points are measurable criteria assigned to a segment of oiled shore used to determine the completion of a specific treatment plan.

End points are the practical definition of "clean" and "completed" for a particular shoreline segment for the spill.

SCAT – *purpose of end points*

The purpose of end points is:

- To assist the spill management team in selecting treatment objectives and techniques;
- To give operations a known point of completion;
- To provide an inspection team with criteria to evaluate the results of the treatment;
- To facilitate recognition and assessment of all the various environmental, social, and economic factors, and
- To create a consensus among stakeholders to reach closure.

SCAT – *factors in selecting end points*

There are range of ecological, social and economical factors that influence the selection of the end points, such as;

- Shoreline type (i.e. bedrock, sea walls, marshes);
- Habitat value or utilization of the segment, and the timing of that use (i.e. wildlife refuge, residential area, industrial area, seal haul-out, park, remote area);
- Operational factors (i.e. access, staging, effectiveness);
- Degree and type of oiling;
- Anticipated rate of natural cleaning;
- Environmental influences such as weather, and
- Social and economic uses.

SCAT – *application of end points*

In setting end points, they can be applied:

- To different scales of coverage;
- To different habitats types, shore types or land-use types;
- To each specific shoreline segment, and
- To different environmental components, e.g., to water, vegetation, surface sediment.

End points vary from one spill to another, depending on the unique features of the incident. There is no uniform or standard approach that can be applied universally.

Nevertheless, each shoreline segment requires its own "set" of end points, whether they be generic or unique.

SCAT – *guiding principles*

Governing principles of cleanup termination decision-making.

- **Worker Safety:** Human health and safety is of primary importance and is not be jeopardized for any cleanup operations.
- **Lowest Practicable Level of Contamination**: Cleanup stops when the cleanup techniques cause more damage to the shoreline than leaving the remaining oil in place (NEBA).
- **Immediate Threat:** Oil that poses an immediate threat of remobilization, of injuring wildlife/marine life, or impacting human health and safety are given priority for removal. All practical measures will be taken to control significant off-segment migration of oil, including from cleanup activities

SCAT – *types of end points*

There are four types of end points:

1. **Qualitative Field Observations** - based on oil presence or absence
2. **Quantitative Field Measurement Methods** - based on presence of oil that exceeds specified conditions
3. **Analytical Measurement Methods** - based on the presence of oil that exceeds analytical measurements of the concentration or toxicity
4. **Interpretive Impact Assessment Methods** - based on an evaluation of broad systems impacts and may include environmental, social economic, and/or cultural variables

For the purpose of SCAT, end points based on qualitative/ quantitative field measurements are the most suitable

SCAT – *selecting end points*

Selecting End Points
defined by Qualitative and Quantitative
Field Observations and Measurements

SCAT – *based on qualitative observations*

Basis: These are simple non-numerical standards based on oil presence/absence with descriptors on

- Oil character and/or
- Oil location

Measurement Technique: A "yes/"no" judgement on attainment of the endpoint is made by visual observations

SCAT –*based on qualitative observations*

Qualitative Field Observations format:

NO **(Oil Character)** at/on **(Location)**

Categories of Locations:

- Surface/Subsurface
- Shore Zone
- Habitat/Use Type
- Substrate Type
- Shoreline Type
- Oiled Debris

SCAT –*based on qualitative observations cont..*

Other examples of qualitative end points:

- NO visible surface oil
- NO mobile oil
- NO sticky oil
- NO oiled vegetation that could contact wildlife
- NO oil on beaches fronting resorts
- NO oil sheen from shore substrates
- NO oil in the upper intertidal zones
- NO subsurface oil

SCAT – *example of end points*

SHORELINE TYPE	CLEANUP ENDPOINT
Exposed rocky shores and wave cut platforms	Cleanup can be terminated when the shoreline no longer generates sheens that affect sensitive wildlife. On exposed rocky shores used as seal haulouts, persistent oil should be removed until the oil is no longer sticky, unless cleanup is determined to be too disruptive to animals at the site.
Solid man-made structures	In industrial areas, cleanup can be terminated when the shoreline no longer generates liquid oil and heavy rainbow sheens. In areas of high public use, more intensive cleanup should be conducted to remove the oil until it no longer rubs off on contact. In areas of low public use, visible oil can remain as stain and patches of coat.
Sand Beaches	Cleanup can be terminated when there is no visible oil on the surface. All tarballs or tar patties that could be removed by reasonable cleanup techniques or that could be remobilised should be removed. Remaining tarballs and patties should be at or below normal background frequency. Cleanup can be terminated when no layers of oil are found in trenches dug into the beach.
Mixed sand and gravel beaches	Cleanup can be terminated when all liquid oil in the sediments has been removed. No more than a stain may remain on the gravel-sized sediments. There should be no oil layers in pits dug. Buried tarballs should be at or below background frequency. Removal of subsurface oil should be terminated when further cleanup efforts will result in excessive habitat disruption that will cause more harm than natural removal of oil residues.

marinepollutionRESPONSEservice
MARITIME NEW ZEALAND

SCAT – *based on quantitative measurement*

Basis: Presence of oil that exceeds specified conditions on location, surface distribution, size/area, thickness and character of the oil.

One or more of the conditions is numerical.

The conditions are identical to the standard terminology for SCAT

Measurement Technique: End points are determined by visual observations and measurements of the quantity and character of oil using the SCAT methodology and terminology.

SCAT –*based on quantitative observations cont..*

Quantitative Field Observations format:

NO **(Oil Character)** at/on **(Location)**
with **> (Thickness)** and/or **(Distribution)**

SCAT –*based on quantitative observations cont..*

Examples of quantitative end points:

- NO oiled areas in intertidal zone that are >1 meter wide and >3 mm thick
- NO tar patches in supratidal zone >3 mm thick and > 50x50 cm across (shovel width)
- NO tar balls over 1 cm in diameter and >5% surface distribution
- NO fresh or sticky oil on >10% of vegetation stems
- NO subsurface oil in intertidal area > 10 cm deep

SCAT – *qualitiative versus quantitiative*

Qualitative description of an end point abides by the KISS principle – **K**eep **I**t **S**imple **S**tupid. Easier for operational personnel to understand and hence achieve, but can be more room for argumentative interpretation.

Quantitative description of an end point is generally reserved for shorelines needing special conditions – generally those shores that are assigned for operational monitoring.

SCAT – *example end points*

WABAMUM TRAIN DERAILMENT, ALBERTA, BC
Shorelines Fronting Residences and First Nation Shoreline

Segment Type	End-Point
Sand, or Mixed Sand/ Gravel Beach	No Visible Surface or Subsurface Oil.
Peat Beach (due to added 'sphagnum sorbent"	No Visible Oil
Natural Cobble/Boulder	Stain (<0.01 cm thick) and < 20% distribution
Manmade Cobble/Boulder or Riprap	Stain (<0.01 cm thick)
Vegetated Cut Bank	Coat (<0.1 cm thick) and < 10% distribution on cut bank. Coat (<0.1 cm thick) on larger tree roots (i.e.,tree root diameter >5 cm)
Bullrush/Reed Bed	Non-sticky Coat (<0.1 cm thick)
Wetland Fringe	Non-sticky Coat (<0.1 cm thick). Mudflats - no tar balls >2 cm diameter. Total tar balls < 2 cm dia not to exceed 10% distribution. TAG will be contacted to give specific instructions if questions arise during treatment.
Piling	No Visible Oil

SCAT – *example end points*

M/V Selendang Ayu Grounding, Alaska (for Spring/Summer 2005)

Segment Type	End-Point
MIXED SEDIMENT/ GRAVEL/COBBLE - STEEP CLIFF BACKSHORE	•Tarballs greater than 2 cm in diameter and all tar patties and tar mats removed •Oiled sediment and gravel removed or cleaned to a light patchy (<20%) coverage of coat (CT) • Oiled cobbles and boulders removed or cleaned to light patchy (<20%) coverage of coat (CT) •Oiled vegetation removed, to a light patchy (<20%) coverage of coat (CT)
OILED SHORELINE DEBRIS	•Small trash and oiled debris, such as containers and plastics, with greater than 10% coverage of oil, will be removed. •Large oiled debris, such as fishing equipment, with greater than 10%coverage of oil, will be cleaned or removed. •Oiled seaweed and marine vegetation will be removed to a light patchy (20%) coverage of coat (CT) •Oiled logs and woody debris will be cleaned or removed to a light patchy (20%) coverage of coat (CT). Oiled sections may be removed from unoiled Sections

SCAT - *communications*

End points are developed in consultation with agencies, responsible party, contractors and stakeholders – generally in the field.

End points are officially communicated on the *Shoreline Treatment Recommendation* (STR) form that describes the treatment and constraints for each shore segment.

The biggest challenges is that "end-points" that meet stakeholder expectations can conflict with "constraints" to achieve a Net Environmental Benefit.

SCAT – *calibrating end points*

Agency, company, contractor, and stakeholder representatives need to have:

- The same understanding of endpoints, and
- An appreciation of the appearance of the final treated shoreline.

Orientation and calibration sessions need to be done for those representing the interests of stakeholders and the RP; and for operational personnel (Division Supervisors and Team Leaders)

SCAT – *monitoring*

Those who set treatment end points need to stay in touch with the actual shoreline treatment operations, both to ground truth the worth and practicality of the initial selection and to be responsive to adjustments should the need arise

SCAT – *operational considerations*

From an operational delivery perspective, there can be:

- A set of several treatment end points within one shore segment such as for for sequential treatment actions – initial deluge (coarse oil removal) to sediment relocation (polishing);
- Practical requirements to consider such as level of precision, effort, turnaround time (e.g. reasonable effort);
- A judgment call by field personnel that the endpoint is not practical or not clear (e.g. matter raised to incident management).

To have operational relevance, the end point definition must be concise, clear and understandable

SCAT – *operational considerations*

Once defined, the end point itself is achieved by human intervention (treatment) techniques or by allowing natural cleaning or attenuation processes to alter and remove the oil without intervention.

Which of these are end points?

The question of when to finish a response operation is pivotal at the outset of a response as this determines the level of effort required by the operations personnel.

SCAT – *closure*

A post treatment survey is conducted by the SCAT team and / or an inspection team that represents the interest of both the responsible parties and stakeholders. The post-treatment inspection team would pass judgement whether:

- The end point criteria have been met and recommend that no further treatment is required.

OR

- The end point criteria have not been attained and recommend further treatment is required.

Despite having clear and simple definitions, some judgement may have to be exercised on infractions, interpretations and transgressions

SCAT - *sample inspection report**

Segment ID: 1357D
Survey:
Date: June 07/2007
Time: 1300 hours
Tide Stage: Mid-tide, falling

Inspection Completed Along Entire Segment? Yes__ No__

SCAT Survey Members:

Representation	*Name*	*Signature:*
Federal	_____	_____
Provincial	_____	_____
Local Govt:	_____	_____
First Nations	_____	_____
Responsible Party	_____	_____

Treatment Endpoint Description

No visible staining of sand sediments

Is treatment or further treatment required? (circle one)
Yes – Action: as defined below
No - Action: provide to Unified Command for Sign-off

Treatment Description: (provide to Operations Section Chief specific action supported by sketch, GPS coordinates, and/or standards as needed to guide operations).

EXAMPLE: Sand sediments located in north end of shore segment between GPS coordinates #### and #### require further cleaning by sediment relocation. Oiled large wood-debris on two logs located at south end of segment required to be chained sawed and removed.

Transmittal Instructions:

Provide copy to SCAT coordinator and Operations Section Chief and original to Documentation Unit

Unified Command Members: *Date:* _____

Representation	*Name*	*Signature:*
Federal	_____	_____
Provincial	_____	_____
Local Govt:	_____	_____
First Nations	_____	_____
Responsible Party	_____	_____

Attachments:

- ❑ Landowner or other stakeholder comments
- ❑ Map(s)
- ❑ Photographs
- ❑ Other_____

Transmittal Instructions:

Provide copy to SCAT coordinator and original to Documentation Unit

** Modified from Alaska's *M/V Selendang Ayu* Segment Inspection Report

SCAT – *striving for closure*

The ultimate objective on determining, applying and assessing end points is the attainment of "closure" – whether one shore unit at a time and eventually for the entire area affected.

Module 19 - SCAT Field Equipment

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *field measuring equipment*

Basic principles of SCAT field equipment are:

- Light-weight
- Robust
- Resiliant to oil contamination (cleanable)
- Simple to use
- Collectively contained in a small package

SCAT - field *equipment*

A typical SCAT field kit

Module 20 - SCAT Field Measurement

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT

The SCAT assessment process generates site-specific recommendations on resource protection and cleanup methodology for **each shoreline segment** by:

1. Taking measurements of oiling coverage, character, thickness;
2. Completing forms and sketches for each segment to identify specific locations to be cleaned, and
3. Making cleanup constraints and recommendations.

Items 1 is the focus of this module

SCAT – NOAA's job aid: *a visual guide*

SCAT – *field measurement calibration*

At a spill, it is very important to "calibrate" by having all team members and stakeholders visit representative oiled shorelines together and agree on the oiling descriptions and demarcating zone IDs (oiling breaks).

This is also an opportunity to garner stakeholder confidence in the SCAT process.

SCAT - *basic field measurements*

The basic field measurements include:

- Measuring the shore segment and surveyed lengths;
- Estimating surface oil distribution as percent coverage;
- Describing surface oiling thickness and type;
- Conducting subsurface oiling type and penetration, and
- Undertaking beach profiles.

This information is used to complete SCAT field forms and to categorize levels of surface oiling.

SCAT – *segment & surveyed length*

It is important to measure or record BOTH the shore segment* and the actual areas of the shoreline surveyed. The tools are either a hip-chain, tape measure, or both.

Flag (with annotation) all surveyed lengths and locate them above the highwater mark

* Segment length can also be obtained from coastal mapping data.

