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Best Practices for Shoreline Cleanup and Assessment Technique (SCAT) from Recent Incidents

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ABSTRACT 300302:

The Shoreline Cleanup and Assessment Technique (SCAT) process, from initial reconnaissance, to generation of Shoreline Treatment Recommendations (STRs) and signoff, is an integral part of oil spill response operations. It is and should remain flexible and scalable based on spill conditions. Several challenging spill responses have contributed to the continuing evolution of the SCAT program. This review examines best practices and unique applications for the SCAT process, coordination within the Incident Command System (ICS), field implementation and tools, and data management. While the basic SCAT process remains the same, the detailed steps can vary greatly from spill to spill. STRs and incident specific forms may be required, additional review procedures for documents and shorelines may occur, endpoints and signoff can become extremely complex, intermediate plans may be generated to manage complexity, and various regulatory consultations may be necessary. Within the ICS, the SCAT program is typically part of the Environmental Unit under the Planning Section, but requires close coordination with the Operations Section. The use of SCAT- Operations Liaisons (both as having Operations on SCAT teams during surveys and as having SCAT team members work with Operations during actual cleanup) is a best practice to improve coordination and treatment effectiveness throughout the response. Field forms, data collection tools, and SCAT staff roles are evolving. The trials of electronic data collection with field computers continue; use of imagery, GPS, and GIS are ever increasing and necessary; and the roles and coordination of various types of field monitors/observers during cleanup operations need to be carefully defined. SCAT team members need to be well-trained, and field calibration should occur regularly within and among teams. SCAT data management now requires dedicated staff and computer data management systems in all but the smallest of spills. The need for high quality data, rapid analysis, and generation of useful products to a varied audience is becoming the expected standard. However, with these expectations come new procedures and specialized skills. QA/QC

of field data is critical to all evaluations and products. Specialized databases have become robust enough to handle the most complex SCAT data and output requirements, and GIS tools can quickly generate a variety of necessary map products for multiple users. These functions require skills not found with typical SCAT field team members. In this paper, we will examine some of the recent advances and unique applications to the SCAT process.

INTRODUCTION:

When spilled oil contaminates shoreline habitats, responders must survey the affected areas to determine the appropriate response. Although general approvals or decision tools for using shoreline cleanup methods can be developed during pre-spill planning stages, responders' specific treatment recommendations must integrate field reconnaissance data on shoreline habitats, oil type, degree of shoreline contamination, spill-specific physical processes, and ecological and cultural resource issues. Cleanup endpoints must be established early so that appropriate cleanup methods (aka 'treatment') can be selected to meet the response objectives. Shoreline surveys must be conducted systematically because they are crucial components of effective decision-making. Repeated surveys can: monitor treatment methods to ensure they are being properly implemented and are effective, document changes in shoreline oiling conditions that may necessitate a change to treatment recommendations, and determine that a recommendation for natural recovery is still appropriate.

The Shoreline Cleanup and Assessment Technique (SCAT) program has become an integral component of spill response and Incident Command System (ICS) in the United States since the *Exxon Valdez* spill in 1989, which was the first spill where standard approaches for documentation, terminology, and decision-making were applied to oiled shoreline reconnaissance (Owens and Teal 1990). Since then, many organizations have developed SCAT programs, manuals, field forms, job-aids, and training courses (e.g., NOAA 2013, Owens and Sergy 2000, ITOPF 2012, POSOW 2013). In North America, Environment Canada and the National Oceanic and Atmospheric Administration (NOAA) Office of Response & Restoration (OR&R) have developed similar SCAT programs and associated products (e.g., NOAA 2013, Owens and Sergy 2000 & 2004).

Many improvements to SCAT were developed during the response to the 2004 *Selendang Ayu* spill in Alaska (Crosby et al. 2008; Owens et al. 2008) and the 2007 M/V *Cosco Busan* spill in San Francisco Bay, including the introduction of Shoreline Treatment Recommendation (STR) and Shoreline Inspection Reports (SIR) forms, and a comprehensive proto-type SCAT database. Over the last several years there have been several spills where substantial SCAT programs were implemented for the response, including the M/V *Cosco Busan*, California (2007); *DM932*-T/V *Tintomara*, Louisiana (2008); *Deepwater Horizon(DWH)*, Louisiana (2010); Kalamazoo River/Enbridge Pipeline, Michigan (2010); Red Butte Creek Oil Spill, Utah (2010); Yellowstone River/Silvertip Pipeline, Montana (2011); Hurricanes Isaac (Louisiana) and Sandy (New Jersey and New York) (2012); and Bay Springs Pipeline Spill, Mississippi (2013). For these incidents some innovative processes, tools, and products were created and tested. We will examine those actions that have led to a "Best Practice" for future SCAT operations.

