UNDERWATER CLEANUP ASSESSMENT PROGRAM DURING THE M/V KUROSHIMA INCIDENT, APRIL 1998

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ABSTRACT: *On 26 November 1997, the M/V KUROSHIMA went aground in Summer Bay on Unalaska Island, Alaska during a severe windstorm (Figure 1). The vessel released approximately 39,000 gallons of Bunker C fuel oil into the intertidal zone. A portion of this oil was forced into Summer Bay Lake by storm winds and high tides. From the outset of the incident, the trustees and the Responsible Party considered the possibility that oil had been submerged and covered parts of Summer Bay Lake substratum. Therefore, an underwater survey was included as part of the overall spring shoreline cleanup assessment program. This paper focuses on the process of performing an underwater survey as part of a larger cleanup operation. Surveys were conducted by representatives for the State of Alaska and the Responsible Party and incorporated standard Shoreline Cleanup Assessment Technique (SCAT) guidelines (Owens, 1992). The primary objective of these surveys was to locate submerged oil, quantify the amount of oil, and to document the characteristics of the oil. The underwater survey program had two main components; delineation and cleanup assessment for sign-off surveys. The logistics and support needed for performing an underwater survey with SCUBA, methods of navigation above and below the water surface, and the generation of maps for the dissemination of survey results to cleanup personnel are discussed.*

Introduction

Incident summary. On 26 November 1997, the M/V KUROSHIMA was dislodged from its anchorage in Unalaska Bay, near Unalaska, Alaska (Figure 1) during a severe windstorm (winds > 100 knots). Subsequently, the hull of the vessel was punctured on rocks near Second Priest Rock and finally grounded at the southern extent of Summer Bay. A release of approximately 39,000 gallons of Bunker C fuel oil occurred into the intertidal zone. High tides, winds and surf caused a portion of that oil to be driven up Summer Cove Creek and into Summer Bay Lake. The oil mixed with sediment while in the surf and intertidal zone, which increased the density of the oil and the potential for sinking when it entered the freshwater conditions of Summer Bay Lake.

Due to the likelihood that oil would have sunk once entering Summer Bay Lake, Unified Command determined that a survey for submerged oil should be conducted. A plan detailing the proposed methods, products and personnel was developed and subsequently approved by the Unified Command. The objective of the survey was to visually inspect the bottom of Summer Bay Lake on predetermined transects using SCUBA divers and to identify any submerged oil using a modified form of the Shoreline Cleanup Assessment Technique (SCAT). The results of this survey would be used to target specific areas requiring underwater cleanup operations.

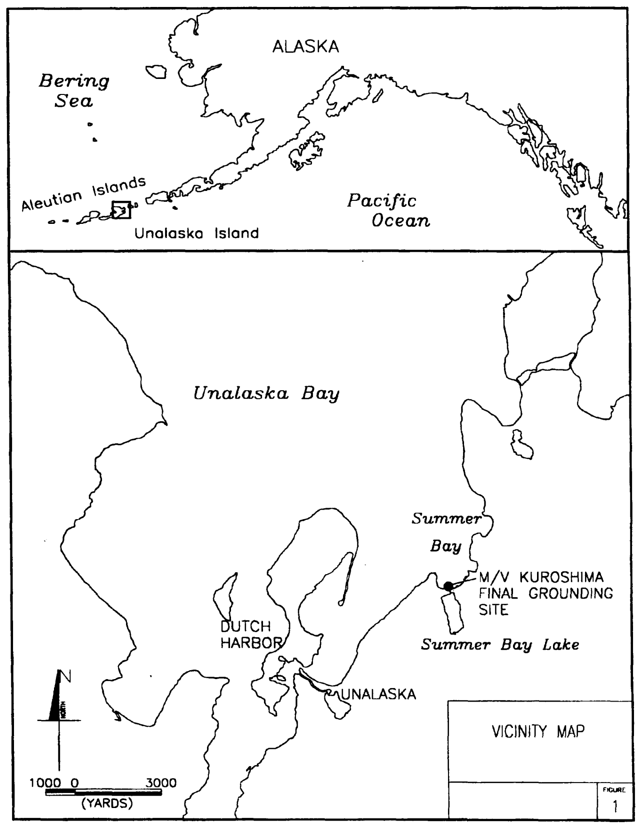

Figure 1.