SCAT – *field data recording documents*

All forms and writing pens/pencils must be water resistant

SCAT

HOW MUCH OIL COVERED THE SHORE?

SCAT – *surface oil distribution (% cover)*

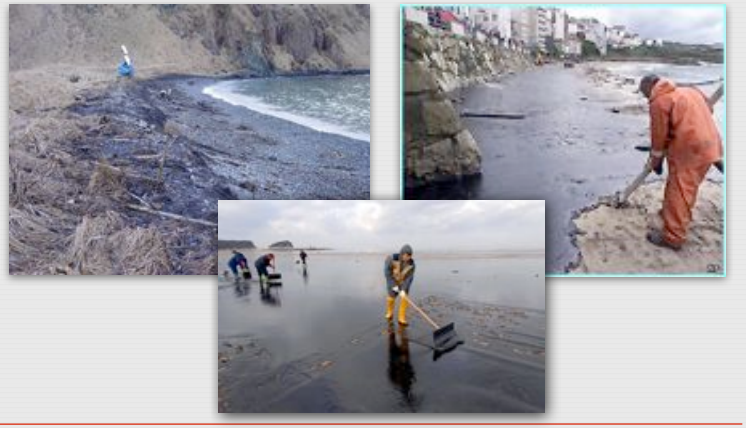
Distribution: Record the **real estimated percent** of oil on the surface, and then the closest matching code for **explaining the situation**:

Code	*Term*	*Description*
C	*Continuous*	91-100% cover
B	*Broken*	51-90%
P	*Patchy*	11-50%
S	*Sporadic*	<1-10%
T	*Trace*	<1%

Codes are used in the SCAT forms to complete data fields**

**Module 21 - examines field data documentation using SCAT forms

Cover Distribution: **C**ontinuous (C) 91 – 100% cover

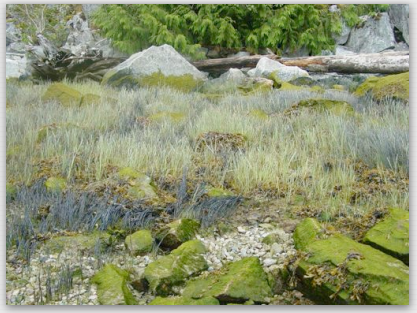


Cover Distribution: **B**roken (B) 51-90% cover

Cover Distribution: **P**atchy (P) 11-50% cover

Cover Distribution: **S**poradic (S) 1-10% cover

Cover Distribution: **Trace** (T) <1% cover



SCAT

HOW THICK WAS THE OIL?

SCAT – *surface oil thickness descriptors*

Code	*Term*	*Description*
PO	*Pooled Oil*	(fresh oil or mousse >1 cm thick)
CV	*Cover*	(oil or mousse from >0.1 cm to <1 cm on any surface)
CT	*Coat*	(visible oil <0.1 cm, scraped off with fingernail)
ST	*Stain*	(visible oil, cannot be scraped off with fingernail)
FL	*Film*	(transparent or iridescent sheen or oily film)

**Module 21 - examines field data documentation using SCAT forms

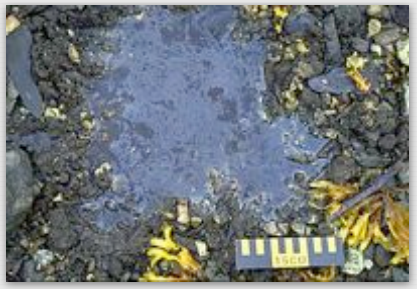
Thickness Descriptor: **P**ooled **O**il (PO) > 1 cm thick

Thickness Descriptor: **C**o**v**er (CV) 0.1 & < 1 cm thick

Thickness Descriptor: **C**oa**t** (CT) < 0.1 cm thick

Thickness Descriptor: **St**ain (ST)

Thickness Descriptor: **Fil**m (FL) – iridescent sheen



SCAT

WHAT CONDITION IS THE OIL?

SCAT – *surface oil type descriptors*

Code	*Term*	*Description*
FR	*Fresh*	(unweathered, liquid oil)
MS	*Mousse*	(emulsified oil)
TB	*Tarballs*	(discrete accumulations <10 cm diameter)
PT	*Patties*	(discrete accumulations >10 cm diameter)
TC	*Tar*	(highly weathered oil, nearly solid)
SR	*Surface Oil Residue*	(non-cohesive, oiled surface sediments)
AP	*Asphalt Pavements*	(cohesive, heavily oiled surface sediments)
DB	*Debris*	(oiled logs, seaweed, dead animals)
NO	*No Oil*	(no evidence of any type of oil)

Type Descriptor: **F**resh **O**il (FO)- unweathered

Type Descriptor: **M**ousse (M) - emulsified

Type Descriptor: **T**ar **B**alls (TB) < 10 cm diameter

Type Descriptor: **P**a**tt**ies (PT) > 10 cm diameter

Type Descriptor: **T**ar **(TC)** – nearly solid

Type Descriptor: **S**urface Oil **R**esidue **(SR)**

Non-cohesive and on the surface only and not mixed with sediments

Thickness Descriptor: **A**sphalt **P**avement (AP)

Cohesive and mixed with sediments to make a pavement

Type Descriptor: **D**e**b**ris (DB)

Dead Sea Otter

Also include:

- woody debris
- Seaweed wracks
- Sorbent pads, booms

SCAT

HOW DEEP DID THE OIL PENETRATE INTO THE SEDIMENT?

SCAT – *subsurface oil descriptors*

Code	Term	Description
OP	*Oil-Filled Pores*	(pore spaces are completely filled with oil)
PP	*Partially Filled Pores*	(oil does not flow out of sediment when disturbed)
OR	*Oil Residue*	(sediments are visibly oiled with black/brown coat or cover on the clasts, but little or no accumulation of oil within the pore spaces)
OF	*Oil Film*	(sediments are lightly oiled with an oil film, or stain on the clasts)
TR	*Trace*	(discontinuous film or spots of oil, or an odor or tackiness)

SCAT – *subsurface oil descriptors cont..*

For describing sheens in standing water within a subsurface pit use:

Code	Term
B	*Brown*
R	*Rainbow*
S	*Silver* or
N	*None*.

For describing substrates in which a pit is dug for measuring subsurface oil use the following codes:

Code	Term
C	Cobble
P	Pebble
G	Granule
S	Sand
M	Mud

This information will be entered into the SCAT form**

Module 21 - examines field data documentation using SCAT forms

Type Descriptor: **O**il-filled **P**ores (OP)

Type Descriptor: **P**artially Filled **P**ores (PP)

Type Descriptor: **S**ubsurface **A**sphalt **P**avement (SAP)

Type Descriptor: **O**il **R**esidue (OR)

Type Descriptor: **O**il **F**ilm (OF)

SCAT – *putting measurements together*

The following examples put the three basic SCAT measurements together (distribution, thickness and type).

As well, the examples show how to delineate shores into zones to provide spatial information.

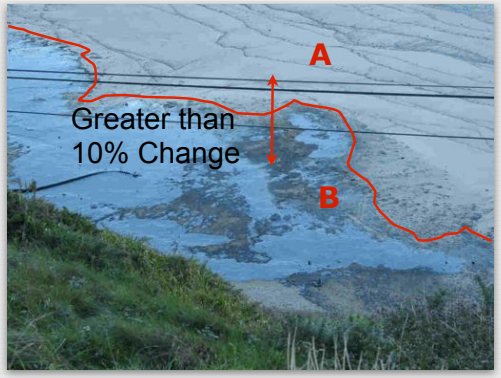
SCAT – *example 1*

***Zone A – Mid intertidal**
Surface Oiling:
Coverage: Broken (B)
Thickness: Pooled Oil (PO)
Type: Mousse (M)

Subsurface Oiling:
No Oil (NO)

* Note: Zones A, B, C... are used in SCAT forms with Zone A being the lowest tidal area where oil is found.

SCAT – *example 2*



Zone B: Upper intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Pooled Oil (PO) *Type*: Fresh Oil (FO)

Subsurface Oiling:
Oil Residue (OR)
Substrate: Sand (S)

Zone A – Mid intertidal
Surface Oiling:
Coverage: Sporatic (S)
Thickness: Cover (CV)
Type: Fresh Oil (FO)
Subsurface Oiling:
No Oil (NO)

SCAT – *example 3*

There is no Mid-intertidal Surface Oiling and therefore not designated as a zone.

Zone B: Supra intertidal
Surface Oiling:
Coverage: Patchy (P)
Thickness: Cover (CV)
Type: Surface Oil Residue (SAP)

Subsurface Oiling:
No Oil (NO) (bedrock)

Zone A: Upper intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Cover (CV)
Type: Fresh Oil (FO)

Subsurface Oiling:
Partially Filled Pores (PP)
Substrate: Cobble and Boulder

SCAT – *example 4*

Zone C: Supra intertidal
Surface Oiling:

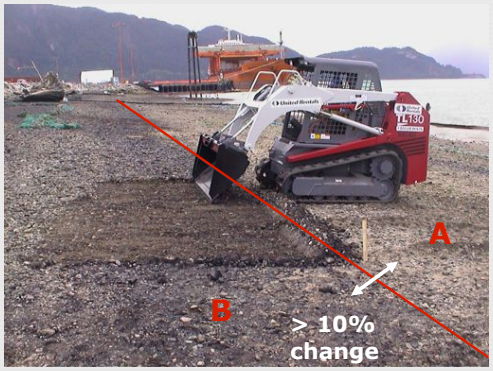
Coverage: Sporatic (S)
Thickness: Coat (CT)
Type: Surface Oil Residue (SAP)
Subsurface Oiling:
Not Applicable - bedrock

Zone B: Upper intertidal
Surface Oiling:
Coverage: Broken (B)
Thickness: Cover (CV)
Type: Fresh Oil (FO)

Subsurface Oiling:
Not Applicable – bedrock

Zone A – Mid intertidal
Surface Oiling:
Trace (T)

SCAT – *example 5*



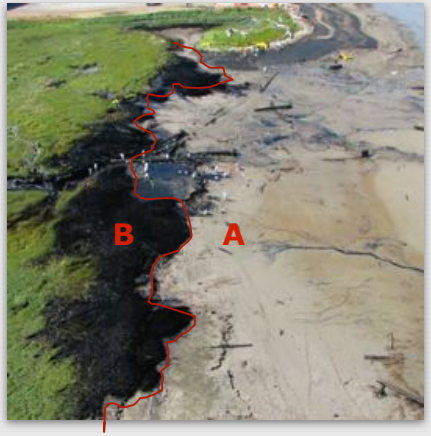
Zone B: Upper intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Coat (CT)
Type: Fresh Oil (FO)

Subsurface Oiling:
Partially Filled Pores (PP)
Substrate: Granules (G)

Zone A: Lower intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Stain (ST)
Type: Fresh Oil (FO)

Subsurface Oiling:
Oil Film (OF)

SCAT – *example 6*



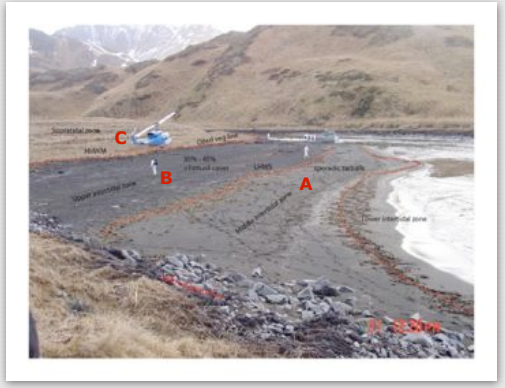
Zone B: Supra intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Cover (CV)
Type: Fresh Oil (FO)

Subsurface Oiling: No Oil (NO)

Zone A: Upper intertidal
Surface Oiling:
Coverage: Sporatic (S)
Thickness: Cover (CV)
Type: Fresh Oil (FO)

Subsurface Oiling: No Oil (NO)

SCAT – *example 7*



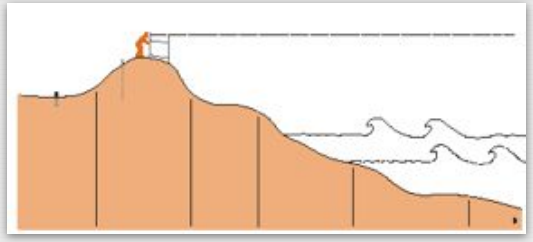
Zone C: Supra intertidal
Surface Oiling:
Coverage: Patchy (P)
Thickness: Cover (CV)
Type: Fresh Oil (FO)
Subsurface Oiling: No Oil (NO)

Zone B: Upper intertidal
Surface Oiling:
Coverage: Continuous (C)
Thickness: Cover (CV)
Type: Fresh Oil (FO)
Subsurface Oiling: No Oil (NO)

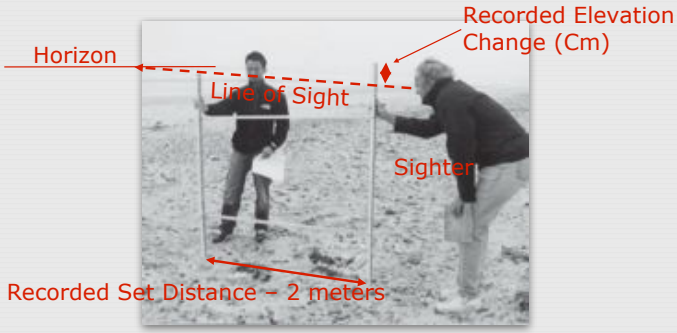
Zone A: Middle intertidal
Surface Oiling:
Coverage: Sporatic (S)
Thickness: Cover (CV)
Type: Fresh Oil (FO)
Subsurface Oiling: No Oil (NO)

SCAT – *beach profiles*

Beach profiles are generally taken on mobile sediment shores if there are ecological/oiling sampling transects for monitoring.