DISCUSSION:

I. The SCAT Process and Adaptations

In this section, we discuss the basic procedures or steps of the SCAT process during a spill, the SCAT data flow through the ICS planning cycle, and adjustments made to address spill-specific needs. We also focus on specific actions related to natural and cultural resource consultations, shoreline segmentation, sign-off, and forms.

A. The Basics

During each spill adjustments were made to the SCAT process that were driven by spill-specific factors such as Unified Command (UC) decisions; political pressures; land owner requirements; duration of spill (instantaneous or continuous); weather and/or season; and habitat, species or archeological constraints. Adjustments to the SCAT process were usually at a level of fine detail (an extra level of STR review, extra surveys or time added to sign-off, special products or outputs to specialized stakeholders). Any adjustments to the SCAT process were in response to the specific needs of the incident and not likely to be repeatable, hence we found no new Best Practices in the SCAT process. However, what was clear is that starting with and keeping to the fundamentals of the SCAT process – scalable, flexible, and standard terminology, forms, and products – was a Best Practice and common to each incident. Each incident followed the basic SCAT process of:

1. Area reconnaissance;
2. Survey oiled shorelines and make treatment recommendations;
3. Monitor treatment and evaluate effectiveness;
4. Post-treatment shoreline inspections; and
5. Final sign-off.

The degree to which these steps are implemented depends on the complexity of the spill. Trained field personnel and an experienced SCAT Coordinator were critical to the success of the SCAT programs examined. The lack of such training and experience was identified as contributing to initial problems. However, for longer responses, the SCAT teams developed the skills needed over time. Within the foundation of the standard SCAT process, each response was able to customize the details to meet their specific needs.

B. SCAT Data Flow

There no longer seems any debate about the purpose of the SCAT program or the value it can bring to a response. The information generated by the SCAT program is critical for many needs and is used throughout the planning and operational processes to expedite an effective cleanup. How information flows through the ICS planning cycle is clearly shown in this new diagram from the Northwest Area Contingency Plan (Figure 1). The SCAT Coordinator synthesizes field data into reports used by the Environmental Unit and Planning Section to support the daily Incident Action Plan (IAP). The information and recommendations are reviewed and approved by the Planning Section and implemented by the Operations Section in shoreline cleanup. The SCAT program supports the response objectives and the mandates of the response operations, as directed and managed by the UC. Shoreline assessment data must be collected and processed quickly since it is necessary for operational decision making.

