Selected Reports from 2003-2008

Non-indigenous Species

Chemical Dispersants

Environmental Monitoring

Oil Spill Prevention and Response

Valdez Marine Terminal

Other

The purpose of this document is to provide you with a glimpse into the type of work that the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has been doing. This document includes a number of abstracts for recent reports. This is not a complete list of reports, but you may view one at www.pwsrcac.org/resources/reports avail.html

Projecting Range Expansion of Invasive European Green Crabs (*carcinus maenas*) to Alaska: Temperature and Salinity Tolerance of Larvae.

http://www.pwsrcac.org/docs/d0018700.pdf

Anson H. Hines, Gregory M. Ruiz, Natasha Gray Hitchcock, Catherine deRivera, Smithsonian Environmental Research Center. 2004.

Executive Summary

The European Green Crab (*Carcinus maenas*) is a global invader, successfully colonizing many world regions and having significant ecological and economic impacts. The Green Crab colonized western North America in the late 1980s, spreading primarily northward from the initial establishment in San Francisco Bay to several other bays in northern California, Oregon, and Washington. Initial analysis, based largely upon temperature tolerance of postlarval crabs, suggests Green Crabs will continue to spread and become established throughout much of Alaska. However, establishment of self-sustaining populations in Alaska may be restricted by environmental conditions for reproduction and larval development, instead of the broad tolerances of postlarval crabs. Using laboratory experiments, we tested conditions required for successful development of Green Crab larvae. We collected ovigerous Green Crabs from California and Maine, and cultured larval stages under various temperature and salinity conditions, measuring conditions necessary for survival and the length of time required for successful development (i.e., metamorphosis to postlarval crab stage). Our laboratory experiments indicate poor larval survivorship and development at temperatures below 10˚C and salinities below 20 ppt. Based upon temperature-specific development rates, several sites within Prince William Sound and elsewhere in Alaska appear warm enough to support self-sustaining Green Crab populations, even though larval tolerances are more restrictive than those for adult crabs. Coupled with northward natural dispersal and ship-mediated transfer in ballast water, our data indicate Alaska is at risk to invasion by Green Crabs. The extent to which biotic interactions (e.g., competition, predation, etc.) may affect colonization success and population sizes remain unresolved.

Non-indigenous Species

Ballast Water Exchange: Efficacy of treating ships' ballast water to reduce marine species transfers and invasion success?

http://www.pwsrcac.org/docs/d0022600.pdf

Smithsonian Environmental Research Center. November 2005.

Abstract

Biological invasion occurs when species establish self-sustaining populations beyond their historical geographic ranges. Marine invasions have received relatively little attention compared to terrestrial and freshwater communities. Nonindigenous species become numerically dominant in invaded marine communities, just as those elsewhere. They have significant impacts on population, community and ecosystem-level processes.

Oil tankers arriving to Prince William Sound deliver approximately 17 million cubic meters of non-oily ballast water annually. Takers that arrive to Prince William Sound from politically foreign ports are required to undergo mid-ocean ballast water exchange. Most ballast water delivered to Prince William Sound, however, comes from domestic ports, including San Francisco Bay, Long Beach, and Puget Sound. Vessels from ports such as these are requested to voluntarily conduct open-ocean exchange of ballast water before reaching their destination port.

Ships practice two basic types of ballast water exchange that replaces coastal water with ocean water: Flow-Through Exchange, and Empty Refill Exchange. Experiments were done with both types of exchange aboard commercial takers arriving to Port Valdez to quantify the efficacy of ballast water exchange in reducing transfer of coastal organisms.

The study demonstrated that ballast water exchange on oil tankers arriving in Prince William Sound was highly effective, with the empty-refill method being more effective than flow-through method. The efficacy of flow-through is variable dependent upon the configuration of the ballast water tank and how that allows the water to enter and exit.