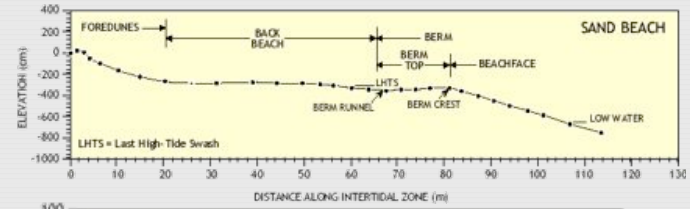


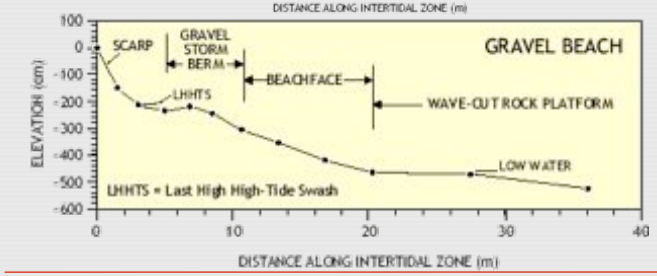
SCAT – *using an parallelogram*



Two – 1.5 meter strips of marked (cm) wood linked together by wood/cord as a set distance (2 metres) to form a flexible parallelogram used to conduct beach profiles.

SCAT – *beach profiles*





SCAT – *application of field measurements*

Characterization of oiling conditions**

DELINEATING WHAT IS HEAVY, MODERATE OR LIGHT OILING

**The following will be revisited again in module 25 on data-management

SCAT – *surface oil cover determinations*

Initial *Surface Oil Cover Matrix* for oil cover data

Oil Distribution %		Width of Oiled Area			
		Wide > 6m	***Medium*** > 3 to 6 m	***Narrow*** >0.5 to 3m	***Very Narrow*** ≤0.5 m
	Continuous 91 – 100%	**heavy**	**heavy**	moderate	light
	Broken 51-90%	**heavy**	**heavy**	moderate	light
	Patchy 11 – 50%	moderate	moderate	light	very light
	Sporadic 1-10%	light	light	very light	very light
	Trace < 1%	very light	very light	very light	very light

SCAT – *surface oil cover determinations*

Final *Surface Oil Categorization* using oil thickness

Average Thickness		Initial Categorization of Surface Oil (based on % distribution/width)			
		Heavy	***Moderate***	***Light***	***Very Light***
	Thick or Pooled > 1 cm	**heavy**	**heavy**	moderate	light
	Cover 0.1 to 1.0cm	**heavy**	**heavy**	moderate	light
	Coat 0.01 to 0.1cm	moderate	moderate	light	very light
	Stain/Film <0.01	light	light	very light	very light

Module 21 - SCAT Field Documentation

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

CANADA

EnviroEmerg.ca

SCAT – *field documentation*

The SCAT process generates site-specific data and recommendations on cleanup methodology for **each shoreline segment** by:

1. Taking measurements of oiling coverage, character, thickness;
2. Completing a *Shoreline Oiling Summary* (SOS) form, sketch and images for each segment to identify specific locations to be cleaned, and
3. Making cleanup recommendations on *Segment Treatment Recommendation Transmittal* (STRT)** form or recommend for no further treatment on a *Segment Inspection Report* (SIR)

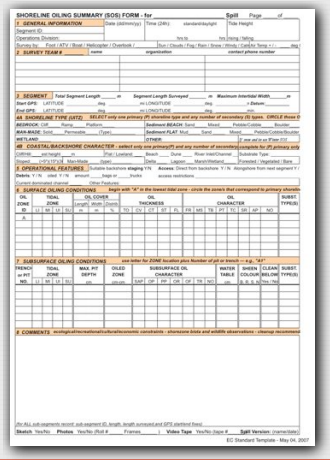
Item 2 is the focus of this module and is subject to field information management requirements and standardization

** The STRT can also be referred to as "**Shoreline** Treatment Recommendation Transmittal"

SCAT - *shoreline oil summary (SOS) forms*

Shoreline Oil Summary forms used for field data recording in marine environments include:

- **SHORELINE OILING SUMMARY***
- **WETLAND OILING SUMMARY**
- **TAR BALL**
- **SKETCH**
- **BIOLOGICAL OBSERVATION**



SHORELINE OILING SUMMARY (SOS) FORM - for _____ Spill Page ___ of ___

1 GENERAL INFORMATION

2 SURVEY TEAM #

3 SEGMENT

4A SHORELINE TYPE (UTZ)

4B COASTAL/BACKSHORE CHARACTER

5 OPERATIONAL FEATURES

6 SURFACE OILING CONDITIONS

7 SUBSURFACE OILING CONDITIONS

8 COMMENTS

EC Standard Template - May 04, 2007

SCAT – shoreline oiling summary (SOS) purpose

The SCAT field data compilation on a *Shoreline Oiling Summary* (SOS) form generally occurs only when there is a shore segment that has <u>observed oil and exceeds an end point criteria</u> - that is contaminated beyond and acceptable (agreed on) level.

The SOS provides the field data details (amount of oil, where, *etc*) to make operational decisions on if, when and how to treat (clean), reduce further environmental damages (constraints) and to what level (endpoint).

No Treatment Required: end point criteria not exceeded

Treatment Required: complete Shoreline Oil Summary form

SCAT - segment treatment recommendation transmittal (STRT) form

If oil is observed and the segment **does not** meet an end-point criteria, then the SCAT team prepares and signs a *Segment Treatment Recommendation Transmittal* (STRT) form to guide clean-up operations.

The STRT package includes supporting *Shoreline Oil Summary* (SOS) form, maps, photographs, sketches and diagrams.

The STRT form describes segment specific observations or situations that might affect treatment, and details of the modified treatment method for the segment that **varies** from the "generic" cleanup method for that type of shoreline and oiling condition.

The STRT reflects agency/stakeholder/RP consultations as well as the field findings of the shoreline oiling summary. This work can be done back at the Incident Command Post.


The Generic Spill
Segment Treatment Recommendation Transmittal

Site Location: | Ops Division:
Segment ID: | Length: | Survey Date:
Shoreline Type: | Coastal Character:

Oiled Area for Treatment

Treatment Recommendations

Operational - Staging - Logistical Information

Ecological/Cultural Comments/Constraints

Waste Issues

Safety Issues

Approved:

Attached: ☐ Sketch Map ☐ SOS Form ☐ Segment Map ☐ Fact Sheet ☐ Other ___

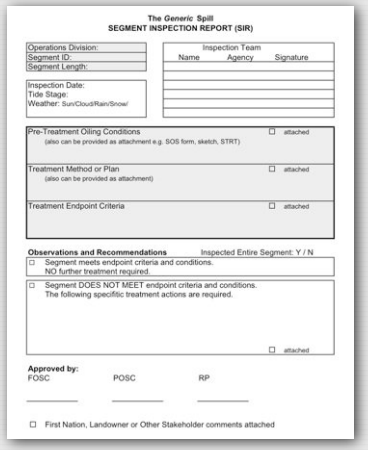
Prepared by:_____ Date:_____

SCAT – the segment inspection report (SIR)

For segments where there is *No Observed Oil* (NOO) or *No Further Treatment* (NFT) is required, this information is transmitted via a *Segment Inspection Report* (SIR). The objectives of this report are:

- To ensure operational effort is directed only where it is needed, and
- To ensure that all stakeholders are confident that each shoreline has been assessed.

The *Segment Inspection Report* ensures agencies and landowners that ALL shores within an affected area have been assessed and findings/ decisions documented.


The Generic Spill
SEGMENT INSPECTION REPORT (SIR)

Operations Division:
Segment ID:
Segment Length:

Inspection Team
Name Agency Signature

Inspection Date:
Tide Stage:
Weather: Sun/Cloud/Rain/Snow/

Pre-Treatment Oiling Conditions ☐ attached
(also can be provided as attachment e.g. SOS form, sketch, STRT)

Treatment Method or Plan ☐ attached
(also can be provided as attachment)

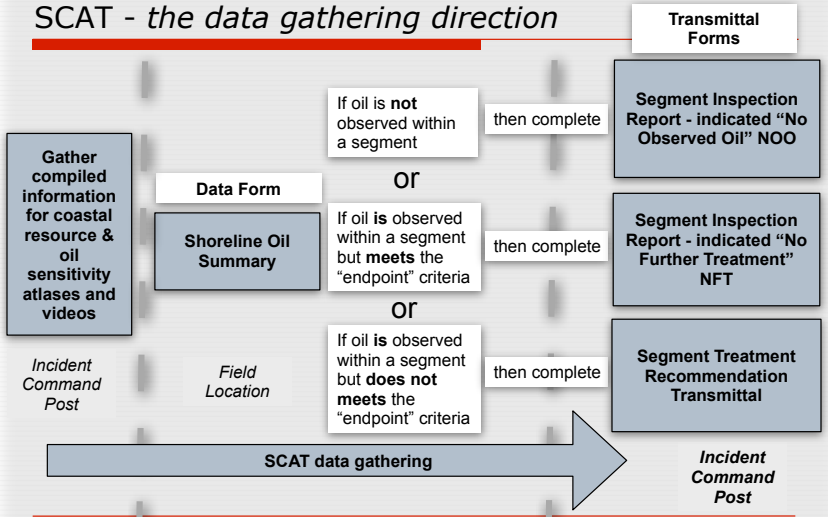
Treatment Endpoint Criteria ☐ attached

Observations and Recommendations Inspected Entire Segment: Y / N
☐ Segment meets endpoint criteria and conditions.
NO further treatment required.
☐ Segment DOES NOT MEET endpoint criteria and conditions.
The following specifitic treatment actions are required.
☐ attached

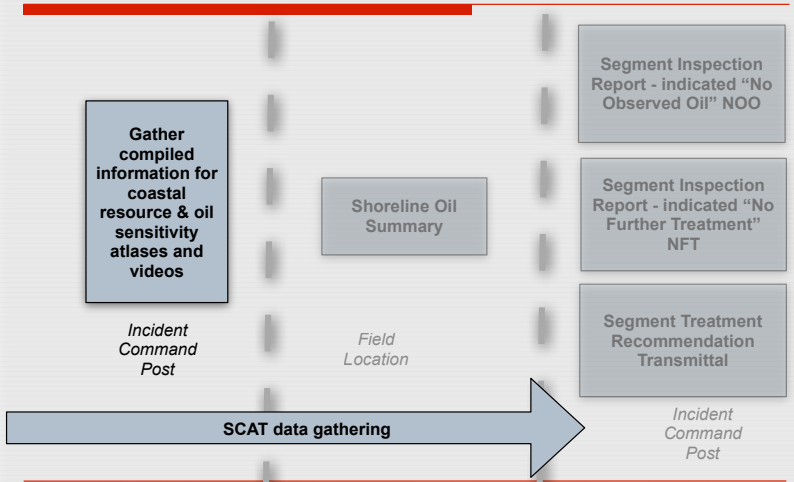
Approved by:
FOSC POSC RP

☐ First Nation, Landowner or Other Stakeholder comments attached

SCAT - *the data gathering direction*



SCAT - *gathering existing coastal information*



SCAT - *gathering existing resource information*

It is important to gather and bring to the Incident Command Post relevant natural resource, land use, hydrological and cultural information for the affected area to use in the SCAT process.

Bring reference materials, plant identification books, SCAT field references, etc.

It is also important to be able to map shoreline segments **in detail** - preferable on a computer system.

If you are in the SCAT business, prepare an overflight kit for both the Incident Command Post and field operations, such as references, documentation supplies, technology, clothing, measuring devices, etc.

SCAT–*sample shore unit for field data*

Shoreline Unit 918

The offshore areas of this region is a swell-dominated exposed environment.

SCAT – *shore unit 918*

Shore Unit 918 - includes islets

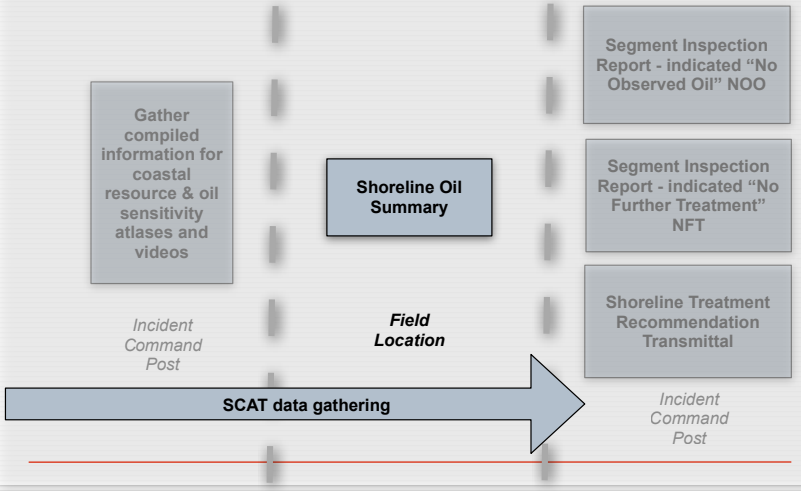
SCAT – *shore unit 918*

Video Overflight

SCAT - the Shoreline Oil Summary form

The following demonstrates how to complete a *Shoreline Oil Summary* (SOS) Form

SCAT - *completing the Shoreline Oil Summary*



SCAT – general and segment information

From GIS Coastal Map or defined on chart

From operations Division map

From tide-tables or tide program

SHORELINE OILING SUMMARY (SOS) FORM - for M/V Maddog Bunker Spill Page 1 of 2

1 GENERAL INFORMATION			
Segment ID: 918	Date (dd/mm/yy) 15/03/2007	Time (24h): standard/daylight 10:30 hrs to 13:30 hrs	Tide Height 2.4 meters
Operations Division: B			rising / falling

Survey by: Foot / ATV / Boat / Helicopter / Overlook / _____ Sun / Clouds / Fog / Rain / Snow / Windy / Calm Air Temp + / -22 deg C

2 SURVEY TEAM #	name	organization	contact phone number
	Don Juan	BC Environment (Bio)	
	Steve Nutter	Environment Canada (Bio)	
	George Plimton	Contractor RP (Geo)	
	Dan O'Rorke	Contractor (Arch)	
	Mark Walley	(First Nations Rep)	

3 SEGMENT Total Segment Length 1430 m Segment Length Surveyed 1430 m Maximum Intertidal Width 30 m

Start GPS: LATITUDE ____ deg. ____ min. LONGITUDE ____ deg. ____ min. Datum: WGS -84

End GPS: LATITUDE ____ deg. ____ min. LONGITUDE ____ deg. ____ min.