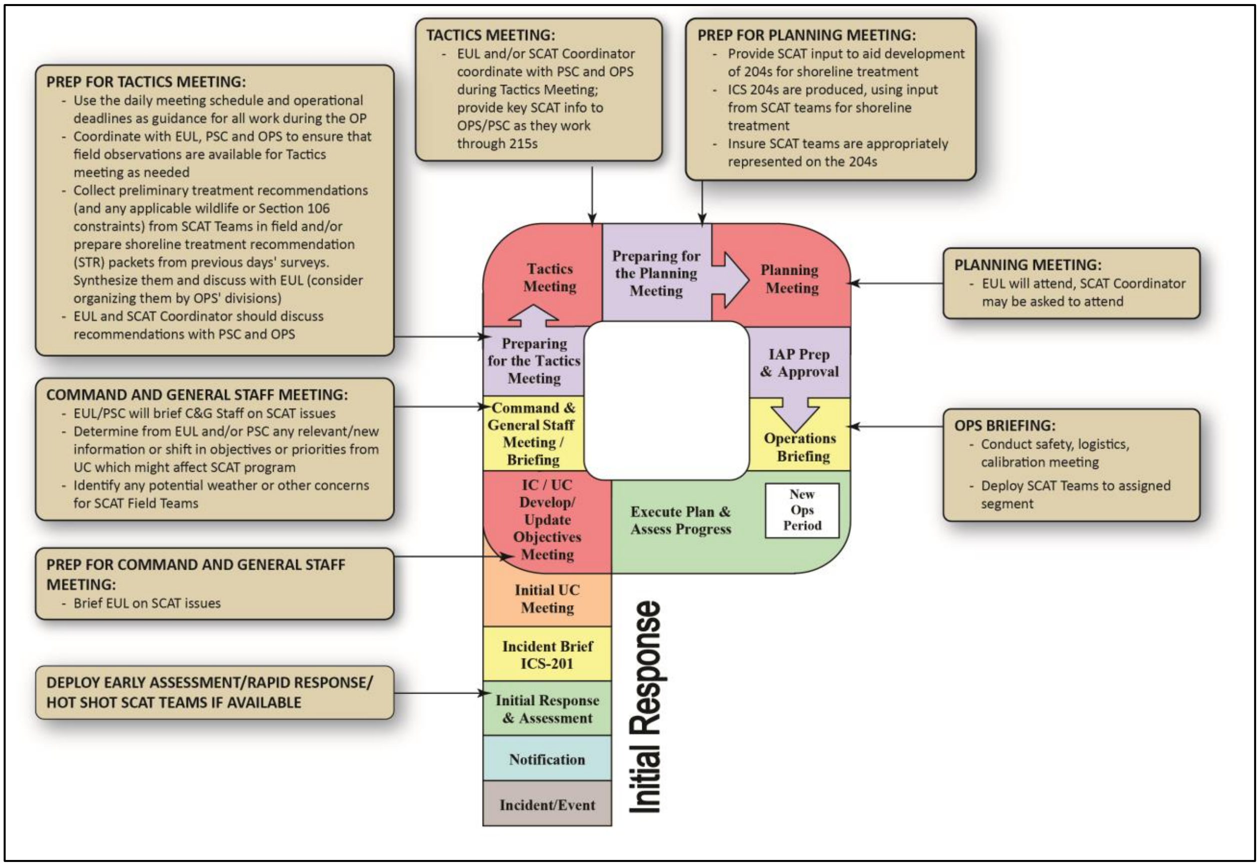

Figure 1. Where SCAT-generated information is used in the “Planning” process (from Northwest Area Committee, 2013).

C. Spill Specific Adjustments

a. Regulatory Consultations

Recent spills across the U.S. have heightened the awareness of potential impacts to species and critical habitats under the Endangered Species Act (ESA), to Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act, and to historical or cultural artifacts and properties under the National Historic Properties Act (NHPA). Local Area Contingency Plans and Regional Response Plans for dispersant use, in-situ burning and shoreline cleaners have received scrutiny recently due to lack of, or out-of-date ESA consultations. These laws require a pre-spill and post-spill 'consultation' with the trustee agency or tribe, and during a response and quick "emergency consultation" is required to heighten awareness of any seasonal differences, new resource information and/or significant changes to the response countermeasures previously identified in the Area or Regional Plans. During a response, these resources are typically addressed under Section 7 ESA and Section 106 NHPA emergency consultations with the appropriate trustee agency representatives, e.g. U.S. Fish & Wildlife Service (USFWS), NOAA National Marine Fisheries Service (NMFS), State Historic Preservation Officer (SHPO), tribes, and the National Park Service (MOA 2001). We have also found it effective to incorporate these representatives, directly into the Incident Command Post (ICP) and STR process to avoid mistakes, potential legal actions and expedite decision-making later. The trustee representatives are essential to review STRs and provide Best Management Practices (BMP) for cleanup operations to avoid adverse impacts to Threatened and Endangered (T&E) species and critical habitat, EFH, and/or historical and archeological sites.

In very sensitive locations, special agency field monitors may be required during cleanup operations and/or during the SCAT surveys to document compliance with the BMPs. During the DWH response, historical and cultural resources were assessed by Cultural Resource Advisors (contractors) as archaeological team members (Santner, et al. 2011). Their observations were later used by the tribal and SHPO representatives to generate BMPs as part of the STR. Resource advisors (READs) and Natural Resource Advisors (NRAs=READs & CRAs, but on federal lands) oversaw both cleanup operations and some SCAT surveys, monitoring sites for bird and/or turtle nesting activities, as well as documenting compliance with the STR BMPs for ESA, Migratory Bird Treaty Act, Marine Mammal Protection Act, and the NHPA. Furthermore, there may be a need to document SCAT program compliance with any BMPs that have been developed for SCAT teams to follow during their field surveys. To guide the U.S. Coast Guard (USCG) and U.S. Environmental Protection Agency (EPA) in these matters, a detailed step-wise document was created: the Inter-agency Memorandum of Agreement Regarding Oil Spill Planning and Response Activities Under the Federal Water Pollution Control Act's National Oil and Hazardous Substances Pollution Contingency Plan and the Endangered Species Act (dated 2001), which is available at:
http://www.uscg.mil/npfc/docs/PDFs/urg/App/ESA_MOA_AppA_04.pdf

b. Shoreline Segmentation

Shoreline segmentation can be difficult to establish and confusing to the Operation Section and others. Traditional SCAT methods teach that segmenting the shoreline is done by the SCAT teams during the incident based on shore type, degree of oiling, natural break points such as headlands or streams, and operational access. Many segments may be included within, but should not be confused with Operational Divisions establish by the Operations Section. Most areas have linear shorelines allowing for a relatively straight-forward numbered sequence to the segments. However, in complicated areas where complex wetlands or many tidal creeks and islands are present (e.g. in Louisiana during the DWH response, in San Francisco Bay during the *Cosco Busan* response) or in flooded rivers were overbank areas are oiled (e.g. Mississippi River during the DM932 response, Kalmazoo River during the Enbridge pipeline response, Yellowstone River during the Silvertip pipeline response), naming conventions to segments are not simple or straight-forward.

In San Francisco Bay, Operational Divisions were pre-identified in the Area Contingency Plan and identified by a two-letter county designation. Numbered segments were then established by the SCAT program during response, for example, **AL-B-12** for Alameda County-Division B-Segment 12.