Broad-Scale Non-indigenous Species Monitoring along the West Coast in National Marine Sanctuaries and National Estuarine Research Reserves.

http://www.pwsrcac.org/docs/d0021300.pdf

Smithsonian Environmental Research Center, the National Estuarine Research Reserve System (NERRS) and the National Marine Sanctuary Program (NMSP). 2005.

Executive Summary

Nonindigenous species have caused substantial environmental and economic damage to coastal areas. Moreover, the extent and impacts of nonindigenous species are increasing over time. To develop predictive models and to identify which areas should be targeted for impact mitigation or early detection, we need a basic foundation of knowledge about the spatial and temporal patterns of invasions. This project was developed because we lacked the necessary data to rigorously evaluate the patterns of coastal invasions. This collaborative project, between the Smithsonian Environmental Research Center, the National Estuarine Research Reserve System (NERRS) and the National Marine Sanctuary Program (NMSP), established a rigorous, large scale monitoring and research program for invasive species in nine protected coastal areas along the US West Coast from San Diego, CA, to Kachemak Bay, AK. Our research included two components, broad-scale and site-specific projects.

The broad-scale component focused on using standardized protocols to collect data on the composition of fouling communities and nearshore fish and crabs. We collected data from 310 settling plates and 140 traps across nine NERRS Reserves and NMSP Sanctuaries. The four most common taxa on the settling plates were Bryozoa, Tunicata, Cirripedia, and Hydrozoa. We identified these four taxa and also Nudibranchia, a mobile molluscan taxa often associated with fouling organisms, to species and noted which were nonindigenous. We found 132 species in the 5 taxa under study. NIS accounted for over one quarter of the diversity in these taxa, with 31 NIS identified. Over half of tunicate species were non-native. The documented NIS included two new US west coast sitings plus 3 other range extensions. We documented two patterns in

NIS, a latitudinal pattern and differences between NIS impacts in marinas versus non-marina sites; research on salinity differences is still underway. Both the number and percent of NIS decreased with increasing latitude. Tijuana River had the most, 21, NIS and Monterey Bay had the highest proportion of NIS (57%). The same pattern of decreasing NIS with increasing latitude was observed when we examined Tunicata only and Bryozoa only. Across latitudes, plates in marinas were more impacted by NIS than were plates in more natural areas. All NIS but one were found at marinas, whereas only half the NIS were found at the non-marina sites. In addition, NIS at marinas accounted for almost 80% of the NIS per site. Therefore, we were able to provide information on the relative risk of invasions for different taxonomic groups and geographic regions. The spatial and habitat patterns can be used for future predictions and will be of even more value once they are confirmed with additional taxonomic groups and hypothesis-driven studies that will continue from this initial study. Our broad-scale trapping study illustrated how recently-introduced NIS quickly can become numerically dominant. Although we only found *Carcinus maenas* at Elkhorn Slough NERR, this recently introduced nonindigenous crab was very common at this Reserve and was the most abundant crab in our traps at 3 of 7 Elkhorn sites.

The site-specific projects were conducted at each Reserve plus Olympic Coast and Monterey Bay Sanctuaries. Several are serving as the first important step in longer term research, such as examining whether a change in shipping policy in Kachemak Bay will increase NIS. Others, such as the South Slough project examining the effect of a salinity cline on the number and proportion of NIS, will be expanded to test hypotheses across several protected areas. Many of these site-specific projects still need further analyses, and analysis is underway.

Non-indigenous Species

Biological Invasions in Alaska's Coastal Marine Ecosystems: Establishing a Baseline.

http://www.pwsrcac.org/docs/d0032100.pdf

Gregory M. Ruiz, Smithsonian Environmental Research Center, et. al. 2006.

Executive Summary

Biological invasions are a significant force of change in coastal ecosystems, altering native communities, fisheries, and ecosystem function. The number and impact of non-native species have increased dramatically in recent time, causing serious concern from resource managers, scientists, and the public. Although marine invasions are known from all latitudes and global regions, relatively little is known about the magnitude of coastal invasions for high latitude systems.

