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Research

The development of the SCAT process for the assessment of oiled shorelines

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Abstract

The Shoreline Cleanup Assessment Team (SCAT) process is a tool to assess oiled shorelines and is now an integral component of spill response operations. The key element of a SCAT survey is a systematic documentation using standard terms and definitions of the shoreline in the areas affected by an oil spill. SCAT programs were initially established to provide objective and accurate shoreline oiling information directly to cleanup operations. The role of the SCAT program has since expanded and the information generated by the field teams is used now by planners and decision-makers and to develop shoreline treatment recommendations, to select appropriate treatment techniques, and to establish the level or degree of treatment that is appropriate. This latter point is an integral part of establishing shoreline treatment criteria or standards and treatment end points.

Keywords: Oil spills; Oiled shorelines; Shoreline documentation; Shoreline assessment; Shoreline cleanup

1. Introduction

The Shoreline Cleanup Assessment Team (SCAT) process is now a familiar part of an oil spill response in many countries, and SCAT teams are a key component in the assessment of the scale and scope of a shoreline response program. Shoreline surveys may range from an aerial reconnaissance by a single person to surveys of the shoreline on the ground by multiple teams in order to document the shoreline oiling conditions. In some instances, multi-disciplinary survey teams also document the health of intertidal communities, the character of coastal zone cultural resources, and potential operational issues such as access, staging potential, and safety considerations.

1.1. Development of the SCAT process

Prior to the development of the SCAT process, various approaches had been used over the years to describe the character of oil stranded on shorelines (e.g., Blount, 1978; Finkelstein and Gundlach, 1981; Gundlach et al., 1981; ITOPF, 1983; Owens, 1984, 1987; Owens and Rashid, 1976). In many cases the assessment of shoreline oiling often was carried out by operations personnel who then planned and directed the treatment or cleanup activities. The use of checklists for shoreline surveys was developed as part of an ongoing shoreline response training program that Environment Canada began in 1977 (e.g., Owens, 1979) and continues today.

The first description of the formal application of these checklists to a spill response was described at the 13th AMOP Technical Seminar (Owens, 1990). To cover the extensive coastal area affected on Vancouver Island, Canada, by the *Nestucca* spill in January and February 1989, a helicopter supported Shoreline Evaluation Team (SET) was used in conjunction with ground or boat-based Shoreline Surveillance Teams (SST). The survey teams used a Shoreline Oil Classification composed of five oil character classes and four oil cover categories. Of particular importance was the participation of a representative of the Nuu Chah Nulth Tribal Council, that represents fourteen First Nations in southwestern and western Vancouver Island. The survey teams initially documented the presence and character of the oil, recommended treatment actions, and, after the cleanup

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operations had been completed, inspected the segments and reported on the condition of the shoreline to the On-Scene Coordinator. In effect, the teams and the documentation program in the *Nestucca* survey followed the basic principles of a SCAT survey, although it would be a few months before the name was introduced and before the process was applied on a totally different scale and with a new dimension of importance.

On the heels of the *Nestucca* spill, the *Exxon Valdez* tanker ran aground in Prince William Sound (PWS), Alaska. By early April 1989, Exxon had mobilized a team to assess the extent and character of the oiled shorelines in order to prepare an operational shoreline cleanup plan. Initially, an Exxon survey team conducted an aerial videotape survey of the affected areas in PWS to locate oiled shorelines and to prepare preliminary maps on the physical shore-zone character. On April 13, after this first phase had been completed in PWS, shoreline inspection teams were created that included federal, state, and Exxon representatives. They began a program of boat- and helicopter-supported surveys that included the segmentation of the shoreline into homogeneous units and the documentation of:

- the physical shore-zone character,
- the distribution and character of the stranded oil,
- the ecological characteristics and the observed effects of the oil on intertidal macro-species,
- the existence or potential presence of cultural/archeological resources within each segment (Wooley and Haggarty, 1995).

These inspection teams began as a joint effort but within a few days the work loads of the government representatives grew rapidly and the teams thereafter were staffed by geologists, ecologists, and archeologists hired by Exxon. Eventually a maximum of nine teams operated simultaneously as part of this program. The field teams were supported by an expediter and by a data management team that was responsible for generating the reports and data summaries that were used by the planners and the operations supervisors. The term SCAT was created by the management group in early May 1989 to reflect the purpose of the survey and this became the recognized name for the data collection process and the survey program.