During the DWH incident response, the typical linear arrangement was suitable for Florida, Alabama, Mississippi, and Texas; however, in Louisiana the widespread oiling and complex network of wetlands, islands, bays and channels presented a great challenge to a establishing a logical shoreline identification system. A grid system on different scales was tried but proved inadequate by itself due to oiled shorelines crossing grids and no apparent natural break when observed in the field. In the end, operational divisions were established over wide areas within a parish, then a guiding grid system was used, and segments were defined as sequentially as possible within the division and grid cell, for example; **LAPL01-27-10** translates to: Louisiana, Plaquemines Parish, Division 01, grid cell 27, segment 10. Critical to this system were GPS waypoints for the beginning and end of the segment, and oiled zones within a segment. Because of the vast and complicated marsh “shoreline,” GPS position locations were the only way to guide operations to cleanup.

In the three large river spills examined, flood conditions during the time of each spill complicated shoreline segmentation and nomenclature due to vast areas of overbank oiling. It was relatively straight forward to number a segment by left or right-descending bank and by river mile (as in the Mississippi River, **E-73-R** for Division E-Segment (mile 73)-Right descending bank), but describing and naming overbank or floodplain areas is a challenge. Eventually, instead of mapping shoreline segments along a coast or river bank as a linear feature, polygons were used as defined by GPS measurements in the field and mapped in the ICP. Similarly, during hurricanes, oil and hazardous materials targets are not always along a linear shore, but often spread across wide areas by wind, flood waters, and storm surge. The use of GPS by field teams and GIS map products is critical to segment/target locations.

One procedure often discussed but rarely completed is pre-spill segmentation. None of the spills examined had pre-segmented shorelines. Although some challenges were encountered in the early days of the spill, they are typically not difficult to solve with some expertise of the SCAT Coordinator and Team Leaders. Further, segments built up to what is required to meet the needs of the spill and capabilities of operations (such as length of segment or number per Division). When shorelines are pre-segmented, the number and locations may or may not make sense for the eventual spill. During the DWH response, the shores of Mississippi, Alabama, and Florida were segmented early in the spill every kilometer prior to oil coming ashore. While this allowed for the establishment of maps and presented an organized system; it also took away flexibility to expand or reduce segment size due to specific oiling. It also created a large repetitious workload for SCAT teams filling out forms for similar oiling conditions kilometer after kilometer. This had further consequences later when each segment had to be inspected multiple times and signed off, requiring forms, recommendations and multiple reviews.

It is the opinion of the authors that pre-establishing large operational divisions by oil spill response organizations based on logistical, habitat, and span of control issues is a Best Practice. However, pre-segmenting shorelines within Divisions prior to a spill is not, at least not in situations where shoreline position changes substantially over time (e.g., coastal Louisiana or where flooding may resulting in complex patterns of oiling, such as for riverine floodplain habitats) or where pre-determined segments cannot be adjusted to meet the appropriate needs of the spill.

c. Use of Special Teams

As in any complex spill there are difficult issues to solve that have no standard solution, involve multiple stakeholders, and/or are always contentious. The spills we examined were no different and yet established similar procedures (an issue-specific team) to solve the issue. The use of special teams with focused objectives is a Best Practice for a SCAT program.

During the Yellowstone River/Silvertip Pipeline spill, a *Science Team* was established to create cleanup endpoints. The state could not fully participate so the team consisted of federal agency and responsible party representatives. To simplify the process, the team created a "menu" of specific cleanup countermeasures approved by the UC for the habitats affected and for use by the SCAT team. This approach relieved decision-makers from endless reviewing of documents and allowed the SCAT team to be more closely aligned with Operations (Ops) (EPA pers. comm.).

Due to the many complex issues and multi-state nature of the DWH incident, two shoreline *Core Groups* were created (in Louisiana and in Mobile for MS, AL, FL) that were comprised of key stakeholder representatives who were involved in the emergency response. These Core Groups made the key decisions on recommended methods, options and goals for shoreline treatment recommendations (STRs) based on both the technical reference materials provided by individual *Technical Working Groups* (TWGs), and on the wider issues and concerns of the Core Group members and other constituents (Santner et al. 2011). The TWGs were established to deliver clear technical guidance on specific treatment recommendations across the spill area for sandy beaches, marshes and mangroves, and man-made shorelines (Santner et al. 2011, Owens et al. 2011). The Northwest Area Committee (2013) included such stakeholder and advisory groups in their SCAT program, anticipating the need to get such groups involved very early in significant spills.