We implemented a nationwide survey and analysis of marine invasions across 24 different bays and estuaries in North America. Specifically, we used standardized methods to detect non-native species in the sessile invertebrate community in high salinity (>20psu) areas of each bay region, in order to control for search effort. This was designed to test for differences in number of non-native species among bays, latitudes, and coasts on a continental scale. In addition, supplemental surveys were conducted at several of these bays to contribute to an overall understanding of species present across several additional habitats and taxonomic groups that were not included in the standardized surveys.

Our standardized surveys included six different bay regions in Alaska: Ketchikan, Sitka, Prince William Sound, Kachemak Bay, Kodiak, and Dutch Harbor. Supplemental surveys were conducted primarily at Kachemak Bay and Kodiak, and an additional low-salinity site in Cook Inlet near Anchorage.

In this report, we report our findings for these sites and compare them to six other bays surveyed along western North America, between California and Washington.

Workshop Report on Testing of Ballast Water Treatment Systems: General Guidelines and Step-wise Strategy Toward Shipboard Testing

http://www.pwsrcac.org/docs/d0028400.pdf

GM Ruiz, GE Smith, & M Sytsma, Aquatic Bioinvasion Research and Policy Institute. 2006.

Preface

We held a workshop on 14-16 June 2005 to review strategies for shipboard evaluation of BWT systems. The overall objective of the workshop was to develop consensus recommendations and general guidelines for a standardized approach to shipboard evaluation, including groundwork leading up to full-scale testing.

Workshop participants were selected to include experts in many areas of ballast water research, toxicology, experimental design, ship operations, and biology/ecology of particular groups of organisms, including bacteria, protists, and zooplankton. Participants included mostly research scientists who were familiar and actively involved in the ballast water issue. Most participants were from the United States, but the workshop also included experts from Canada, Japan, Singapore, and UK.

The workshop was not a venue to examine or discuss specific technologies. Speakers were not invited to present technology-specific information or input. Our intent was to be technology-neutral in considering standard approaches to evaluating the performance of BWTs aboard ships.

This report provides a synthesis of information from the workshop presentations and discussions, exploring many key issues in testing BWT. Although the primary focus of the workshop was intended to be shipboard testing, the role of scale and when to conduct shipboard tests was a central theme. Thus, the output of this workshop includes explicit consideration of both scale and experimental approach, in establishing general guidelines for treatment testing.

Potential for Photoenhanced Toxicity of Spilled Oil in Prince William Sound and Gulf of Alaska Waters

http://www.pwsrcac.org/docs/d0002100.pdf

Mace Barron. March 2000.

Abstract

This report examines the potential for photoenhanced toxicity of spilled oil in Prince William Sound and associated Gulf of Alaska waters. Photoenhanced toxicity is the increase in the toxicity of a chemical in the presence of ultraviolet light (UV), compared to a standard laboratory test conducted with fluorescent lighting (minimal UV). Oil products and weathered oil are phototoxic, as are specific polycyclic aromatic compounds present in oil. Photoenhanced toxicity may occur through two processes: photomodification and photosensitization, which are further detailed in the report. No studies have investigated the photoenhanced toxicity of oil in Alaska waters. Although there are substantial uncertainties, the results of this evaluation indicate there is potential for photoenhanced toxicity of spilled oil in Prince William Sound and associated Gulf of Alaska waters. Additional research needed to characterize the potential for photoenhanced toxicity may include determining the seasonal and spatial variability in UV irradiance of the habitats of potentially exposed organism. Doseresponse studies could be performed to establish UV and oil exposure thresholds necessary for photoenhanced toxicity. Additionally, the phototoxicity of chemically dispersed oil could be evaluated in the laboratory and compared to the photoenhanced toxicity of non-chemically dispersed oil.

The Effectiveness of Corexit 9527 and 9500 in Dispersing Fresh, Weathered, and Emulsion of Alaska North Slope Crude Under Subarctic Conditions.

http://www.pwsrcac.org/docs/d0001400.pdf

Adam Moles, Larry Holland, and Jeffrey Short. April 2001.