Cleanup operations were initiated immediately following the grounding in late November 1997. Due to the extreme winter weather conditions and the freezing of Summer Bay Lake, cleanup operations were suspended on 5 January 1998 and resumed in early April 1998. The underwater delineation survey was conducted during between the 6th and 25th of April 1998 while shoreline cleanup operations were conducted. Cleanup of the submerged oil began on 5 May 1998 and continued through 20 May 1998. The underwater cleanup assessment survey was conducted from the 12th through the 19th of May 1998 with signoff occurring on the 20th of May 1998.

Geographic Setting. Summer Bay Lake is approximately 4,700 feet (1430 meters) long and 2,100 feet (640 meters) wide. Its long axis trends in a generally north - south direction. A creek enters the lake at the southwest. The lake discharges to Summer Bay at the northeast corner. The bottom topography of Summer Bay Lake was discovered to be gently sloping and shallow at the northernmost reaches of the lake. At approximately 300 feet (100 meters) south of the north shore, there is an increase in the slope at -10 feet (-3 meters) and the bottom drops to between -20 and -30 feet (-6 and -10 meters) deep. It remains this deep with relatively low relief dynamics until the southernmost few hundred feet where it begins gently sloping up to the shore. The bottom substrate was predominantly silty sand with areas of freshwater green algae. The lake temperature was 34° Fahrenheit (1° C). Weather conditions during the survey ranged from calm and sunny to winds blowing in excess of 50 knots and snowing.

Objectives. The entire scope of the survey included multiple tasks. First was to perform a delineation survey to determine general areas where submerged oil was most likely to be present. Based on the findings of this survey, the second task was to add additional transect lines or to perform a more detailed survey effort to better define the quantity and extent of oiling. The third task was to identify and delineate the areas that required cleanup with sufficient accuracy of location to expedite cleanup operations. The fourth task was to perform a cleanup assessment survey to determine the effectiveness of cleanup and document that the cleanup criteria were met. The observations during the surveys needed to be performed in a consistent manner and be able to be related to standard SCAT terminology and guidelines.

In addition to simply performing the survey, the divers' observations needed to be accurately mapped and the data available for immediate review. On land, position and location data (latitude/longitude and landmarks) are simple to record and provide to the cleanup operator; underwater, position and location data are more difficult to determine and report. These tasks required a combination of a Differential Global Positioning System (DGPS) and an acoustic underwater navigation system to determine precise position information for the divers and submerged oil. Data recorded by these systems were post-processed in the office and the divers' survey observations were synchronized to the navigation data before being inserted into AutoCAD software for the generation of maps. Underwater video was taken and correlated to position data.

Methods

Navigation. Navigation to determine the position of divers and location of transect lines was an integral component to the success of the survey and was performed with two different methods. The first was the use of a DGPS. Using differentially corrected GPS signals was necessary during this incident for two reasons: first, the government induced error (Selective Availability) was still in effect during the incident therefore uncorrected GPS signals would not provide the qualitative position information required. Secondly, position accuracy increased from over 80 feet (25 meters) to within 6 – 9 feet (2 – 3 meters) with the use of DGPS. Even with the selective availability removed, DGPS provides enhanced positioning.

The lack of a United States Coast Guard maintained differential navigation beacon required that a GPS base station be established on a City of Unalaska survey monument at the north end of the lake. This station broadcast GPS correction values via radio modem to the mobile DGPS receiver used by the survey team. The GPS systems used were Motorola LGT 1000 units equipped with a differential receiver used was a Starlink MRB-2A MSK differential receiver.

The DGPS did not provide the divers with real-time navigation information, rather it recorded the diver's locations as the divers navigated using bathymetry and compass bearings. This approach involved placing a GPS receiver with internal recording capabilities and radio modem receiver on a 1-foot diameter floating platform. At the beginning of a transect, the dive tender enabled the DGPS receiver to start recording. The dive team then towed the DGPS platform as they swam the transect. When the transect was completed the dive tender terminated the recording process. This system was used for the three transects that ran the length of the lake and the four transects that ran across the lake.