Segment can be provided from GIS coastal database or atlas or measured between land-marks

From hip-string, tape measuring or range-finder down the middle of the surveyed area.

From GPS or GIS map coordinates

Standard used for GPS data capture

SCAT – *shoreline type (fate and persistence)*

4A SHORELINE TYPE (UITZ) SELECT only one primary (P) shoreline type and any number of secondary (S) types. CIRCLE those OILED

BEDROCK: Cliff____ Ramp____ Platform____	Sediment BEACH: Sand S Mixed____ Pebble/Cobble P Boulder____
MAN-MADE: Solid____ Permeable____ (Type)____	Sediment FLAT: Mud____ Sand____ Mixed____ Pebble/Cobble/Boulder
WETLAND:____	OTHER: If snow and ice use Winter SOS

Oil primarily affects the intertidal zone. In this case, it was mixed sediment beach of Pebble/Cobble within the upper intertidal berm that was oiled.

For shore unit 918, the atlas notes the shoreline type (Coastal Class) as C-27 which is a *Wide Sand Beach* where sediments are <10% gravel and >50% sand content

Choose ALL shoreline types present and CIRCLE the one(s) "oiled".

There can be multiple secondary (S) shoreline times identified.

SCAT – *backshore (operational)*

4B COASTAL/BACKSHORE CHARACTER - select only one primary(P) and any number of secondary(S)						complete for (P) primary only
Cliff/Hill: est height 3 m	Flat / Lowland: ___	Beach P	Dune S	River Inlet/Channel ___		Substrate Type: U
Sloped: 10 (5°)(15°)(30°	Man-Made ___ (type) _____	Delta ___	Lagoon ___	Marsh/Wetland ___		Forested / Vegetated / Bare

Operational activities take place – such as equipment staging - in the **backshore** - which is described by the "coastal character" of the shore segment**.**

Codes:
R- Bedrock
U - Unconsolidated
B - Boulder
C - Cobble
P - Pebble
G - Granule
S - Sand
M - Mud/Silt/Clay
O - Organic
VEG - Live Vegetation
MMS - Manmade Solid
MMP - Manmade Permeable

SCAT – *operational features*

5 OPERATIONAL FEATURES			
Debris Y N	oiled Y N	amount 30 bags or ___ trucks	Suitable backshore staging Y N
Current dominated channel ___	Other Features:	Debris oiled, suitable for in-situ beach burning for disposal.	Access: Direct from backshore Y N Alongshore from next segment Y N access restrictions ___
			Crossing over to shore unit 916 behind headland (unit 917) is via a Cultural Reserve

"Current dominated channel' or **'strong current'** identifies this as an operational constraint in marine channel and river environments.

'Other features' are to capture operationally important features such as train bed, airstrip, road.

For shoreline unit 918 there is a high inferred potential for cultural and archeological interests based on coastal inventory and land use information such as, in front of an Cultural Reserve, backshore dunes comprised of midden materials, and offshore islets with potential burial caves.

Remember SCAT is the "eyes and ears" of planning and operations and are there to represent both agency and stakeholder interests

SCAT – *surface oil conditions (location)*

It is important to document **where** the oil is stranded.

6 SURFACE OILING CONDITIONS — begin with "A" in the lowest tidal zone - circle the zone/s that correspond to primary shoreline type

OIL ZONE	TIDAL ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
ID	LI	MI	UI	SU	Length m	Width m	Distrib. %	TO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO	
A	X																				
B		X																			
C			X																		

Oil Zone ID (A, B, C…) are used because operational personnel will not be familiar with intertidal zonation terms. Use a different ID for each different oil occurrence, e.g., two distinct bands of oil at mid-tide and high-tide levels, or alongshore where the oil distribution changes from 10 % to 50%. Describe each different occurrence on a separate line.

Codes:

LI – Lower Intertidal

MI - Middle Intertidal

UI - Upper Intertidal

SU - Supra Intertidal

SCAT – *surface oil conditions (oil cover)*

6 SURFACE OILING CONDITIONS — begin with "A" in the lowest tidal zone - circle the zone/s that correspond to primary shoreline type

OIL ZONE	TIDAL ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
ID	LI	MI	UI	SU	Length m	Width m	Distrib. %	TO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO	
A		X			310	1	5														
B			X		800	5	35														
C				X	600	1.5	3														

Length: as measured by hip-chain or tape measure

Document in detail, not by category: length is 310 meters NOT > 300 metres.

Width: represents the average measured width of oiled area or band in the shoreline segment. If multiple bands or areas occur, width represents their sum.

Distribution: represents the percentage of the surface WITHIN a band or area covered by oil.

Note: **Width** and **Distribution** are used to in the initial *Surface Oil Matrix*

SCAT – *surface oil cover (initial determinations)*

Initial *Surface Oil Cover Matrix* for oil cover data

Oil Distribution %	Width of Oiled Area: *Wide* > 6m	*Medium* > 3 to 6 m	*Narrow* >0.5 to 3m	*Very Narrow* ≤0.5 m
Continuous 91 – 100%	**heavy**	**heavy**	moderate	light
Broken 51-90%	**heavy**	**heavy**	moderate	light
Patchy 11 – 50%	moderate	moderate		light
Sporadic 1-10%			very light	
Trace < 1%	very light	very light	very light	very light

Oil ID Area B – Upper Intertidal

Oil ID Area A – Middle Intertidal

Oil ID Area C – Supratidal

SCAT – *surface oil conditions (thickness)*

6 SURFACE OILING CONDITIONS — *begin with "A" in the lowest tidal zone - circle the zone/s that correspond to primary shoreline type*

OIL ZONE ID	TIDAL ZONE LI	MI	UI	SU	OIL COVER Length m	Width m	Distrib. %	OIL THICKNESS TO	CV	CT	ST	FL	OIL CHARACTER FR	MS	TB	PT	TC	SR	AP	NO	SUBST. TYPE(S)
A		X			300	1	5		X												
B			X		800	5	35		X												
C				X	600	1.5	3			X											

Codes:

TO - Thick Oil**

CV - Covered

CT - Coat

ST – Stain

FL - Film

***Alternative code is PO – Pooled Oil*

Oil Thickness: represents the average or dominant oil thickness in the band or area.

Note: **Oil Thickness** is used to determine the final *Oil Cover Category*

SCAT – *surface oil cover (final determinations)*

Final *Surface Oil Categorization* using oil thickness

Average Thickness	Initial Categorization of Surface Oil (based on % distribution/width): *Heavy*	*Moderate*	*Light*	*Very Light*
Thick or Pooled > 1 cm	**heavy**	**heavy**	moderate	light
Cover 0.1 to 1.0cm		heav		light
Coat 0.01 to 0.1cm	moderate	moder		very light
Stain/Film <0.01	light	light	very light	very light

Oil ID Area B – Upper Intertidal

Oil ID Area A – Middle Intertidal

Oil ID Area C – Supratidal

SCAT – *surface oil conditions (oil character)*

6 SURFACE OILING CONDITIONS — *begin with "A" in the lowest tidal zone - circle the zone/s that correspond to primary shoreline type*

OIL ZONE ID	TIDAL ZONE LI	MI	UI	SU	OIL COVER Length m	Width m	Distrib. %	OIL THICKNESS TO	CV	CT	ST	FL	OIL CHARACTER FR	MS	TB	PT	TC	SR	AP	NO	SUBST. TYPE(S)
A		X			300	1	5		X					X							
B			X		800	5	35		X				X								
C				X	600	1.5	3			X								X			

Codes:

FR – Fresh

MS - Mousse

TB – Tar Balls

PT – Patties

TC – Tar

SR – Surface Residue

AP – Asphalt Pavement

NO – No Oil

DB - Debris

Oil Character: represents the dominant oil character in the band or area.

SCAT – *surface oil conditions (substrate type)*

6 SURFACE OILING CONDITIONS *begin with "A" in the lowest tidal zone - circle the zone/s that correspond to primary shoreline type*

OIL ZONE ID	TIDAL ZONE LI	MI	UI	SU	OIL COVER Length m	Width m	Distrib. %	OIL THICKNESS TO	CV	CT	ST	FL	OIL CHARACTER FR	MS	TB	PT	TC	SR	AP	NO	SUBST. TYPE(S)
A		X			300	1	5		X					X							Gs
B			X		800	5	35		X				X								Pg
C				X	600	1.5	3			X								X			P

Codes:
R- Bedrock
U - Unconsolidated
B - Boulder
C - Cobble
P - Pebble
G - Granule
S - Sand
M - Mud/Silt/Clay
O - Organic
VEG - Live Vegetation
MMS - Manmade Solid
MMP - Manmade Permeable

Substrate Type(s): represents the type of substrates surface oil covers

NB: If two substrates are present, a capital letter indicates the dominate surface substrate and lower case the interstial substrate.

SCAT – *sub-surface oil conditions (location)*

7 SUBSURFACE OILING CONDITIONS *use letter for ZONE location plus Number of pit or trench — e.g., "A1"*

TRENCH or PIT NO.	TIDAL ZONE LI	MI	UI	SU	MAX. PIT DEPTH cm	OILED ZONE cm-cm	SUBSURFACE OIL CHARACTER SAP	OP	PP	OR	OF	TR	NO	WATER TABLE cm	SHEEN COLOUR B, R, S, N	CLEAN BELOW Yes / No	SUBST. TYPE(S)
B1			X		50	0 - 20											
B2			X		50	5 - 15											

Codes:
LI – Lower Intertidal
MI - Middle Intertidal
UI - Upper Intertidal
SU - Supra Intertidal

SCAT – *sub-surface oil conditions (character)*

7 SUBSURFACE OILING CONDITIONS *use letter for ZONE location plus Number of pit or trench — e.g., "A1"*

TRENCH or PIT NO.	TIDAL ZONE LI	MI	UI	SU	MAX. PIT DEPTH cm	OILED ZONE cm-cm	SUBSURFACE OIL CHARACTER SAP	OP	PP	OR	OF	TR	NO	WATER TABLE cm	SHEEN COLOUR B, R, S, N	CLEAN BELOW Yes / No	SUBST. TYPE(S)
B1			X		50	0 - 20			X					50	B	Y	Pg
B2			X		50	5 - 15		X						50	B	Y	P

Codes:
SAP - Subsurface Asphalt Pavement
OP - Oil-Filled Pores
PP - Partially Filled Pores
OR - Oil Residue
OF - Oil Film
TR - Trace
NO - No Oil

Codes:
B – Brown
R – Rainbow
S – Silver
N - None

Codes:
C - Cobble
P - Pebble
G - Granule
S - Sand
M - Mud

SCAT – *recommendations & constraints*

8 COMMENTS *ecological/recreational/cultural/economic constraints - shorezone biota and wildlife observations - cleanup recommendations*

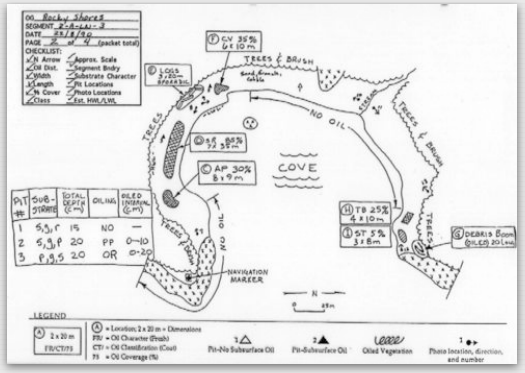
Cleanup recommendations: manually remove and bag oily small wood and sea-weed wracks.
Chain-saw off oiled portions of large woody debris (e.g. logs) – there are about 5 logs present.
In-situ burning of logs recommendation with constraint that burning occurs in a) one-place, b) on the backshore.
Water deluge treatment in heavy oiled upper intertidal areas with constraint that this is done during tides greater than 1.5 meters to prevent oil migration with boom and skimmer for on-water collection of residue
Sediment relocation for remaining oiled substrate with pom-poms with constraint that is done on raising tide

Other Constraints: No access to up-land areas demarcated by yellow ribbon – culturally sensitive areas. Staging area in backshore, but not on the dunes. Any found culturally modified artifacts to be reported to supervisor and handled according to protocol. No staging near large palm trees north end or shore – Egret nesting **Safety Issues:** Sharks present all year round.

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes No **Photos** Yes No (Roll # _____ Frames_____) **Video Tape** Yes No (tape #_____) **Spill Version:** (name/date)

SCAT – *sketch map*



The field sketch is an important for two reasons:

1. It provides a focused picture of the oil distribution within the entire segment, and
2. It adds discipline to the field observation process, because it forces the person doing the sketch to make detailed mental notes of all the relevant features.