Abstract

The effect of various states of weather: no weather, 20% evaporatively weathered, and emulsification on the effectiveness of oil dispersants Corexit 9527 and Corexit 9550 in dispersing Alaska North Slope Crude oil into the water column was tested at a combination of realistic subarctic salinities and temperatures. A modified version of the swirling flask effectiveness test was conducted at temperatures of 3, 10 and 22˚C with salinities of 22% and 32%. Petroleum dispersed into the water column following application of dispersant was measured by gas chromatography with FID detection. Results showed dispersants dispersed less than 40% of the fresh oil, none of the weathered oil, and were most effective when used to disperse a stable oil/water emulsion at 10˚C. At the combinations of temperature and salinity most common in the estuaries and marine waters of Alaska, the dispersants were largely ineffective (<10% effective, the detection limit of the tests) at dispersing fresh or weathered Alaska North Slope crude oil in laboratory tests.

A White Paper on Oil Spill Dispersant Effectiveness Testing in Large Tanks

http://www.pwsrcac.org/docs/d0001700.pdf

Merv Fingas, Environment Canada. November 2002.

Abstract

This white paper is a perspective on testing the effectiveness of oil spill dispersants in large tanks. Literature that relates to testing methodology is reviewed.

The following are 17 critical factors that need to be considered and included in any test for measuring the effectiveness of dispersants in a tank in order for that test to be valid. These factors are reviewed in this assessment.

1. Mass balance
2. Proper controls
3. Analytical method
4. Differential plume movement
5. Time lag and length of time plume followed
6. Mathematics of calculation and integration
7. Lower and upper limits of analytical methods
8. Thickness measurement
9. Behaviour of oil with surfactant content
10. Surfactant stripping
11. Recovering surface oil
12. Background levels of hydrocarbons
13. Fluorescence of dispersant
14. Herding
15. Heterogeneity of the oil slick and the plume
16. True analytical standards
17. Weathering of the oil
18. Temperature and salinity

Procedures are given that take into account lessons learned during the detailed work conducted at the Imperial Oil tank in Calgary, Alberta and the SERF tank in Corpus Christi, Texas. These procedures will make it possible to reasonably estimate the effectiveness of dispersants in a large test tank.

Chemical Dispersants

A Review of Literature Related to Oil Spill Dispersants Especially Relevant to Alaska.

http://www.pwsrcac.org/docs/d0002700.pdf

Merv Fingas, Environment Canada. March 2002.

Abstract

This paper is a review of the literature on oil spill dispersants published from 1997 to January, 2002. As in the literature before this time period, it was found that results are often contradictory from one study to another. The paper also identifies and summarizes recent advances in dispersant effectiveness, toxicity, and application technology.

The results of the review indicate that dispersant effectiveness continues to be a major issue and is unresolved for Alaska North Slope (ANS) crude oil. Results of one recent dispersant effectiveness study for moderate-energy apparatus demonstrate dispersant effectiveness values ranging from 5 to 15% for ANS crude oil. This study was conducted at water salinities and temperatures known to occur in Alaskan waters, specifically Prince William Sound. High-energy tests such as the MNS, IFP, and EXDET demonstrate higher dispersant effectiveness results; however, the temperatures and salinities used are outside the range of those known for Prince William Sound. New studies question the high values of such tests. Large-scale testing and field tests show effectiveness values that are fractions even of the moderate-energy tests.

Since 1997, there have been numerous studies on the toxicity of oil and dispersed oil. Many of these indicated that the acute toxicity of chemically dispersed oil and physically (naturally) dispersed oil is different for different marine test species. In most of the cases, the chemically dispersed oil is somewhat more toxic than the physically dispersed oil. Studies of the food chain indicate that dispersed oil is more likely to result in the passing of naphthalene through the food chain. Similarly, body burdens of PAHs vary depending on the marine species and whether the oil is naturally or chemically dispersed.