A Dive Tracker Acoustic Navigation System (DTS) manufactured by Desert Star provided the diver with precise along-transect position information for underwater navigation. The DTS operates by placing three acoustic transponders at known locations on the bottom of the lake. The positions of the transponders were established relative to real world coordinates by use of the DGPS system. One of the divers carried a DTS Diver Unit that consisted of a waterproof computer and sonar transducer. The DTS unit calculated the position of the diver by triangulation of ranges to the transponders and record this position with a time stamp in memory. The DTS Diver Unit was also used to record information regarding sediment type, oil distribution and water depth. Positions were accurate to within 3 feet (1 meter) with this system. The DTS system had a maximum working range of 3300 feet (1000 meters). The DTS was utilized for active navigation by the dive team on the east - west transects at the north end of the lake and the north - south transects in the southeast corner of the lake.

Products – maps and video. All observations made by the divers and navigation information were mapped using AutoCAD software at the end of each days field efforts. Observations made by the divers while using the DGPS mode of navigation required manual transcribing and coordination with the navigation information prior to mapping. The data collected with the DTS Diver Unit were downloaded and mapped. Maps were created that depicted the transect lines surveyed, distribution of oiling, defined areas of cleanup, and cleanup assessment survey transect lines. Underwater video was taken along all transects during the delineation and cleanup assessment surveys. The video was time stamped to correlate with the navigation. It was necessary for the divers to synchronize their dive watches and the underwater video camera's time stamp with the DGPS system in order to precisely map observations and provide video footage on underwater conditions for specific locations of the lake.

Support. The two divers were supported in the field by a single dive tender who also acted as a backup diver. On-water operations were conducted from a 14-foot john boat. The dive crew used a 20-foot conex container as a base of operations and for shelter from adverse weather conditions.

Surveys

The shoreline cleanup assessment technique (scat) utilized by divers. To maintain a consistent approach in making observations and to be meaningful to the Unified Command and cleanup operators, the SCAT process (Owens, 1992) was modified for use by divers in an underwater environment. Due to the physical limitations of diving and the uniformity of the area being surveyed, the divers focused solely on documenting the distribution and type of oil. The characterization of submerged oil was described every 20 to 50 feet along each transect or whenever the oil distribution or type of oiling changed. The divers were able to characterize conditions in 25 foot (7.5 meter) swaths. To follow the consistency of the SCAT process, oiling distribution was broken into five categories:

1. No Oil – 0% coverage,
2. Very Light or Sporadic - <10% coverage,
3. Light – 11% to 30% coverage,
4. Moderate – 31% to 50% coverage, and
5. Heavy – 51% to 100% coverage.

Physical characteristics of the oil were also recorded. The standards the divers used when describing the amount and type of submerged oil followed these guidelines: tarballs were considered to be <1" to 6" in diameter, tar patties were considered to be 6" to 1' in diameter and tar mats were greater than 1' in diameter.

Delineation survey. The assessment for submerged oil was conducted during the delineation survey and an emphasis was placed on the assessment for submerged oil in the northern portion of the lake. The delineation survey was conducted between 6 April and 25 April 1998 by divers representing the Responsible Party and the trustees (Alaska Department of Environmental Conservation). Predetermined transects were established in the north section of the lake as well as the east and west shorelines and center (lengthwise) of the lake (Figure 2). The northern section of the lake was divided into transects with a spacing of 50 feet running east to west. These transects began at the north shoreline and extended south to a distance of 300 feet. In response to the survey teams findings of submerged oil, Unified Command requested additional transects be added. Six transects spaced 50 feet apart in the north end of the lake, continuing from the planned transect set at 300 feet to a distance of 600 feet from the north shore were added. In addition four cross-lake (widthwise) transects and 5 transects spaced 50 feet apart in the southeast corner of the lake were surveyed. Once completed, the total delineation survey (6.5 transect miles) was twice as large as the initially planned survey (3.3 transect miles) and identified three main zones for underwater cleanup operations.

Oil distribution and physical characteristics. The greatest concentration of oil, and most extensive amount of oil, occurred in the northwest corner of the lake. The concentrations were only defined as light to moderate (10% - 20% coverage). The remainder of the northern zones had light and scattered distributions of oil (10 % coverage). The southeast zone had areas with 20% oil coverage, but the zone on as a whole had very light oiling (less than 10% coverage). Along the eastern shore, pockets of oil distributions as high as 40% were recorded over short distances (up to 20 feet length).