SCAT – *sketch text data and annotations*

SCAT member: _____

Site Name: _____

Segment No. _____

Date _____

Time _____

Page _____

△ Pit – No Subsurface Oil

▲ Pit – Subsurface Oil

Photo number and direction

Oil Vegetation

Pit No.	Substrate	Total Depth (cm)	Oiling	Oiled Interval

SCAT – *sketch checklist*

Checklist

- ✓ North Arrow
- ✓ Segment Boundaries
- ✓ Scale (metres)
- ✓ Oil Distribution (including NO OIL)
- ✓ Oiled Debris, Wildlife
- ✓ High and Tide Lines
- ✓ Substrate Types
- ✓ Pit Location(s)
- ✓ Photo Locations and Direction
- ✓ Upland Characteristics (access)
- ✓ Out-of-bound Work Areas
- ✓ Key location landmarks and names
- ✓ Potential Safety Hazards (bear sighting)

SCAT - *some tips in capturing field data*

TIPS:

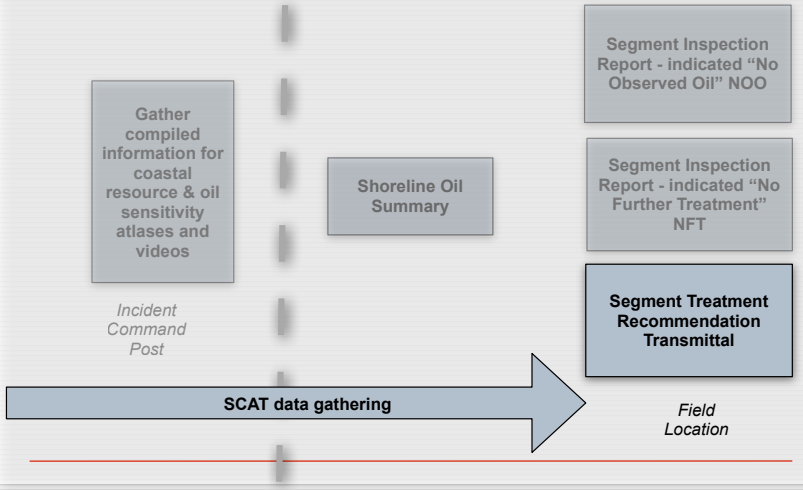
➡ Divide the duties among team members

➡ Measure the length and width of the intertidal zone and the size of some conspicuous features such as groins or seawall segments

➡ Lightly sketch in the outline of the intertidal zone or habitat being surveyed. Show in final form (i.e., heavy pencil marks) the aerial distribution of the oil, using a hatched pattern.

The oil distribution should be the most conspicuous feature on the sketch

SCAT - *completing the STRT*



SCAT - *full documentation requirements*

Completing the *Shoreline Oil Summary* form is only part of the field document process. SCAT process needs to ensure and document that:

- All shore segments have been inspected, and
- Operations focus on areas that have oil and that need treatment either beyond "generic" treatment or require a *Site Specific Plan* (SSP) as a sensitive area.

SCAT - *STRT preparation and review*

A *Segment Treatment Recommendation Transmittal* (STRT) form is completed in the SCAT leader - generally back at the Incident Command Post. The SCAT leader seeks consensus of the SCAT members which may have stakeholder representatives. The form is forwarded to the SCAT Coordinator at the Command Post for review by:

- The Safety Officer for safety concerns, and
- An Operations representative for practicality
- The Planning Section Chief for environmental priorities**.

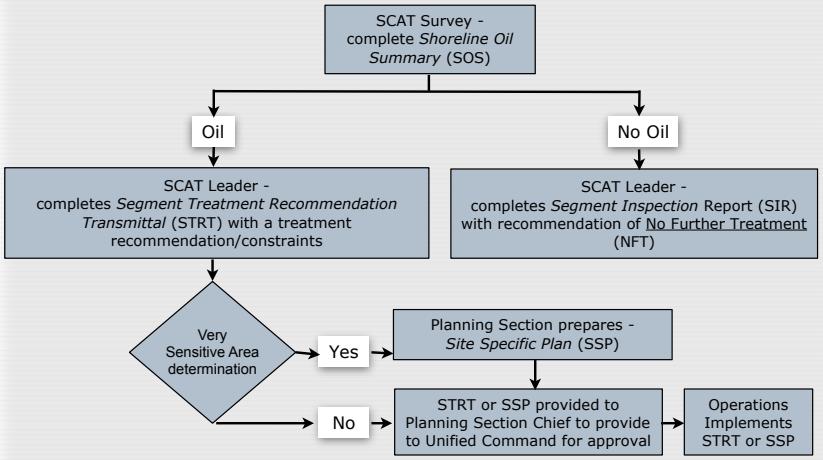
The form then is reviewed and approved by Unified Command. Once approved the STRT is forward to Operations as part of the Incident Action Plan.

** Note: the Historic Properties Specialist and the Environmental Unit Leader will review and advise the Operational Chief completeness.

SCAT - *very sensitive area & site specific plan*

If an area of the segment is designated as a "Very Sensitive Area" by the SCAT team and stakeholders, then treatment recommendations may take the form of a specific and detailed *Site Specific Plan* (SSP) .

SCAT - *STRT/SSP information & approval process*



Module 22 - SCAT Health and Safety

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *health and safety*

This module contains recommended safety and health guidelines for oil related SCAT activities, as well as environmental and physical hazards that may be encountered in the field.

This module does not replace requirements for basic oil spill safety, HAZWOPER* or other safety training often required by government and/or industry to go into the field.

** HAZWOPER: **Haz**ardous **W**aste **Op**erations and **E**mergency **R**esponse standard, *Title 29 of Code of Federal Regulations (CFR)*

SCAT - *health and safety context*

SCAT members are often:

- Operate within the contaminated area (hot zone) where volatile organic vapours from spilled product pose acute and chronic safety and health concerns.
- Work in either remote wilderness or urban industrial environments that pose risks from wildlife interactions (bears) and equipment operations (trucks, excavators),respectively.
- Use a variety of transportation methods to access shores such as helicopters and/or small water-crafts that have injury risks.

SCAT - *inherent risks*

Inherent health and safety concerns includes:

1. **Environmental Situations:** fog, rain, heat
2. **Transport Requirements:** aircraft/vessel access and egress
3. **Working Conditions:** trips, falls, wildlife
4. **Product Exposures:** oil vapours & contamination

Responder Health and Safety is Everyones Responsibility

SCAT - *what risks?*

- Entering coastal cave or going under log-piles: *feeling wosy and short-of-breath?*
- Handing harmed wildlife: *an eye-for-an-eye!*
- Walking up-slope from a helicopter while rotors are turning: *off-with- the-head!*
- On a coastal platform beach without due attention to a rising tide: *feeling trapped-like-a-rat?*
- Back to ocean swells when working - *are you a good swimmer?*
- Didn't recording location with Safety Officer - *gone and forgotten!*
- Breathing fumes - *benzene.. on a high... no problem!*
- Caught in fog - *a pleasant night on the beach?*

SCAT - *safety categories*

For the purpose of this module, safety is divided into four categories.

- **Site Entry Criteria** provides guidance on establishing minimum standards for site entry by properly trained spill responders.
- **Personal Protective Equipment** provides guidance on protective equipment to be worn during site entry by properly trained spill responders.
- **Personnel Decontamination** provides guidance on establishing minimum standards for decontamination by properly trained spill responders.
- **Wilderness and Transport** provides some insights and tips on wilderness and transport safety risk and risk mitigation.

SCAT - *safety plans and procedures*

Documents required to be reviewed by the SCAT coordinator and communicated to the field team are either:

1. The Incident-specific *Site Safety Plan* prepared and approved by unified command; and/or
2. The Oil Spill Response Organization safety procedures and training for employees/responders

SCAT - *general limits to entry onto an oiled shoreline*

No Entry is authorized if the percentage of **L**ower **E**xplosive **L**imit (LEL) exceeds 10% on a calibrated direct reading explosive gas meter.

No Entry is authorized if the oxygen percentage exceeds 23.5% or less than 19.5%.

No Entry is authorized if the benzene level exceeds 1.0 ppm.

The decision as to whether or not any given entry shall be attempted is ultimately the responsibility of Command with advice and guidance from:

- The Site Safety Officer
- The Field Team Leader
- Unified Command

SCAT - *site safety assessment*

Before commencing spill response, a site safety assessment should be completed by a Site Safety Officer to determine:

✓proper **P**ersonal **P**rotection **E**quipment (PPE)
✓oil spill safety training
✓remote wilderness training (wilderness survival) and
✓transportation safety (helicopter access/egress)

The proof of training is often the "show-stopper" for SCAT that can disallow a member from going into the field.

Site safety assessment is often provided as a "tailgate" safety briefing by a Safety Officer (or designate) responsible for one or more field "Divisions"

SCAT - *personal protective equipment*

Personal Protective Equipment (PPE) includes:

- **Respiratory** protection with respirators
- **Skin** protection with protective clothing, boots and creams
- **Eye** protection with safety glasses, goggles, and face shields
- **Head** injury protection with a hard hat
- **Body** thermal protection with cold and hot weather clothing
- **Hearing** protection with earplugs or headphones

For SCAT members, PPE requirements are defined by the Safety Officer and or a Safety Plan to meet their working environment that is different from cleanup operations

SCAT - *levels of protection*

There are defined levels of protection for entry into varying hazardous material conditions. The SCAT coordinator - or field team leader - is required to consult with a "competent person" for job specific PPE requirements as designated by the Safety Officer of an Incident Management Team.

Movie: 1989 *Exxon Valdez* oil spill worker safety concerns

The greater the level of risk, the greater the level of PPE required

SCAT - *levels of protection*

There are four levels of protection for entry into varying oiling conditions. These levels are referred to as: A, B, C, and D. They reflect a 12-hour work shift

Very High

Level A - fully encapulated with Self-Contained Breathing Apparatus (SCBA)

High

Level B - protective clothing with Self-Contained Breathing Apparatus (SCBA)

Medium

Level C - protective clothing with half-mask/cartridge

Low

Level D - protective clothing / coveralls

SCAT - *levels of protection*

For SCAT field entry, shoreline conditions that require Levels C or D site entry PPE - or combinations thereof ** - should be adequate.

** Combining protection levels requires approval by the Safety Officer

Level C - protective clothing with half-mask/cartridge

Level D - protective clothing / coveralls

SCAT - *decontamination*

Decontamination involves the removal of oil or other contaminants from personnel or equipment after they leave the Hot Zone - the oiled shore.

The purposes of decontamination are to:

- Minimize worker contact with contaminants.
- Prevent spread of contaminants to clean areas and exposure to personnel there.
- Remove contaminants from equipment to allow its reuse.

SCAT - *decontamination considerations*

Decontamination considerations for SCAT personnel include:

- Wrap electronic equipment(GPS, computers) in disposable see-through plastic.
- Use disposable protective gloves and clothing
- Prevent contamination of transport aircraft, boats and vehicles

Tips:

1. **Carry a lot of nitrile disposable gloves**
2. **Where tyvek arm-guards over shirt/jackets**
3. **Put on tyvek boot-covers over oiled boots before accessing a helicopter, vehicle or vessel to prevent contamination**
4. **Plastic-bag wrap oiled shovels and equipment before putting into transport**

SCAT - *ready for the working environment?*

SCAT - *safety & transportation*

Suggested safety training for remote wilderness SCAT activities:

- Basic Oil Spill Safety
- Helicopter Safety
- Boat Safety

These training requirements are typical "show-stoppers" that prevent a SCAT member to go into the field

SCAT - *remote operations advice*

Safety advice when doing wilderness SCAT:

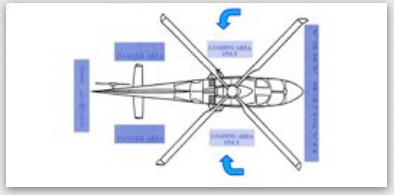
- always prepare and leave a trip-plan with the Safety Officer
- wear full survival suits when flying over water
- carry a survival kit and a signal mirror
- have "all" survival gear /communications in your survival suit
- carry a spare set of clothing

SCAT - *remote operations advice*

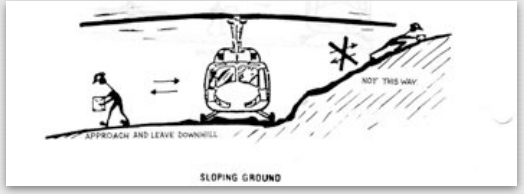
Safety advice when doing wilderness SCAT:

- always prepare and leave a trip-plan with the Safety Officer
- wear full survival suits when flying over water
- carry a survival kit and a signal mirror
- have "all" survival gear /communications in your survival suit
- carry a spare set of clothing

SCAT - *helicopter safety*



Watch where you walk.
Hold on to loose materials and keep equipment low.



Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *field objectives*

This module is a field tour of selected shore types, habitats and environments. The objective of the field tour is view the setting from the perspectives of:

- Government agencies
- Industry (Responsible Party)
- Stakeholders (community)
- Operations personnel (Division Supervisor)

SCAT - *field objectives continued*

Other considerations include:

- Spill Risk scenarios
- Safety issues and communications
- Operational constraints
- Recommended tactics
- Suggested end-points

Module 24 – Automation of SCAT Field Data Collection

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid

EnviroEmerg Consulting Services

Duncan, British Columbia

CANADA

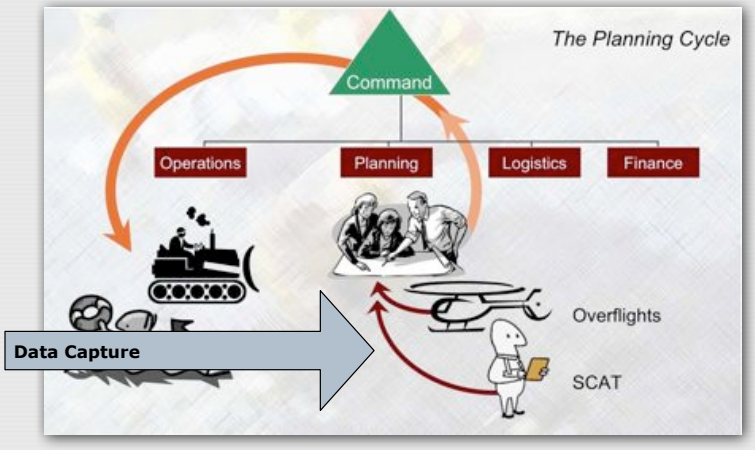
EnviroEmerg.ca

SCAT - *field electronic data collection*

This module examines:

- **Part 1** - challenges and opportunities to use technology in-the-field
- **Part 2** - core and supplementary system requirements
- **Part 3** - field equipment
- **Part 4** - GPS photo geo-referencing
- **Part 5** - SCAT data collection using a Personal Digital Assistant (PDA)

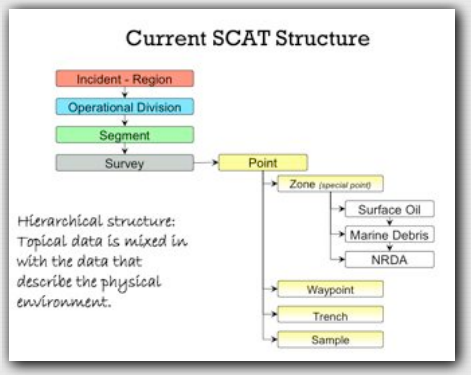
SCAT



SCAT - *field data: capture models*

US National Oceans and Atmospheric Administration (NOAA) - Sept 2007

CURRENT & FUTURE



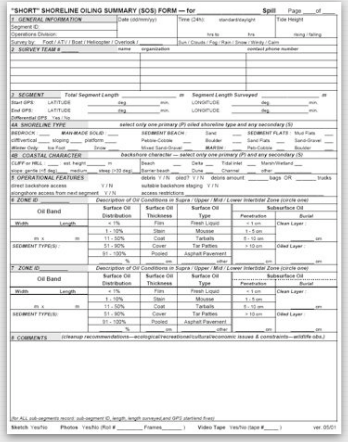
SCAT - *challenges & opportunities*

Part 1 - challenges and opportunities to use technology in-the-field

SCAT – *forms*

The lowest form of SCAT data collection and management is by "paper" field forms.

Hand-scribed information requires a high level of Q&I just to ensure readability and completeness, let alone transfer to an analytical system such as a database or spreadsheet.


"SHORT" SHORELINE OILING SUMMARY (SOS) FORM — for Spill Page ___ of

1. GENERAL INFORMATION Date (dd/mm/yy) Time (24hr) standard/daylight Tide Height

Segment ID

Operations Division

Survey by: Foot / ATV / Boat / Helicopter / Overlook / _____ hrs to hrs rising / falling

Sun / Clouds / Fog / Rain / Snow / Windy / Calm

2. SURVEY TEAM # ____ name organization contact phone number

3. SEGMENT Total Segment Length ____ m Segment Length Surveyed ____ m

Start GPS: LATITUDE ____ deg. ____ min. LONGITUDE ____ deg. ____ min.

End GPS: LATITUDE ____ deg. ____ min. LONGITUDE ____ deg. ____ min.

Differential GPS: Yes / No

4A. SHORELINE TYPE select only one primary (P) oiled shoreline type and any secondary (S)

BEDROCK ____ MAN-MADE SOLID ____ SEDIMENT BEACH: Sand ____ SEDIMENT FLATS: Mud Flats ____

cliff/vertical ____ sloping ____ platform ____ Pebble-Cobble ____ Boulder ____ Sand Flats ____ Sand-Gravel ____

Wetter Only ____ Ice Foot ____ Snow ____ Mixed Sand-Gravel ____ MARSH: Peat-Cobble ____ Boulder ____

4B. COASTAL CHARACTER backshore character — select only one primary (P) and any secondary (S)

CLIFF or HILL ____ est. height ____ m Beach ____ Delta ____ Tidal Inlet ____ Marsh/Wetland ____

steep, gentle (>5 deg.) ____ medium ____ steep (>35 deg.) ____ Barrier beach ____ Dune ____ Channel ____ other ____

5. OPERATIONAL FEATURES direct backshore access Y / N debris Y / N debris amount: ____ bags OR ____ trucks

suitable backshore staging Y / N

alongshore access from next segment Y / N access restrictions

6. ZONE ID ____ Description of Oil Conditions in Supra / Upper / Mid / Lower Intertidal Zone (circle one)

Oil Band	Surface Oil Distribution	Surface Oil Thickness	Surface Oil Type	Subsurface Oil Penetration	Subsurface Oil Burial
Width Length	< 1%	Film	Fresh Liquid	< 1 cm	Clean Layer :
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	6 - 10 cm	____ cm
SEDIMENT TYPE(S) :	51 - 80%	Cover	Tar Patties	> 10 cm	Oiled Layer :
	81 - 100%	Pooled	Asphalt Pavement		
	%	cm	other	cm	cm

7. ZONE ID ____ Description of Oil Conditions in Supra / Upper / Mid / Lower Intertidal Zone (circle one)

Oil Band	Surface Oil Distribution	Surface Oil Thickness	Surface Oil Type	Subsurface Oil Penetration	Subsurface Oil Burial
Width Length	< 1%	Film	Fresh Liquid	< 1 cm	Clean Layer :
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	6 - 10 cm	cm
SEDIMENT TYPE(S) :	51 - 80%	Cover	Tar Patties	> 10 cm	Oiled Layer :
	81 - 100%	Pooled	Asphalt Pavement		
	%	cm	other	cm	cm

8. COMMENTS (cleanup recommendations—ecological/recreational/cultural/economic issues & constraints—wildlife obs.)

Use ALL sub-segments: record: sub-segment ID, length, length surveyed,and GPS (darkend lines)

Sketch Yes/No Photos Yes/No (Roll # _____ Frames_____) Video Tape Yes/No (tape #_____) ver. 05/01

SCAT - *limitations imposed*

Limitations imposed by manual "paper data forms", results in:

- Incomplete, incorrect, illegible, inconsistent field forms;
- Delay in getting SCAT data back to Command Post for processing;
- Little opportunity to QA the forms or to debrief field teams,and
- Need to transcribe forms into electronic database for analysis and reports.

Often requires "night shift" to do all the work

SCAT – *automation of field data collection*

SCAT data assessment can be automated to support the development of response options by use of databases that link to Geographical Information Systems (GIS). The data analysis and mapped presentations enhance response decisions and progress.

Tools that are now available include:

- Personal Digital Assistant (PDA) (e.g. palm pilot/computer)
- digital cameras
- Geographic Positioning System (GPS)& data loggers
- geo-referenced systems for images
- shoreline resource information maps (coastal/inland resource inventory and oil sensitivity maps)

SCAT - *core & supplementary requirements*

Part 2 - core and supplementary system requirements

SCAT – *automation of field data collection*

SCAT electronic requirements field data collection comes in two flavours:

1. **core** - essential
2. **supplemental** - helpful

SCAT - *core requirements*

Core System requires that the hardware, software & procedures:

- Enable digital input of SCAT data in the field (electronic forms)
- Force correct, complete, consistent data entry where standardization is appropriate
- Automate integration of spatial data (onboard or linked GPS)
- Append field data from multiple units into single database

SCAT - *supplemental requirements*

Supplemental requirements are helpful, but not essential, such as:

- Wireless data transmission back to Command Post;
- Moving map displays;
- Access to "job aides" (e.g., % cover chart, abbreviations);
- Integrated photo geo-referencing, and
- Field customizable –generate new forms/databases in the command post.

SCAT - *key ingredients for success*

To be useful (and be used), a field data system needs to be:

- simple to use
- intuitive input format (menu driven)
- easy to install & configure
- well-documented
- rugged components
- rechargeable or user -swappable batteries
- generates outputs that looks "familiar" (e.g., SCAT forms)
- managed by dedicated command post support staff to download/analyze data, maintain equipment, etc.
- field users adequately trained

SCAT - *field data capture equipment*

Part 3 - field equipment

SCAT – *field tools*

Technological tools in the field affect how data is managed at the Incident Command Post. Field tools examined include:

- GPS Receivers & Data Loggers
- Digital Cameras
- PDA's

SCAT – *GPS receivers*

Characteristics

- Uses signals from satellites to calculate geographical coordinates
- Horizontal measurement accuracy between 1 to 20 meters

Limitations

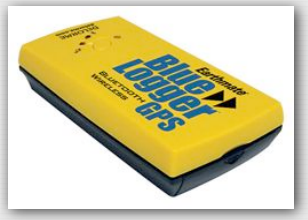
- Will not work in certain areas (clear view of the sky needed)
- Variable accuracy of the coordinate measurement

Uses to support SCAT

- Navigation to the start or end of a shoreline segment
- Record location of surface oil zones, pits, pictures or other affected resources

SCAT – *GPS data loggers*

Same characteristics, limitations and uses as a GPS receivers, but do not provide a map display. They just log waypoints and time.



SCAT – *digital cameras*

Characteristics

Can record high resolution still images or video clips

Limitations

- Digital documents can be modified easily
- Data is easily lost or destroyed
- Easy to operate – **with the possibility to record too many images**

Uses to support SCAT

- Very valuable complement to SCAT observations
- A strict data transfer procedure must be developed so image files are accurately documented

Ensure camera has EXIF metadata stored as part of the photo that includes the date and time the photo was taken.

SCAT - *geo-referencing photographs*

Part 4 - GPS photo geo-referencing

SCAT

GPS photo-link software allows a user:

- To imprint ("watermark") coordinates on photo;
- To plot photo location onto base maps;
- To import photos into GIS or Google Earth, and
- To work with digital cameras with time stamp & GPS units with downloadable track log.

No wires connect the camera & GPS in the field. Linkage occurs at the Incident Command Post with special software.

As long as the GPS was in the same location as the camera this represents the location of the photo.

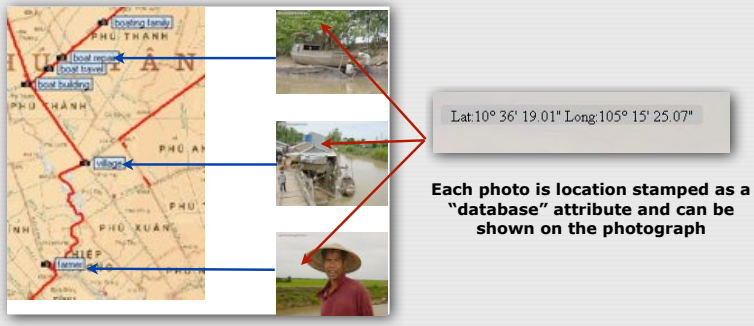
SCAT- *how geo-referenced photos work*

To geo-reference photographs, software synchronizes the camera clock with the GPS clock. The program reads the digital time stamp on each photograph then looks for the closest time-stamp from the GPS. It matches the location with the time. The photo can then be mapped and have a location data-field imbedded. Proprietary software includes:

- *OziPhotoTool* - works with *OziExplorer* http://www.oziphototool.com/
- *Photo Logger* - an open source application www.photologger.org
- *Sony GPS* (CS1KA) - used with Picture Motion Browser
- *JOBO photoGPS* – GPS receiver fits directly on digital camera's hot shoe and works with Adobe LightRoom
- HOUDAGEO - available from Apple.com

SCAT- *how geo-referenced photos work*

The software generates map features on maps, watermarking the photos, embedding location information in GPS EXIF tags, generating HTML output, or creating GoogleEarth kml/kmz files so you can share you photo locations.



Each photo is location stamped as a "database" attribute and can be shown on the photograph

SCAT - *camera image and GPS integration*

It is important to have a dedicated "receiving/reception station" with a technician to pick up BOTH camera and GPS unit from SCAT members as they arrive at the Incident Command Post.

The technician's task is to integrated the GPS/Camera then have the SCAT team review their pictures - annotate or delete.

The SCAT member can then proceed to the SCAT coordinator with their data for further Q&I.

SCAT - *field data capture electronically*

Part 5 - SCAT data collection using a Personal Digital Assistant

SCAT - *field PDA's*

There are a variety of PDA's that have been configured to include SCAT data collection tools. They have been widely used in the US. They can:

- Store data in XML database and shape files;
- Allow the capture of coordinates from a GPS;
- Incorporate information found in a *Shoreline Oiling Summary* form;
- Use raster or vector images as basemaps, and
- Integrate data within other databases at the Incident Command Post

SCAT - *examples of PDA-based systems*

The following shows the "screen-shots" of NOAA's *"eSCAT"* the EPDS *"Pocket - SCAT"* programs that runs off a palm-pilot or equivalent PDA.

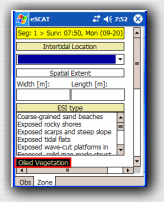
Pocket - SCAT *eSCAT*

SCAT - *eSCAT*

NOAA's eSCAT **:**
A Field Data Capture Tool for Spill Response

A product of : National Oceanic and Atmospheric Administration

Contact: Ian Zelo
(ian.j.zelo@noaa.gov)
206 526-4599



SCAT - *pocket SCAT*

Pocket SCAT **:**
A Field Data Capture Tool for Spill Response

A product of : EPDS
Environmental **P**erformance & **D**ecision **S**upport

(514) 598-7832
epds@epds-central.com
www.epds-central.com

Module 25 – SCAT Data Management at the Command Post

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT – *data management*

Module based on *Development of a SCAT Data Management Manual* 2007 by Alain Lamarche (Environmental Performance and Decision Support (EPDS) Montreal, Quebec), Edward H. Owens (Polaris Applied Sciences, Inc. Bainbridge Island, Washington) and Gary A. Sergy (Environment Canada Edmonton, Alberta)

This module provides direction and the tools for both the SCAT data manager and the SCAT coordinator tasked with working with field data at an Incident Command Post.

SCAT - *setting up a SCAT data management system*

Though SCAT principles and methods remain unchanged from its original development, the scope of data application has markedly increased.

SCAT – *data uses*

The data generated by SCAT surveys supports every aspect of the work necessary to develop and apply shoreline treatment measures, including:

- Planning treatment operations;
- Selecting treatment methods;
- Providing detailed instructions to operations personnel, and
- Evaluating the response effort.

To use SCAT field data effectively, the data needs to be understood, validated, captured within computerized systems, processed and transformed into support documents, including maps, tables and reports.