There is little new in operational matters regarding application of dispersants. The finding that Corexit 9500 is much less effective on thick oil slicks when applied diluted with water than when applied neat is, however, significant.

A review of legislation shows that there are no significant changes in dispersant use policy in North America or Europe. There are only eight documented cases of dispersant use in the literature during this time period. One of these is in Nigerian waters, one in Australia, one in Israel, one in Venezuela, one in Britain, and the other three are in the U.S.

Photoenhanced Toxicity of Aqueous Phase and Chemically-Dispersed Weathered Alaska North Slope Crude Oil to Pacific Herring Eggs and Larvae.

http://www.pwsrcac.org/docs/d0002200.pdf

Mace Barron, Mark Carls, Jeffrey Short, Stanley Rice. February 11, 2002.

Summary

Most of the available data on the toxicity and risks of oil and chemically-dispersed oil have been derived from laboratory studies that do not incorporate exposures to the ultraviolet radiation (UV) that occurs in aquatic environments. UV is a component of sunlight, but is not visible to humans. UV contains light energy that can be absorbed by specific components in oil, including PAHs (polycyclic aromatic hydrocarbons). Photoenhanced toxicity has recently been reviewed in an RCAC sponsored study, and is now published in the scientific literature (Barron and Ka'aihue, 2001). The UV that is present in aquatic environments includes UVB (280 to 320 nm) and UVA (320 to 400 nm), where a nanometer (nm; 1 billionth of a meter) is a measure of the specific wavelength of sunlight. Understanding photoenhanced toxicity is important because petroleum and weathered oil is known to be phototoxic, exhibiting a two to greater than 1000 fold increase in toxicity in the presence of UV compared to standard laboratory lighting conditions with fluorescent lights and minimal UV. The photoenhanced toxicity of Alaska North slope crude (ANS) to Alaskan fish species has never been determined, and the potential for photoenhanced toxicity of chemically-dispersed ANS has not been previously evaluated in any species.

This study investigated the photoenhanced toxicity of weathered ANS to eggs and larvae of the Pacific herring (Clupea pallasi), and the relative toxicity of chemically-dispersed and aqueous phase oil. Aqueous phase oil is the portion of petroleum that dissolved or accommodated into the water used in toxicity tests. Herring are ecologically and economically important in Prince William Sound and Gulf of Alaska waters, and are known to be sensitive to ANS at concentrations as low as 0.4 ug/L (parts per billion) of total PAHs (tPAH; sum of all individual PAHs that were quantified). Herring were exposed to a series of aqueous phase doses prepared with high energy mixing of ANS with the chemical dispersant Corexit9527 either present or absent. Corexit[R] 9527 is the chemical dispersant stock piled in Prince William Sound for possible use in oil spill responses. Herring eggs (a few days after fertilization) and larvae (a few days after hatching) were exposed to a combination of oil, dispersant, and UV treatments in the laboratory, with some UV exposures occurring outdoors in sunlight.

Report on Visit to OHMSETT to Observe Exxon/MMS Cold-Water Dispersant Tests.

http://www.pwsrcac.org/docs/d0001500.pdf

By Stan Jones, PWSRCAC. March 2002.

Summary

This report gives an account of Cold-Water Dispersant tests that took place at the Oil and Hazardous Materials Simulated Environmental Test Tank in Leonardo, New Jersey in March of 2002.

It discusses the way in which the tests were conducted, including what kinds of equipment was used and the results of those tests. The report also includes photographs.

A White Paper on Oil Spill Dispersant Field Testing

http://www.pwsrcac.org/docs/d0001900.pdf

Merv Fingas, Environment Canada. May 2002.

Abstract

This white paper is a perspective on the field testing of the effectiveness of oil spill dispersants. All field tests conducted to date are briefly reviewed and literature that relates to testing methodology.