A Science Advisory Team (SAT) was established during the Kalamazoo River/Enbridge Pipeline spill to provide recommendations to the UC regarding various response methods and objectives. The SAT was comprised of environmental representatives from federal, state and local stakeholder agencies and had the primary mission of making recommendations to the UC and to the FOSC to help guide oil recovery in a manner least damaging to the environment (Dollhopft and Durno 2011).

d. Forms

No brand-new forms have been developed in recent years. Even with the complex spills that we examined, the SCAT forms and processes have performed fairly well. However, refinements to existing forms are done frequently to meet the needs of the incident. For example, at the DM-932 incident, the Shoreline Oiling Summary (SOS) form was customized for the specific habitats encountered along the river, a maximum of four oil zones (per Ops) and no buried oil. Similar changes were made for freshwater habitat and oiling conditions at the Kalamazoo River spill (Pfeifer et al. 2011). At the DWH response, the STR was modified with an extensive signature block to include ESA and NHPA consultation approvals (Michel et al. 2011). The Shoreline Inspection Report (SIR) is used to document the oiling conditions prior to moving a segment out of the response (Owens et al. 2008). This is the one form that is most often modified for spill-specific conditions to capture specific endpoints, habitats and oiling conditions. Our review suggests that the SCAT form development process has matured. The creation of new forms and terminology is discouraged unless absolutely necessary.

II. SCAT Implementation & Cleanup Operations

Like all functions within the ICS, the SCAT program must remain flexible to the scale and complexity of the incident. The SCAT program also must operate in strong coordination with several other elements within the ICS to ensure maximum oil recovery while minimizing resource injuries. Several best practices in the structure and organization of the SCAT activities have emerged in recent incidents that can improve the coordination and efficiency.

A. Coordination

During a spill response, the SCAT program is an integral component of the response organization that is conducted as part of the ICS. The SCAT function in a typical ICS structure fits into the Planning Section under the Environmental Unit (EU) with strong interaction with the Operations Section (Ops, Figure 2). The need for this strong coordination is clear in all of the spills we examined. In fact, when the SCAT program and Ops do not communicate frequently enough, cleanup actions and understanding are diminished (Dollhopft and Durno 2011, EPA pers. comm. for Yellowstone and Kalamazoo River spills, NOAA pers. comm. for Hurricane Isaac). Further information regarding ICS, response structures, and roles can be found in the US Coast Guard Incident Management Handbook (USCG 2013).

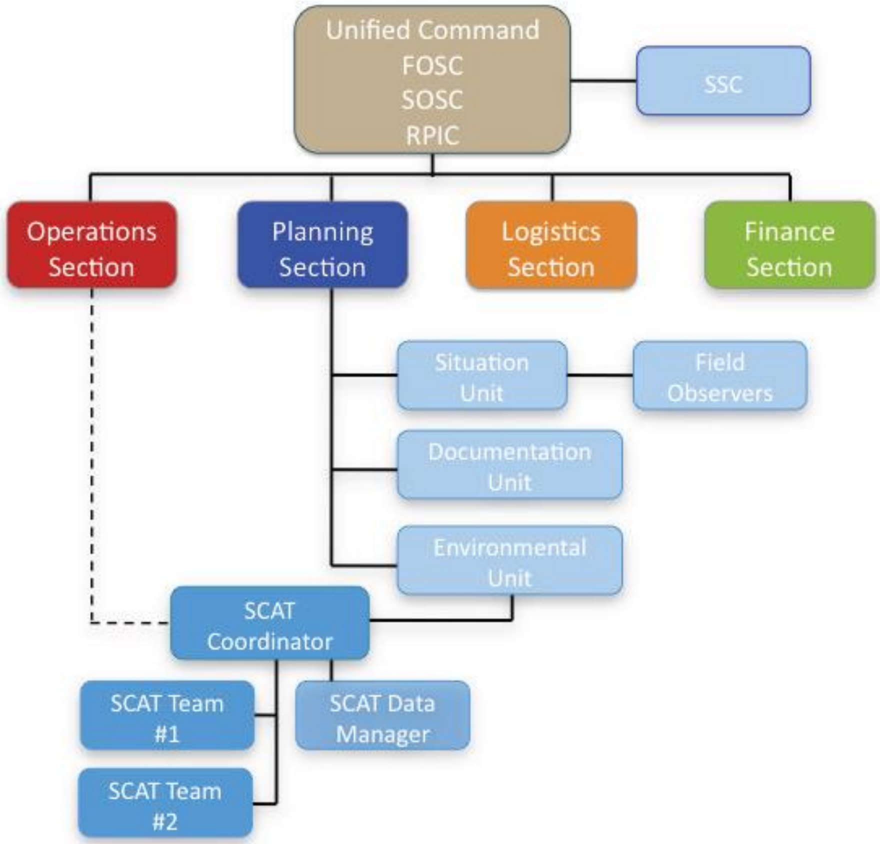

Figure 2. The Unified Command Structure of the Incident Command System. The SCAT program is placed in the Environmental Unit of the Planning Section, but works very closely with Shoreline Cleanup Unit of the Operations Section (NOAA 2013).