SCAT – *challenges*

Challenge #1 - *gathering the data*

Tools such as palm-pilots, digital cameras, and GPS are now available to automate field data collection. These pose significant data-management challenges regarding the volumes of data collected.

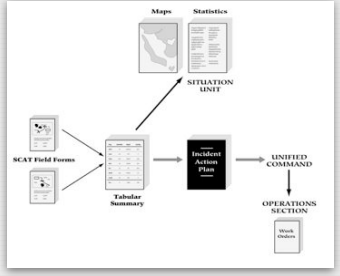
Challenge #2 - *what to do with the data*

The areas that are particularly lacking in SCAT data management at an Incident Command Post include:

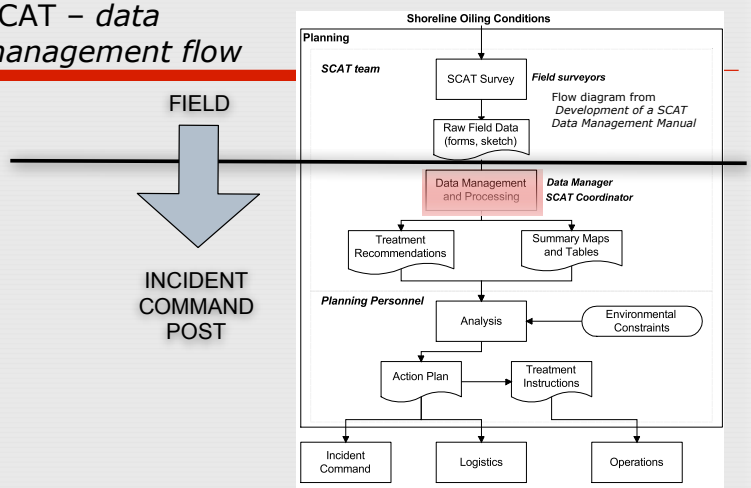
- Descriptions of the tasks involved;
- Determinations of responsibilities and abilities;
- Details on how to summarize and analyze data, and
- Methods to standardized maps and documents for decision-making and information exchange.

SCAT

The process and details on how to integrate these tools and what the "out-puts" should be and look like are not well developed.



SCAT – *data management flow*



SCAT - *setting up data management*

Being prepared to arrive at an Incident Command Post to handle SCAT data is of paramount importance to success.

Factors to "dovetailed" are:

1. **How** is the field data being collected - *paper-form, or electronically (palm-pilots, GPS, digital cameras), or combinations thereof*.
2. **What** are the expected SCAT deliverables: *oil summary maps, Shoreline Treatment Recommendation Transmittal* (STRT) Form.

Bring your "tools" - computers, printers - to the Incident Command Post. Don't rely on others.

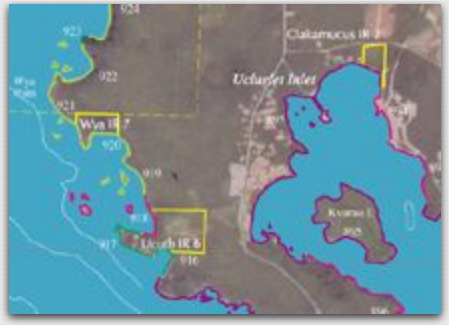
SCAT - *getting started*

Some initial steps to establish the data-management framework and process

1	Obtain Operational Divisions established by the Operations Section and transpose onto SCAT shore/unit maps.
2	Establish staffed station to receive field SCAT report forms (paper) and for electronic data (digital camera, palm-pilot, GPS) for Q&A and downloading
3	Provide Planning Section Chief proposed nature and timing of summary oiling condition maps and tables
4	Provide SCAT transmittal forms for Incident Command approvals and operational direction

SCAT - *summarizing a shore segment oiling*

Summarizing an oiled shore segment by surface oil category - using shore segment 918 (module 21)



Shoreline Unit 918

SCAT - *summarizing oiling (segment 918)*

"SHORT" SHORELINE OILING SUMMARY (SOS) FORM — for M/V Maddog Bunker Spill Page ____of ____

1 GENERAL INFORMATION	Date (dd/mm/yy)	Time (24h): standard/daylight	Tide Height
Segment ID: **918**	**15/03/2007**	**10:30** hrs to **13:30** hrs	**2.4 meters** rising / falling
Operations Division: **B**			
Survey by: Foot / ATV / Boat / Helicopter / Overlook / _____		Sun / Clouds / Fog / Rain / Snow / Windy / Calm	

2 SURVEY TEAM # _____ name	organization	contact phone number
Don Juan	**BC Environment (Bio)**	
Steve Nutter	**Environment Canada (Bio)**	
George Plimton	**Contractor RP (Geo)**	
Dan O'Rorke	**Contractor (Arch)**	
Mark Walley	**(First Nations Rep)**	

3 SEGMENT	Total Segment Length **1430 m** m	Segment Length Surveyed **1430 m** m
Start GPS: LATITUDE _____ deg. _____ min.	LONGITUDE _____ deg. _____ min.	
End GPS: LATITUDE _____ deg. _____ min.	LONGITUDE _____ deg. _____ min.	
Differential GPS Yes / No		

Segment Total Length Surveyed

SCAT - *summarizing shoreline oiling*

Summarizing **where** the oil is stranded.

6 SURFACE OILING CONDITIONS *begin with "A" in the lowest tidal zone*

OIL ZONE ID	TIDAL ZONE LI	MI	UI	SU	OIL COVER Length m	Width m	Distrib. %	OIL THICKNESS PO	CV	CT	ST	FL	OIL CHARACTER FR	MS	TB	PT	TC	SR	AP	NO	SUBST. TYPE(S)
A		X																			
B			X																		
C				X																	

Oil Zone ID (A, B, C...) A = zone nearest to low tide that oil was present.

Codes:

LI – Lower Intertidal

MI - Middle Intertidal

UI - Upper Intertidal

SU - Supra Intertidal

SCAT - *summarizing shoreline oiling*

6 SURFACE OILING CONDITIONS — *begin with "A" in the lowest tidal zone*

OIL ZONE	TIDAL ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
					Length	Width	Distrib.														
ID	LI	MI	UI	SU	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO	
A		X			310	1	5														
B			X		800	5	35														
C				X	600	1.5	3														

Width: represents the average measured width of oiled area or band in the shore segment.

Distribution: represents the percentage of the surface WITHIN a band or area covered by oil.

Note: **Width** and **Distribution** are used to in the initial *Surface Oil Matrix*

SCAT – *surface oil cover (initial determinations)*

Initial *Surface Oil Cover Matrix* for oil cover data

Oil Distribution %	Width of Oiled Area: ***Wide*** > 6m	***Medium*** > 3 to 6 m	***Narrow*** >0.5 to 3m	***Very Narrow*** ≤0.5 m
Continuous 91 – 100%	**heavy**	**heavy**	moderate	light
Broken 51-90%	**heavy**	**heavy**	moderate	light
Patchy 11 – 50%	moderate	moderate	light	
Sporadic 1-10%			very light	
Trace < 1%	very light	very light	very light	very light

Oil ID Area B – Upper Intertidal

Oil ID Area A – Middle Intertidal

Oil ID Area C – Supratidal

SCAT – *surface oil conditions (thickness)*

Document in detail, not by category: width is 15 meters NOT > 3 metres.

6 SURFACE OILING CONDITIONS — *begin with "A" in the lowest tidal zone*

OIL ZONE	TIDAL ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
					Length	Width	Distrib.														
ID	LI	MI	UI	SU	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO	
A		X			300	1	5		X												
B			X		800	5	35		X												
C				X	600	1.5	3			X											

Codes:

PO – Pooled

CV - Covered

CT - Coat

ST – Stain

FL - Film

Oil Thickness: represents the average or dominant oil thickness in the band or area.

Note: **Oil Thickness** is used to determine the final *Oil Cover Category*

SCAT – *surface oil cover (final determinations)*

Final *Surface Oil Categorization* using oil thickness

Average Thickness	Initial Categorization of Surface Oil (based on % distribution/width): ***Heavy***	***Moderate***	***Light***	***Very Light***
Thick or Pooled > 1 cm	**heavy**	**heavy**	moderate	light
Cover 0.1 to 1.0cm				light
Coat 0.01 to 0.1cm	moderate	moderate		very light
Stain/Film <0.01	light	light	very light	very light

Oil ID Area B – Upper Intertidal

Oil ID Area A – Middle Intertidal

Oil ID Area C – Supratidal

SCAT - *summarizing oil category (seg. 918)*

Segment 918 Data		
Oil Zone ID	**Length (m)**	**Oil Category***
A	310	Light
B	800	Heavy
C	600	Very Light

Total Segment Length: 1430 meters

SUMMARIZE BY THE FOUR OIL CATEGORIES

1	**Heavy Oiling** Add all segments and their lengths that are heavily oiled
B = 800 meters. .... THEN....	
2	**Moderate Oiling** Add all segments and their lengths that are moderately oiled
0 meters...THEN...	
3	**Light Oiling** Add all segments and their lengths that are lightly oiled
A = 310 meters	
4	**Very Light Oiling**** Add all segments and their lengths that are lightly oiled
C = 600 meters	

SCAT - *segment 918 summarize cont.*

Rationalize Oiled Segment Lengths and Total Segment Length

Oiled lengths exceed total segment length by 280 meters. **Correct lowest oil category as follows....

600 m very light oiling - 280 m = 320 m Modified very light oiling length is 320 meters

SUMMARIZE BY SEGMENT LENGTH

Segment 918 Summary (1430 meters total length) Length of shoreline by surface oil category (meters)				
Heavy	**Moderate**	**Light**	**Very Light**	**No Oil**
800	0	310	320	0

It is this information that is either mapped or put in summarized tables.

SCAT - *segment 918 summarize cont.*

The reason for rationalization it to reduce confusion by overlapping oil segments that in total may be longer than the shore unit itself.

It is more important to focus on the highest levels of oiling lengths from an operational and environmental assessment

SCAT - *example of a complex segment*

The following is an example of a complex segment whereby there are multiple oiled zones that had been contaminated at different amounts.

SCAT - *summarizing oil category*

Segment CZ-28 Data		
Oil Zone ID	**Length (m)**	**Oil Category***
A	100	Heavy
B	150	Heavy
C	175	Heavy
D	90	Heavy
E	130	Moderate
F	350	Light
G	125	Light
H	150	Moderate
I	200	Moderate
J	208	Moderate

Total Segment Length: 1239 meters

SUMMARIZE

1	**Heavy Oiling** Add all segments and their lengths that are heavily oiled
A (100) + B (150) + C (175) + D (90) = 515 meters. .... THEN....	
2	**Moderate Oiling** Add all segments and their lengths that are moderately oiled
E (130) + H (150) + I (200) + J (200) = 688 meters...THEN...	
3	**Light Oiling**** Add all segments and their lengths that are lightly oiled
F (350) + G (125) = 475 meters	
**Oiled lengths exceed total segment length by 439 meters. Correct lowest oil category 475 m light oiling - 439 m = 36 m = modified light oiling length.	

SCAT - *example summary results*

Segment CZ-28 Summary Length of shoreline by surface oil category (meters)				
Heavy	**Moderate**	**Light**	**Very Light**	**No Oil**
515	688	36	0	0

SCAT - *data summary products*

There can be a multitude of maps, tables, and reports used for decision-making.

Overview & Summary Maps

Oil category from Initial Response Surveys
Surface Oil Categories
Subsurface Oil Categories
Remobilization Potential
Work Status

SCAT - *examples of compiled data*

M/V Westwood Anette Bunker spill - August 4th, 2006 in Squamish Estuary & Howe Sound, British Columbia

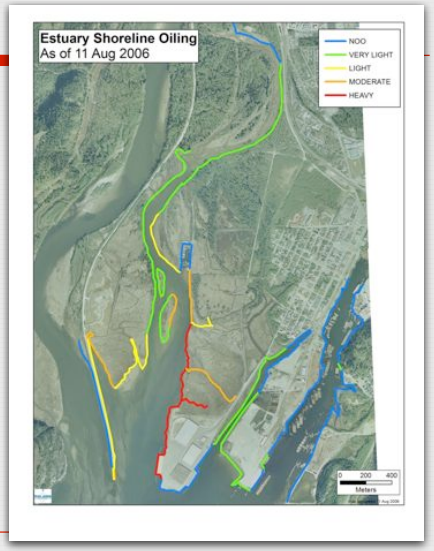
M/V Seledang Ayu incident - December 8, 2004, Skan Bay off Unalaska Island in the Aleutian chain, Alaska

PEPCO Pipeline rupture -Patuxent River a tributary of Chesapeake Bay, Maryland (April 7, 2000)

SCAT

SCAT data to document shoreline surface oiling:

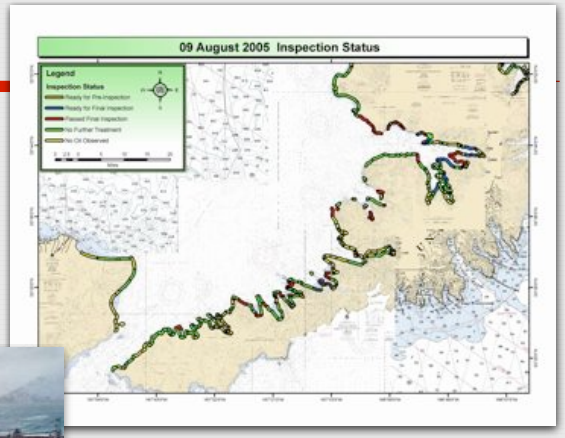
M/V Westwood Anette Bunker spill (Squamish Estuary & Howe Sound)



SCAT

SCAT data to document shoreline inspection status and final treatment recommendations.