More than 5500 km of shoreline were surveyed and 1149 segments were defined and mapped during the field program in 1989. In addition to the shoreline documentation field activities, the Exxon SCAT group:

- established a Geographical Information System (GIS) system to archive the data and produce maps,
- completed the aerial videotape survey of PWS and then extended the coverage to the Gulf of Alaska (GOA) (a total of more than 8000 km was eventually taped in this program) and repeated the PWS videotape survey in October 1989,
- provided technical advice to the shoreline operations team,
- established fate and persistence study sites to monitor the changes in oiling and intertidal ecology, and
- established a winter monitoring program to document the affected shorelines in PWS and the GOA, that included monthly visits to the study sites and a series of time-lapse photography stations (Owens and Teal, 1990).

Two important changes were made prior to the 1990 SCAT survey (the Spring Shoreline Assessment Team—SSAT—survey): (1) the teams were now composed of federal, state and Exxon representatives and (2) the original forms were modified for easier use and for easier data management (Owens, 1990). Later in 1990, Environment Canada began preparation of a "SCAT Manual for British Columbia" that adopted the basic template of the Shoreline Oiling Form that was introduced for the SSAT surveys. In this manual the standard terms and conditions were defined, user guidelines and directions prepared for field use, and the procedures used in the PWS surveys were modified to be applicable to a wider range of conditions. The National Oceanic and Atmospheric Administration (NOAA) subsequently adopted the Environment Canada (Environment Canada, 1992) and *Exxon Valdez* material into their own manual (NOAA, 1992). By 1991 the process and methodology had become formalized (Owens, 1991) and a few years later Environment Canada published an upgraded generic second edition SCAT Field Guide in a pocket format (Owens and Sergy, 1994).

Since its conception and development in 1989 and 1990, SCAT programs have been a component of almost every spill of any size in North America. Both the process and documentation have been adopted overseas. Similar manuals have been prepared by the EC and by French, Australian, and British organizations (Jacques et al., 1996; Kerambrun, 1993; MPCU, 1994). SCAT surveys have been used on freshwater as well as marine spills and the terms and definitions have been translated into several languages (French (Owens and Sergy, 2000b), Portuguese, Russian, and Spanish). Descriptions of the SCAT programs have been presented for a number of spill response operations including the 1991 Gulf War oil spills (Saudi Arabia: Gundlach et al., 1993); the 1993 Tampa Bay spill (Florida, USA: Owens et al., 1995), the *Morris J. Berman* spill (Puerto Rico: Petrae, 1995), the Komi pipeline spills (Sienkiewicz and Owens, 1996), the *Iron Baron* spill (Tasmania: Lamarche and Owens, 1996), the *Puerto Rico* spill (San Francisco, USA; Lamarche and Tarpley, 1997), the *Buffalo 292* barge spill (Texas, USA; Martin et al., 1997), the *Sea*

Empress spill (South Wales: Little et al., 1997), and the *New Carissa* spill (Oregon, USA: Owens et al., 2000a).

1.2. The year 2000 upgrade

A review of the SCAT field forms that had been used on recent spills identified some items or areas in need of improvement (Owens, 1999). This evaluation led to a cooperative upgrading of the forms by Environment Canada and NOAA that included: (i) a revised standard shoreline oiling form, (ii) a revised "short" form, (iii) a tar ball form, and (iv) a revised marsh/wetlands oiling form (Owens et al., 2000b; Michel et al., 2001). Environment Canada also developed (v) a tidal flat form, and (vi) a revised sketch map base. Recommendations for variations on these basic forms were provided for large freshwater lakes, arctic coasts, mangrove, coral reef, river, and stream environments and for winter or ice and snow conditions (Owens and Sergy, 2000a,b).

For all intents and purposes the systems and field forms used by the Environment Canada and NOAA are now identical, although some very minor differences remain out of internal necessity, particularly with respect to the standard shoreline types that are used to describe the shore-zone character by these two agencies. NOAA has produced a useful visual job aid to assist in the description of oiled shorelines (NOAA, 1998) in addition to the third edition of their SCAT manual (NOAA, 2000).

2. A SCAT program

2.1. What is SCAT?

Over the last decade, the term SCAT has taken on a number of meanings and has grown to embody a range of potential functions in various spills. Broadly speaking SCAT involves both a protocol and a mechanism to collect field information to describe oiled shorelines, and to utilize that information in shoreline treatment planning, decision making, and response activities.

The fundamental objective of SCAT is to enhance and expedite informed decisions for oiled shoreline treatment planning and response operations. All SCAT activities are directed toward this goal. A SCAT program includes field assessment surveys, data management, and data application components housed within the spill management organization. The surveys use a set of specific and standard terminology to describe and define shoreline oiling conditions. However, the SCAT process is a flexible approach. The assessment activities, the oiling descriptions and definitions, and the data application are designed on each occasion to match the individual spill conditions and organization.