SCAT Teams must coordinate their inspection field activities with the Operations Division supervisors working in the areas being treated, so that teams can ensure that all operations are conducted effectively and with the least environmental impact (e.g., reduced beach traffic during bird nesting season). This can be of particular concern in remote or sensitive environments where every visit by response personnel has the potential to create some form of negative impact and specific areas identified for treatment may be difficult to relocate. Further, it is a critical opportunity for the SCAT program and Ops to exchange important information directly in the field.

In some situations it may seem logical to place the SCAT program function directly in Ops, to make sure that they have the support they need and work closely with Ops. This was done by the EPA for the Yellowstone and Kalamazoo River spills where the SCAT program expertise was limited and oiling conditions complex (Whelan and McGaver 2011). With the SCAT program in Ops, cleanup activities were held closely to SCAT program recommendations. However, because the SCAT program is the eyes and ears of the UC, it is important to maintain independence and objectivity when conducting inspections to determine whether the segment meets cleanup endpoints. Thus, it is Best Practice in most cases that the SCAT program operates under Planning/EU, particularly when there are contentious issues with the progress of the shoreline/habitat cleanup.

At the Bay Springs Pipeline Spill in Mississippi (2013), the early and continued use of the SCAT process provided valuable feedback to the UC on the progress of the cleanup and the appropriateness of the tools and the cleanup endpoints selected for the site. The close coordination of the SCAT Team Leader and the Ops Chief enhanced the efficiency of the cleanup by ensuring that problem areas could be addressed swiftly. The SCAT team feedback during post-treatment inspections also allowed for the modification of endpoints for habitat-specific needs within a site where needed to prevent additional impacts.

In Salt Lake City during cleanup of the Red Butte Creek Oil Spill in 2010, it was critical to have the SCAT team travel with Ops Supervisors during site inspections because of sensitive resources at risk from excessive response-related actions. The endpoint was not easily communicated in a way that cleanup contractors could implement in the field. The environmental expertise provided by the SCAT team enabled a determination or modification of the endpoint by working with the cleanup crew and stopping before more harm than good was done to the site. This greatly improved efficiency because it eliminated multiple mobilizations and allowed the resource managers on the SCAT team to make nuanced endpoint determinations.

B. Use of specialized SCAT positions

For large, complex responses, SCAT teams will be very busy conducting surveys and may not have the time to work in the field with Ops Supervisors as shoreline cleanup begins. This was the case during the DWH incident. Under these conditions, a SCAT-Ops Liaison position was created (Santner et al. 2011, Michel et al. 2011). The SCAT-Ops Liaison was field-based and coordinated directly with Ops to ensure cleanup instructions on the STR were understood, implemented well, and the intended results achieved. They provided advice and support in equipment selection and operation, training on cleanup techniques, liaised with U.S. Coast Guard (USCG) observers and local stakeholder representatives, and reported progress to the SCAT program leadership. The SCAT-Ops Liaison role can also include specific cross-trained personnel working as intermediaries or specialized personnel addressing key topics or providing field recommendations or oversight. The SCAT-Ops Liaison is a Best Practice for complex cleanups and should be filled by experienced responders who understand both SCAT and shoreline cleanup operations.

For responses that require complex logistics to get SCAT teams into the field, making all the logistical arrangements is a full-time job that the overall SCAT Coordinator cannot perform. In this situation, a SCAT Logistics Coordinator is essential to making sure that the teams have the resources needed to get to their assigned segments, including field and safety gear, boats, aircraft, vehicles, etc. The SCAT Logistics Coordinator is always looking forward in the response and where the teams need to be a couple days ahead, in order to have the time to schedule any special transportation or acquire necessary equipment. This position works closely with Air Ops, Boat Ops and the Logistics Section to keep SCAT teams working efficiently.

With increasing expectations and data requirements for significant spills, the role of the SCAT Data Manager is essential to success. The Data Manager either singly or with a team processes and stores SCAT field data (e.g., forms, photos, GPS data), then processes them to create the desired products to support operational decisions for the UC and others (NOAA 2013). This may be done in spreadsheet format or pre-built databases specific for SCAT. For a complex spill with hundreds of SCAT surveys, a database is essential.

Working directly with the Data Manager are GIS specialists who can serve a variety of functions such as: SCAT data entry; assisting with production of daily status maps showing current SCAT deployments and assessment activities; maintaining archive copies for distribution and reference; assisting with management and Quality Assurance/Quality Control (QA/QC) of SCAT Teams' GPS tracklogs and waypoints from GPS units and digital photos with appropriate geo-tagging photo software tools. The GIS specialist is a vital support link from the SCAT teams in the field to the data management and product processing in the ICP.

III. SCAT Tool Improvements

In this section, we discuss various tools that are now in common use in SCAT and/or that have been proposed for use in SCAT. This includes the use of emergent technology like tablets and smartphones, as well as older technology like the use of GPS which has revolutionized SCAT products and the expectations of those who use SCAT products.