M/V Seledang Ayu incident - Alaska



STRT: when a segment does not meet an end-point criteria, then the SCAT team prepares and signs a *Segment Treatment Recommendation Transmittal* (STRT) form to guide clean-up operations

SCAT

SCAT data to document shoreline oiling by surface category.

PEPCO Pipeline rupture -Patuxent River a tributary of Chesapeake Bay Maryland (April 7, 2000)

No 2 & 6 fuel oils 126,000 gal.

SCAT - *data management systems*

SCAT data management systems can range from hand-written scribing of tables and colouring of maps TO sophisticated computer data entry/ analysis systems. The following looks at some “database” examples.

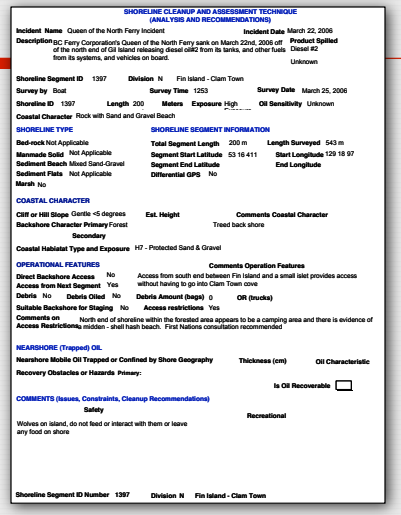
Both work but have limitations

SCAT

Ministry of Environment - “filemaker pro”.

Queen of the North Ferry Grounding - March 22, 2006 Gil Island/ Wright Sound, British Columbia

Pro: Simple and low cost. Template can be modified as required.
Con: Limited data analysis capability. Doesn’t readily link to GIS shoremapping



SHORELINE CLEANUP AND ASSESSMENT TECHNIQUE
(ANALYSIS AND RECOMMENDATIONS)

Incident Name Queen of the North Ferry Incident **Incident Date** March 22, 2006
Description BC Ferry Corporation's Queen of the North Ferry sank on March 22nd, 2006 off of the north end of Gil Island releasing diesel oil#2 from its tanks, and other fuels from its systems, and vehicles on board. **Product Spilled** Diesel #2 Unknown

Shoreline Segment ID 1397 **Division** N Fin Island - Clam Town
Survey by Boat **Survey Time** 1253 **Survey Date** March 25, 2006
Shoreline ID 1397 **Length** 200 **Meters** **Exposure** High **Oil Sensitivity** Unknown
Coastal Character Rock with Sand and Gravel Beach

SHORELINE TYPE
Bed-rock Not Applicable
Manmade Solid Not Applicable
Sediment Beach Mixed Sand-Gravel
Sediment Flats Not Applicable
Marsh No

SHORELINE SEGMENT INFORMATION
Total Segment Length 200 m **Length Surveyed** 543 m
Segment Start Latitude 53 16 411 **Start Longitude** 129 18 97
Segment End Latitude **End Longitude**
Differential GPS No

COASTAL CHARACTER
Cliff or Hill Slope Gentle <5 degrees **Est. Height** **Comments Coastal Character**
Backshore Character Primary Forest Treed back shore
Secondary
Coastal Habitat Type and Exposure H7 - Protected Sand & Gravel

OPERATIONAL FEATURES **Comments Operation Features**
Direct Backshore Access No Access from south end between Fin Island and a small islet provides access without having to go into Clam Town cove
Access from Next Segment Yes
Debris No **Debris Oiled** No **Debris Amount (bags)** 0 **OR (trucks)**
Suitable Backshore for Staging No **Access restrictions** Yes
Comments on Access Restrictions North end of shoreline within the forested area appears to be a camping area and there is evidence of a midden - shell hash beach. First Nations consultation recommended

NEARSHORE (Trapped) OIL
Nearshore Mobile Oil Trapped or Confined by Shore Geography **Thickness (cm)** **Oil Characteristic**
Recovery Obstacles or Hazards **Primary:**
Is Oil Recoverable ☐

COMMENTS (Issues, Constraints, Cleanup Recommendations)
Safety **Recreational**
Wolves on island, do not feed or interact with them or leave any food on shore

Shoreline Segment ID Number 1397 **Division** N Fin Island - Clam Town

SCAT

ShoreAssess
Management system for the assessment of oiled shorelines
A product of : EPDS
(Environmental Performance & Decision Support)

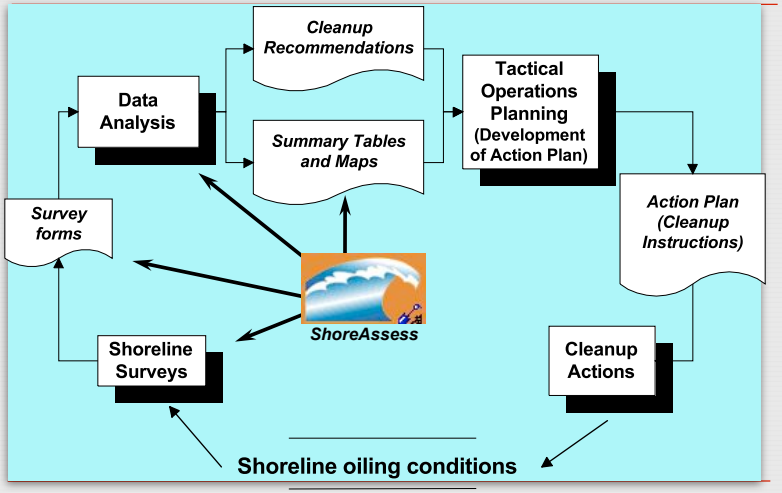
SCAT - *ShoreAssess*

ShoreAssess is a sophisticated database that has been widely adopted in Canada. Supported by Environment Canada.

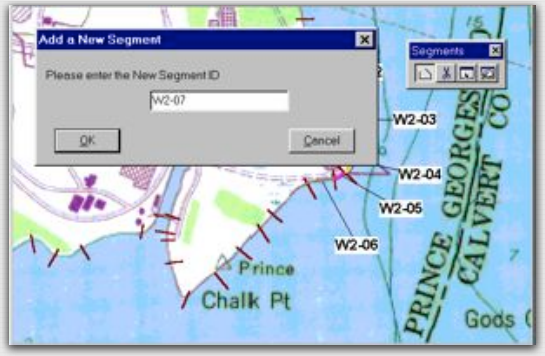
Pros:
✓ensures that all data is collected and validated as it is captured,
✓provides oiling assessments and cleanup recommendations,
✓accelerates the production of support documents,
✓allow the production of summary maps used for decision making.

Cons:
✓expensive and high operator learning required.

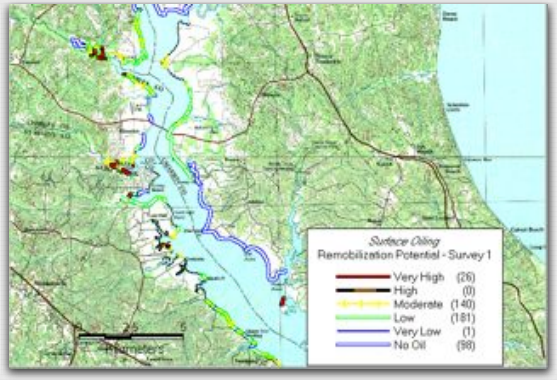
SCAT - *ShoreAssess cont...*



SCAT - *ShoreAssess screen shots cont..*



SCAT - *summary maps*



SCAT - *Lake Wabamum*

SCAT - *Data manager providers*

Environmental Performance & Decision Support:
CANADIAN: Montreal

Phone: (514) 598-7832
E-mail: epds@epds-central.com
Web: http://www.epds-central.com/english/4index1024.html

Polaris Applied Sciences
US: State of Washington

Phone: (425) 823-4841
E-mail: tallard@polarisappliedsciences.com
Web: www.polarisappliedsciences.com/welcome.html

Entrix
US: Multiple Locations

Phone: (713) 666-6223 or (800) 368-7511
E-mail: GRobilliard@entrix.com
Web: http://www.entrix.com/index.php

SCAT - *Data manager providers cont...*

EML Environmental Mapping Ltd
CANADIAN: Saanichton, BC

Phone: (250) 652-9739
E-mail:eml@eml.ca
Web: http://www.eml.bc.ca/

Coastal & Ocean Resources Inc.
CANADIAN: Sidney, BC

Phone:(250) 655-4035
E-mail: john@coastalandoceans.com
Web: http://www.coastalandoceans.com/

Module 26 – SCAT table top exercise

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - exercise *objectives*

The objective the SCAT table-top exercise is to integrate all the training elements from:

- arriving and establish SCAT at an Incident Command Post
- transition through response phases
- standardization of SCAT
- establish field SCAT
- safety briefings
- field data collection
- quality assurance
- data management, to
- operational briefing.

This is a table-top exercise is a "walk-through". It is not a test.

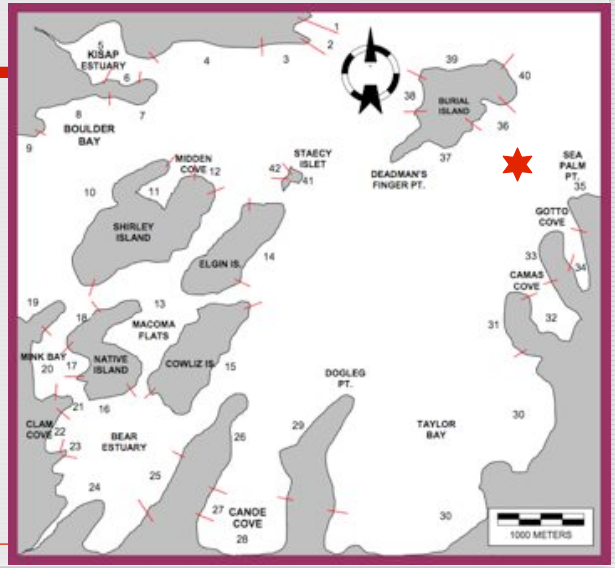
SCAT – *scenario*

The *M/V Blackguard* bulk carrier vessel carried 1600 cubic meters (10,000 barrels) of Intermediate Fuel Oil and 68 cubic meters (430 barrels) of marine diesel went aground and broke in half spilling its entire fuel load.

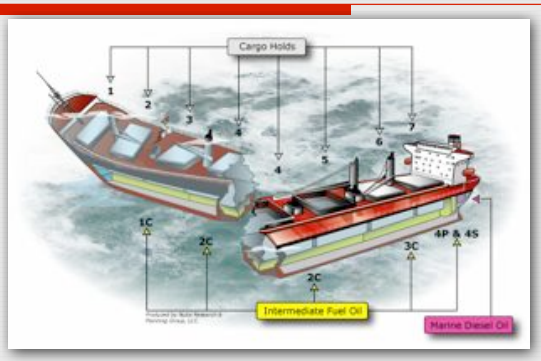
Flag Malaysia
Type Single deck bulk carrier
Built Hudong Shipyard, China, 1998-01
Class ABS
Length (LOA) 225.00 m
Beam 32.26 m
DWT 74,893.00 mt
GRT 39,775.00

M/V Blackguard

Incident Location



SCAT – *fuel release*



Intermediate Fuel Oil (IFO-380)
Center Tanks 1 to 3 C
Total 16,000 cubic meters

Marine Diesel Oil (MDO)
Tanks Port, Starboard, Settling, and Service
Total 68 cubic meters

SCAT – *about intermediate fuel oil*

Density: 0.989 g/cc; fresh water is 1.00 and oceanic seawater is 1.025, as such the oil is lighter than both fresh water and seawater.

Pour Point: 2 to 10°F and at ambient water temperature (low 40's) will quickly cool and form thick "patties" rather than remaining as a sheen.

Viscosity: 346 centistokes (cSt) at 122°F and at ambient water temperature greater than 3500 cSt, Oil viscosity would initially be similar to honey and increase to peanut butter.

Composition: the chemical composition is generally unknown, but heavy refined products such as Intermediate Fuel Oils are routinely made by blending a diesel (Fuel Oil No. 2) with a heavy residual oil or with the residuum from the refining process itself.

Fate: typically, 5 to 10% of the oil would evaporate within 5 days.

SCAT – *about marine diesel*

Density: 0.839 g/cc; therefore, diesel oil is lighter than both fresh water and seawater.

Viscosity: ~10 centiStokes (cSt) and at ambient water temperature will spread to form a thin film or sheen.

Composition: the actual chemical composition is not known.

Fate: typically, 30 to 60% of the oil could evaporate in 5 days.

SCAT - *exercise players*

Workshop participants will assume Incident Command System, SCAT and stakeholder representation positions:

AT INCIDENT COMMAND POST:

** Operations Section Chief _____
** Logistics Section Chief
** Safety Officer _____
** Liaison Officer _____
Planning Section Chief _____
SCAT coordinator _____

****Short-term players**

IN THE FIELD:

SCAT leader (geomorphologist) _____
SCAT biologist _____
SCAT archeologist _____
SCAT local rep 1_____
SCAT local rep 2 _____
SCAT RP rep _____

SCAT - *exercise materials*

Exercise materials such as oil trajectory, shoreline types and shoreline oiling levels will be provided during the exercise

ONLY ONE RULE: BE HARD ON PROCESS...BUT EASY ON PEOPLE

Module 27 – SCAT course evaluation

Shoreline Cleanup Assessment Techniques (SCAT) for Oil Spills in Tropical Marine Environments

Stafford Reid
EnviroEmerg Consulting Services
Duncan, British Columbia
CANADA
EnviroEmerg.ca

SCAT - *evaluation*

CONTENT:
1. Objectives clear
2. Objectives met
3. Appropriate length
4. Relevance to job
5. Course complexity
6. Theory/Practice mix
7. Participation
8. Course materials
9. Assignment

A COURSE EVALUATION FORM WILL BE PROVIDED FOR COMPLETION

INSTRUCTOR:
10. Knowledgeable
11. Confidence
12. Style, approach

FACILITIES:
13. Suitable venue
14. Class size

COMMENTS?