2.2. Role or functions of shoreline assessment surveys

The core function of shoreline assessment surveys is to:

- systematically survey and document the affected area to provide a rapid and accurate geographic description of the shoreline oiling conditions and real-time issues or constraints.

Other auxiliary functions or roles can include the:

- development of treatment or cleanup recommendations,
- development of treatment or cleanup standards or criteria,
- post-treatment inspection and evaluation,
- provision of long-term monitoring, and
- management of special issues.

2.3. Fundamental principles of shoreline assessment surveys

There are several fundamental principles of shoreline assessment surveys. These include:

- a systematic assessment of all shorelines in the affected area,
- a division of the coast into homogeneous geographic units or "segments",
- the use of a standard set of terms and definitions for documentation,
- a survey team that is objective and trained, and
- the timely provision of data and information for decision making and planning.

In addition, and particularly for the auxiliary functions of the program, a survey team may be composed of:

- inter-agency personnel to represent the various interests of land ownership, land use, land management, or governmental responsibility.

The systematic approach, with standard terms and definitions, provides consistent and accurate data. This allows a comparison of data and observations between different sites, between different observers, between the same sites over time, and before and after cleanup/treatment. The information on shoreline oiling conditions is likewise presented using a set of standard terms and definitions, so that the potential for misunderstanding or misinterpretation is minimized. All data and observations are keyed to shoreline segments. These are distinct alongshore sections of shoreline that are homogeneous in terms of physical features, sediment type (shoreline type), and oiling condition and that are used as operational work units.

2.4. Scope of shoreline assessment surveys

SCAT surveys are flexible and adapted to the spill conditions. They can be conducted:

- on spills of different oil types, and with different types of shoreline oiling conditions,
- on spills of different sizes, from small to large,
- in different environments, including marine, freshwater and terrestrial,
- by different methods, both aerial and ground level, and
- in various levels of detail, from simple single-discipline surveys to complex programs with geomorphological, ecological, and cultural resource components.

An example of the adaptation of the SCAT process to a specific spill situation is described in the 23rd AMOP Proceedings for tar ball surveys during the *New Carissa* response (Owens et al., 2000a). In this case the traditional methods and terminology could not provide accurate information for this type of oiling, so the field and data management team developed a process that was appropriate for these conditions.

2.5. Method of surveys

Shoreline surveys can be conducted by different methods and at different scales depending on the size of the affected area, the character of the coastal zone, and the level of detail that is required:

- Aerial reconnaissance provides an overview of the extent and character of the oiled shorelines. This information is critical to develop regional objectives, to define the overall scale of the potential response operation, and to direct the initial deployment of response resources.
- Aerial surveys can be used to systematically document shoreline types and shoreline surface oiling conditions, typically using videotape mapping techniques. This information is used for regional strategies and plans, for segmentation of the shoreline, and for the definition of lengths of oiled shoreline in terms of shoreline types and the oil character (Owens and Reimer, 2001).
- Systematic ground surveys typically are the primary source of detailed data and information. This systematic documentation of the location, character, and amounts of surface and subsurface oil in all of the segments within the affected area is the foundation for planning and implementing the shoreline treatment or cleanup operations.
- Special spot ground surveys are used to focus on special issues or to investigate atypical oiling conditions.

2.6. Data, observations and decisions from the field

Shoreline assessment surveys describe:

- the shoreline types and coastal character,
- real-time location, character, and amount of stranded oil,
- real-time environmental, cultural, archaeological, human-use, or economic issues or constraints (this real-time assessment is different from the information that may be available from pre-existing maps or databases as it is current at the time of the spill response operation and probably more accurate in terms of the level of detail on a segment-by-segment basis), and
- factors that may assist or constrain operations.

The survey team also may be directed to provide recommendations for treatment options, cleanup standards, and the completion or reactivation of cleanup activities.

2.7. Use and application of SCAT survey data

In North America, the SCAT teams are included in the Incident Command System as part of the Environmental Unit. The groups that typically use the information and data generated by the SCAT program include:

- *Unified command*, to evaluate the scale of the problem and the scope of the response.
- *Planning section*, to:
  - define shoreline treatment priorities,
  - select cleanup or treatment methods,
  - identify the required level of effort for shoreline operations,
  - apply cleanup or treatment endpoint criteria, and
  - monitor cleanup and treatment progress.
- *Logistics section*, to estimate the resources required to complete the cleanup or treatment work on a site-by-site or segment-by-segment basis.
- *Operations section*, to locate the work sites and the oil and to implement the cleanup task.
- *Waste management unit*, to determine what and how much waste will be generated at each site.
- *Environmental unit* teams, to (i) identify potential liabilities and (ii) assess effects and recovery.
- *Safety officer(s)*, to identify shore-zone hazards and other safety issues at each work site.
- *Public information* team, to provide accurate data to the media and others on the scale of the oiling and on the progress of the cleanup operation.