A. e-SCAT, Tablets, Smartphones

Because of the complexity and variety of SCAT data collection fields and post-processing, the complete digitization of the SCAT process has yet to be accomplished. As an example, there have been multiple attempts in recent years to digitize SCAT data forms for direct download to a server. These attempts have met with mixed success, as the tools focus on field data collection units and less on the data storage and processing (Lamarche et al. 2004, Lankford et al. 2008, Pfeifer et al. 2011, and during DWH-pers. obsv.). As technology improves and becomes more accessible and mobile, we expect to have advancements in field data collection in the near future, particularly for complex and long-duration responses.

B. **GPS** (Global Positioning System)

The GPS continues to prove essential for the modern SCAT process for mapping and precision cleanup. As mentioned above, the GPS is critical site location for complex shorelines. In extremely dynamic environments that are undergoing rapid erosion and/or accretion, GPS has proven critical for understanding where the shoreline existed previously. The use of GPS coordinates have also made it easier than ever to direct cleanup operations to the appropriate locations, and for SCAT teams to complete interrupted surveys, particularly if the team has not been to a given area for many weeks or months. GPS coordinates have been useful in relocating buried oil and response materials (e.g. boom) for removal. Finally, GPS coordinates and track lines are critical to feed GIS for producing a variety of oiling/cleanup maps, which are integral to the planning cycle and for reporting purposes. All SCAT members should be proficient with a GPS unit.

C. Digital Photography

SCAT photos are essential for providing value-added products to operations, the UC, media and for repeat SCAT surveys. Properly logged and archived photos are important to long-term management, recovery, Natural Resource Damage Assessment, educational and/or legal purposes. The ease and quality of digital photography is better than ever with cameras and smartphones, and when paired with a GPS waypoint or position, enables accurate mapping of spill zones and segments, quantifying oiled shorelines, and producing reference documents. Geo-referencing/tagging photographs is relatively easy to accomplish with simple software, but requires a specialist and time to do the processing. Geo-referencing, labeling, and describing photos are critical to maintaining the photography's usefulness. Because digital cameras and smartphones are so easy to use, it can lead to taking too many unnecessary photos, adding to processing time. Prudent picture taking is recommended but hard to enforce. We have found that SCAT personnel can benefit from photo training and calibration among teams, resulting in more standardized photos of oiling and habitat conditions. We also think it is beneficial to take representative photos of areas where SCAT surveys document no oil observed (NOO) conditions, for documentation and comparison purposes.

D. Aerial/Satellite Imagery

Recent remote imagery is very important, especially on complex shorelines. Imagery is helpful to the SCAT teams when locating a specific shoreline, orientation of segments, and images are often used as a base for field sketches, base maps, STRs, etc. This in turn is helpful to the GIS specialist in the SCAT data management group to accurately map the segments.

In addition, some aerial and satellite imagery has been used to describe shoreline oiling conditions similar to SCAT, at least in a research setting, perhaps with an aim towards future potential use as a response tool. Kokaly et al. (2013) and Khanna et al. (2013), provide examples from the DWH incident. Their maps of heavy shoreline oiling were similar to STR maps produced using SCAT data for the same area. Perhaps during some future incidents of similar scale, rapidly attained and processed aerial imagery collected by dozens of aerial drones will support SCAT data collection and response decision-making.

IV. Data Management & Products

During the Deepwater Horizon oil spill, up to 26 SCAT teams, consisting of Federal, State, local, and BP representatives, conducted thousands of field surveys spanning four states and greater than 7,000 km for nearly four years, representing by far the most complicated SCAT program for a spill to date (Santner, et al. 2011). As of May 2013, this effort involved over 7,100 SCAT team-days during which 7,058 kilometers (km) of shoreline were surveyed; however, over 46,000 km of total shoreline have been surveyed, because of the many repeated surveys of the same sections of shoreline over time (NOAA 2013). A robust SCAT database and reporting tools were refined and became essential to managing the data from this large SCAT program effort.

Spreadsheets containing the most vital data still work for small spills, but complete relational databases built specifically for the SCAT program are essential for any significant spill in today's response environment. SCAT data collection is too complex to build a system during the event or modify another database. During large incidents, the SCAT field data comes into the ICP quickly and in large volumes. The requirement to process data quickly for operational recommendations and produce summary products cannot wait for a SCAT data management system to be built. Therefore, companies and spill response organizations should identify contractors or government agencies that can provide a fit-for-purpose SCAT data management system in the event of an incident or design and pre-build one themselves. SCAT data management systems used during several recent incidents provided a foundation for data management adaptations and improvements for use during future spills. The use of GPS and GIS tools are important parts of the recent SCAT data management systems. For the SCAT program, this now requires GIS specialists imbedded in the SCAT program to process and manage data, and to produce geospatial data products to various user groups under the response.