The majority of the submerged oil had a weathered appearance. The oil had a grey exterior coloring but retained a fresher brown interior. The oil had slightly negative buoyancy. Tarballs disturbed by the divers slowly re-settled to the bottom. Submerged oil was observed as tarballs ranging in size from less than 1 inch up to 6 inches in diameter, tar patties ranging in size from 7 inches to 12 inches in diameter and tar mats, ranging in

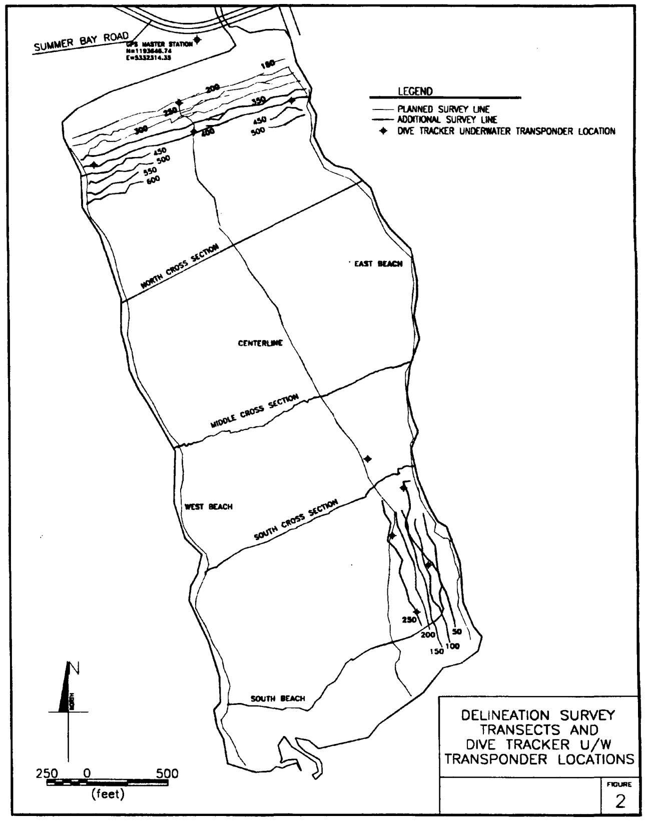

Figure 2.

size from 1 foot to typically 4 feet in diameter (one tar mat was observed to be 5 feet by 12 feet having a thickness of 18 inches). Larger tar patties and tar mats appeared to have been rolled in with freshwater plants. This may have been due to the oil rolling downslope due to gravity or being rolled back and forth due to wave motion and tangling with the vegetation. Sediment from either the beach or lake bottom was also mixed with the oil.

Cleanup. The results of the delineation survey were presented to Unified Command and used to target specific areas that underwater cleanup operations would take place. Due to the harsh environmental conditions the divers were operating in, the expense of an underwater cleanup operation and the desire to remove all significant quantities of submerged oil, the Unified Command identified 10 specific locations for underwater cleanup operations to take place. These areas maximized the quantity of oil recovered and reduced the bottom time of the divers. The Unified Command marked these areas on the maps created during the delineation survey and the dive-survey team was then able to place markers in the lake using the DGPS method of navigating for the cleanup crew to locate the submerged oil.

The northern reaches of the lake, the southeast corner, and alongshore segments of the east bank were targeted as needing oil removal. In the north and southeast these areas were demarcated by either driving rebar into the substratum at the corners and stretching line between the rebar posts or placing a single rebar stake in the center of contamination and indicating a specific search radius. The northwest and southeast areas were also subdivided into smaller sections to assist the cleanup operators perform an efficient operation. Floats were attached to the rebar stakes to provide crews on the surface with a visual reference to the cleanup areas. Along the eastern shore, rebar was placed along shore indicated the northern and southern extents of oiling for 4 specific areas needing cleanup and a swath width was defined. Maps were generated that illustrated these specific cleanup zones and disseminated to cleanup personnel.

The underwater cleanup operations were performed by Global Diving and Salvage of Seattle, Washington between 5 and 20 May 1998. Within the areas demarcated by the dive-survey team, the cleanup operations recovered all tar mats, tar patties and tarball greater than 1 inch in diameter. This effort resulted in the recovery of approximately 17,000 pounds of oil.