Fig. 1. Field data logging of oiling conditions using a weatherproof hand-held field computer linked to a GPS. Al Musallamiyah, Eastern Province Saudi Arabia, October 2002 (photo by T. Gale, EESA).

- *Documentation unit*, to record what happens.
- *Agencies and trustees*, to evaluate the proposed activities and to monitor progress. In many regions in North America often these groups now expect to see a SCAT team in action very early in a spill response and to be able to participate in the field surveys.

2.8. Data management

A critical element of a SCAT program, particularly during the hectic initial stages of a spill response, is to ensure that the data are quickly made available to the users in the planning and shoreline operations groups. A data manager is essential for all but small responses, such as those that involve only one or two teams, as the field surveyors rarely have sufficient time to conduct a quality control review on the data and to package the key information in a user-friendly format. After the initial response period, when SCAT teams typically can then progress at a slower pace, data management remains an integral part of the process to ensure that maps and data tables are kept up-to-date and that the data is suitably stored (Lamarche and Tarpley, 1997). Typically, data management involves a dedicated individual or persons and specially-designed software that may be linked to a GIS for map production (Lamarche and Owens, 1997; Lamarche et al., 1998; Williams et al., 1997).

The integration of data collection and data management through the use of computers in the field has progressed to include the use of Personnel Digital Assistant's (PDA's) combined with a Global Positioning System (GPS) and with the real-time relay of data to a command post (Simecek-Beatty and Lehr, 1996). An extension of this concept includes the use of a field-portable notebook computer that combines a GPS and a GIS to map oiled areas with a Wireless Local Area Network (WLAN) link to a command post (Rubec et al., 1998). A large SCAT survey of the shoreline oil residues from the 1991 Gulf War spills in Saudi Arabia that is being carried out in 2002–2003 demonstrates this application of these recent technology advances to enhance the accuracy of the data and the efficiency of the field teams. In this survey the site description and oiling condition data are recorded to a weatherproof hand-held field computer using a set of drop-down menus and an object-related data base system is used to combine geographic or location data, obtained from GPS units, with the field observations (Fig. 1). The key advantage of these tools is to streamline the data management process, beginning with the field data collection, and to facilitate the QA/QC process.

A wide range of products can be generated to assist in the understanding of the oiling conditions, for use by the management team or the public information team, or simply to document the operations activities or the changes in oiling conditions. Lamarche and Tarpley (1997) present examples of maps produced by the SCAT teams to support a response operation that included:

- shoreline material, segment limits and operational divisions;
- oiling category (including changes through time);
- estimated surface oil volume (including changes through time);
- oil remobilization potential;
- estimated oil persistence;
- segment treatment or cleanup priority;
- recommended cleanup or treatment methods;
- cleanup status map (updated daily).

On the NEW CARISSA response operation the products from the SCAT data base included (Owens et al., 2000a):

- daily maps of the geographic distribution of stranded oil concentrations oil by segment,

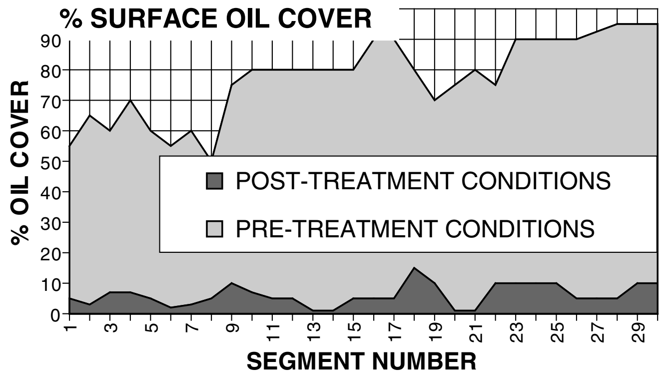

Fig. 2. Example of pre- and post-treatment surface oil cover data from a river spill (from Sienkiewicz and Owens, 1996).

- daily histogram and scatter diagram of oil volume,
- daily histogram and scatter diagram of normalized tar ball weight (in gm/m^2),
- weekly map of maximum volume of oil by segment,
- weekly summary table of daily oil volume by segment and by day,
- weekly histogram of tar ball volumes by category,
- monthly tar ball size frequency distribution histograms for all observations.