V. Training

A. Just-in-Time & Calibration Exercises

Having personnel trained in the SCAT process is essential to a successful response. SCAT protocols are too detailed and require specific knowledge and training before personnel can function as SCAT team members in the field. Because the SCAT process is a team approach, even if some don't have the full SCAT training they can still be valuable team members if they have a basic familiarity with the SCAT process and have detailed experience with operational methods, the local environment or cultural resources. Ideally, trained and experienced SCAT responders will staff the teams. However, in some spills this is not the case. During the Yellowstone and Kalamazoo River spills, there was a shortfall in trained SCAT personnel. The Kalamazoo spill occurred shortly after the DWH and most SCAT trained personnel were already working the DWH response. As such, the RP was forced to conduct "Just-in-Time" (JIT) SCAT training during the response with local contractors (Whelan and McGraver 2011, Pfeifer et al. 2011). Trainees were provided with the basics of the SCAT process, simplified SOS forms and customized field guides for the river habitats impacted.

At the DWH incident, because the SCAT program was so vast and long-term, SCAT trained personnel from around the world cascaded in to support the effort. Even still, NOAA conducted two formal SCAT training courses for potential USCG, Federal and State agency SCAT personnel, and several informal refresher and task-specific trainings were also provided. The RP also conducted multiple field calibration exercises to familiarize team leads with protocols, available treatments and oiling conditions. Because of the complicated response protocols and changing oil character, these calibration exercises were critical to keep surveys as consistent as possible, and should be encouraged and used to an even greater extent during future large-scale or long-term responses

B. SCAT Courses

Proficiency in the SCAT process comes from training and repeated experience. In the U.S., there are only a handful of government agencies and private sector consultants that offer training. NOAA is the principal government agency instructor to the USCG and has developed a three-day training course for SCAT Team Members and a half-day introductory course for spill response managers. NOAA has also just completed a significant revision of their Shoreline Assessment Manual (4^{th} ed.) that covers technical topics that SCAT Team Members need to be familiar with to perform their duties. Some of these topics include: the SCAT process, forms, protocols, an introduction to Environmental Sensitivity Index (ESI) maps, coastal processes, oil types and behavior, case studies, oil behavior and cleanup on different shoreline types, and field exercises. Similarly, NOAA and EPA have developed a similar three-day training program for Inland SCAT, using examples and case studies from inland river and lake environments.

In addition to NOAA and EPA offering SCAT training, there are several well established SCAT training programs offered through private industry. Topics and duration of the basic SCAT course is very similar and provide a solid foundation for a SCAT team member. This training and implementation is especially important where industry plans to a play a pivotal role in the shoreline decision-making process.

C. SCAT Manuals

There are numerous SCAT manuals and field job aids available that discuss the conditions and processes related to the assessment of shoreline oiling, standardized methods for assessing shorelines, shoreline types and the habitats and resources associated with them, and how SCAT techniques form the foundation of the cleanup strategies. Manuals range from very comprehensive, almost classroom-like textbooks, to simple step-by-step field procedure guides. Some are designed for the field – in size (fits in your pocket) and brief content (pictures, codes, checklists) to serve as a reminder from more detailed classroom materials. Other manuals are customized for specific habitats, such as freshwater systems and the Arctic environment. SCAT manuals and field job aids are available from: NOAA (2004, 2013), the State of Alaska (Crosby et al. 2008), Environment Canada (Owens, E.H., and G.A. Sergy 2000 and 2004(Arctic)), Australia and New Zealand (AMSA 2003), France (CEDRE 2006), United Kingdom (MSA 2007), ITOPF (2012), and Europe (POSOW 2013).

CONCLUSION:

A review of significant inland and coastal spills over the last five years has validated SCAT principals, procedures, and also has revealed several Best Practices. It is clear from this analysis that basic SCAT principals, process, forms, and function in ICS are sound. While spill-specific modifications are made to forms or processes for most complex incidents, the form and function of SCAT works in all cases. Best Practices were observed when incorporating agency resource specialists directly into the SCAT process for T&E species and historical/cultural resource consultations, expediting BMPs and treatment recommendation approvals. Coordination and proactive communication is not surprisingly also a Best Practice. Frequent interactions in the field between SCAT teams and Division Supervisors within Ops is important to ensure cleanup recommendations are understood, and in the ICP, to clarify treatment methods and priorities. Establishing special advisory teams, like a SAT or TWG, are an important method to study a difficult issue and create solutions. Several specialized positions worth noting have been used to accomplish critical tasks, such as: SCAT-Ops Liaison, SCAT Logistics Coordinator, SCAT Data Manager, and GIS specialists. Similarly, specialized data management and GIS systems are most helpful to critical in complex spills to rapidly analyze field data and produce reports for decision-makers. It is also a Best Practice to continue training, preferable in advance of a spill, but we must also be prepared for refresher, calibration and JIT training sessions. This review has highlighted many improvements to the SCAT process and products, and has found continued evidence that the SCAT program remains an essential component to effective spill response.

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