Cleanup assessment survey. The cleanup assessment survey was conducted between 12 May and 19 May 1998. The survey was conducted by the same two divers who performed the delineation survey to ensure consistency of observations. The survey documented that the Unified Command criteria of removing all tarballs greater than 1 inch in diameter, all tar patties and tar mats was met. Underwater video was taken during the entire cleanup assessment survey phase for further verification that the criteria were met (Figure 3). The survey zones of Summer Bay Lake were officially signed off as having met cleanup criteria on 20 May 1998.

Conclusion

The conditions during the M/V KUROSHIMA grounding and oil spill were such that oil made its way into Summer Bay Lake and sank. The Unified Command decided that a survey of the lake bottom was necessary to determine the extent of submerged oiling. A delineation survey was conducted between the 6th and 25th of April, 1998. This survey successfully mapped and video-documented the type and extent of submerged oiling in the lake. The results of the delineation survey allowed the Unified Command to designate specific areas that required underwater cleanup operations. These cleanup operations removed approximately 17,000 pounds of submerged oil from areas identified by the dive-survey team. Following cleanup operations, a cleanup assessment survey was conducted between the 12th and 19th of May 1998 to document that the cleanup criteria as set by Unified Command was met. The bottom of Summer Bay Lake was signed off as clean on the 20th of May 1998.

The success of the survey is attributable to the detailed navigation and time stamped observations of the divers. Both the DGPS and the underwater acoustic DTS methods of navigation worked well and complimented each other. The DGPS method worked well for longer, reconnaissance type surveys while the DTS method worked well for shorter, more detail oriented surveys. The commitment of the divers to keep time recorded notes enable the synchronization of their observations to the navigation in order to produce accurate maps of the submerged oiling conditions and to direct cleanup operations efficiently.

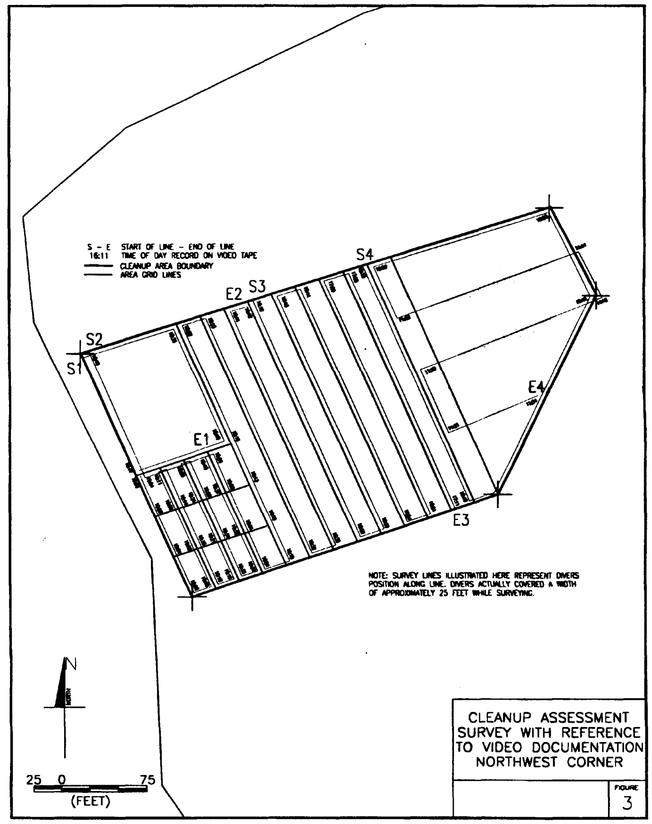

Figure 3.

Biography

Andrew Martin is a Marine Scientist for Polaris Applied Sciences, Inc. with 7 years of experience performing fieldwork in the marine environment. He provides SCAT and scientific support to response and salvage operations and Natural Resource Damage Assessment studies during oil spill and ship grounding incidents. He has experience in sediment, water and biological sampling, geophysical surveys, physical oceanographic studies and CAD/GIS support.

References

1. Owens, E.H. 1992. A Summary of the SCAT Process for Shoreline Oil Spill Response. *Proc. Seminar on Physical Recovery of Spills*: Region VI, RRT, Eighth USCG District, Corpus Christi, Texas, July 27-28, Session V, 14 pp.