Fig. 2 provides an example of surface oil cover data collected as part of SCAT surveys on a series of river spills to illustrate how pre- and post-treatment data can be used to evaluate the effective of the response operation.

2.9. Decision making

At the macro-scale or regional level the SCAT program gathers information to provide the basis for an evaluation of the overall scale and scope of the problem with respect to shoreline operations. At this general scale the information is also used by decision-makers and planners to establish:

- regional response priorities,
- regional and segment treatment or cleanup objectives,
- treatment or cleanup strategies and techniques, and
- acceptable levels of treatment (i.e., standards or criteria for a “sign off”) (Fig. 3).

At a more detailed, site-specific or segment scale in the decision and planning process, the results of SCAT surveys provide information to planners, operations supervisors, and safety officers on the character of a specific segment of shoreline so that they can arrive at a location with:

- the right number of people to do the work,

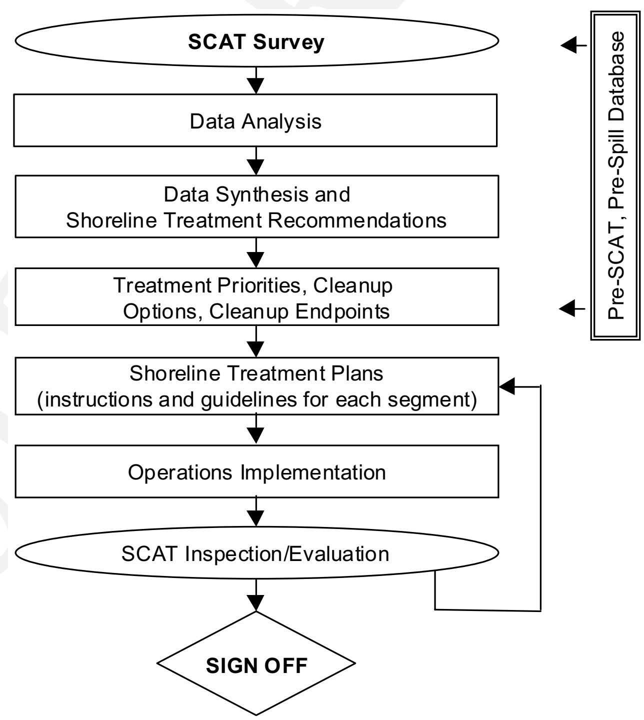

Fig. 3. Typical fit of the SCAT process into the spill management decision process (Owens and Sergy, 2000a).

- the right tools to complete the job,
- an understanding of the objective and of the treatment or cleanup end point for that location,
- a waste management system to deal with the materials generated by the work effort, and
- a knowledge of any logistic and safety problems and issues that may be faced at the location, and the right support (health and safety, catering etc.).

2.10. Pre-SCAT shoreline surveys

One element of shoreline surveys during a spill response is to document the physical shore-zone character, and sometimes the ecological character and the cultural resources. These data can be obtained as part of spill planning activities and can be integrated with shoreline sensitivity mapping programs. The SCAT philosophy is an integral part of Environment Canada's National Sensitivity Program (Owens and Dewis, 1995; Percy et al., 1997), which has generated a GIS-compatible data base for over 34,000 km of the coast of Atlantic Canada (http://www.ns.ec.gc.ca/mapping/index.htm). The shoreline component of this system is based upon the mapping of segments that describe the physical shore-zone character and operational characteristics, such as access and staging potential. Shoreline segmentation based on SCAT principles is also the basis for the Alyeska Pipeline (SERVS) mapping program for PWS in Alaska (O'Brien et al., 1995; Hankins and Wilson, 2001). This SERVS mapping program also includes pre-spill identification of cultural resource sites that might affect operations decisions regarding access and staging potential within individual segments (Wooley et al., 1997). In both of these programs, the mapping scheme was designed specifically to generate data that would be the basis for SCAT surveys in the event of a spill.

3. Concluding comments

In a recent review of shoreline response advances over the past 10 years, the USCG (2002) notes that "Perhaps more importantly, the overall shoreline cleanup management process has been greatly improved through the development of the SCAT process..." The function of a SCAT team is now built into most oil spill management systems and typically is identified as a separate team in the Environmental Unit of the Planning Section.

There is a wide range of uses and applications for the information obtained by the field surveys (Fig. 3). Typically, the role and function of a shoreline assessment survey is to gather the information and to make recommendations. The role of the SCAT program is not to make the decisions, but rather is to enable others in the spill management team to make informed decisions.

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