Twenty-five considerations on the field testing of dispersants were discussed. Each of these

Chemical Dispersants

factors are important to the appropriate outcome of the dispersant field experiment. Important factors are the ability to determine a mass balance, use proper controls, analytical methods and to avoid procedures that will result in incorrect results.

Experimental design is discussed throughout this paper. Two experimental designs that are noted as very poor and would result in very large errors are described. The first one, the measurement of surface oil remaining after dispersant application on oil contained in the boom given that currents/waves are near the critical loss velocity. The second experiment that results in very large errors is the integration of dispersed oil under the slick.

Two experiments that could yield useful results are summarized. The first is a steady-state discharge of oil and dispersant in constant current. The second is an experiment where the concentration of oil in the water column after 24 hours is used to define effectiveness.

This report points out the technology and understanding that is necessary to conduct an accurate dispersant field test. There are many nuances; however these revolve around good chemistry, physics and understanding of the process involved.

Field Notes and Critical Observations from the OHMSETT Heavy Oil dispersant Trials, October 13-16, 2003

http://www.pwsrcac.org/docs/d0032200.pdf

James R. Payne, Ph.D., Payne Environmental Consultants, Inc.

Introduction

This report contains the transcriptions of tape-recorded notes and observations completed by Dr. James Payne during a PWS RCAC-sponsored field audit of the 13-16 October 2003 heavy fuel oil dispersant tests completed by SL Ross and Alun Lewis Consultancy at the MMS OHMSETT facilities in Leonardo, New Jersey. The draft report delivered to PWS RCAC in October 2003 contained initial observations only and figures were supplied as separate files on compact disk. This final report contains all the time/date-stamped figures referenced in the earlier report along with additional data from SL Ross that were not available at the time the original report was prepared.

Appendix A: Figures and Photo Documentation
Appendix A pages 1-50 http://www.pwsrcac.org/docs/d0032300.pdf
Appendix A pages 51-100 http://www.pwsrcac.org/docs/d0032400.pdf
Appendix A pages 101-150 http://www.pwsrcac.org/docs/d0032500.pdf
Appendix A pages 151-178 http://www.pwsrcac.org/docs/d0032600.pdf
Appendix B: SL Ross/OHMSETT Operating Plan
http://www.pwsrcac.org/docs/d0032700.pdf

Critical Evaluation of CROSERF Test Methods for Oil Dispersant Toxicity Testing under Subarctic Conditions

http://www.pwsrcac.org/docs/d0002400.pdf

Mace G. Barron, P.E.A.K. Research. January 29, 2003.

Executive Summary

The Alaska Region Oil and Hazardous Substance Pollution Contingency Plan requires that decisions regarding chemical dispersants use in oil spill response in Alaska consider the potential impacts of chemically dispersed oil, including the toxicity to aquatic organisms. This review critically evaluates the aquatic organism toxicity testing protocols developed by the Chemical Response to Oil Spills: Ecological Research Forum (CROSERF) for applicability to assessing chemical dispersant toxicity under subarctic conditions. CROSERF was established as a working group of industry, government, and university scientists to coordinate and disseminate research on chemical oil spill dispersants. CROSERF participants developed aquatic toxicity testing protocols during 1994 to 2000 with the foremost objective of standardizing test methods and reducing inter-laboratory variability. A number of refinements are recommended to adapt the CROSERF protocols for testing with subarctic species under conditions of expected longer oil persistence. Recommendations were focused on providing toxicity test data most relevant to risk management decisions regarding dispersant use in subarctic environments, rather than the primary CROSERF objective of standardizing procedures. Recommended refinements of the CROSERF protocols include (1) testing both a fresh and moderately weathered oil under conditions of moderate mixing energy, (2) testing both Corexit 9500 and 9527 using a high dispersant:oil ratio, (3) preparing toxicity test solutions using variable dilutions rather than variable loading, (4) using static exposures in open chambers, (5) increasing the duration of tests from 4 days to 7 days to allow assessment of delayed mortality, (6) quantifying approximately 40 polycyclic aromatic hydrocarbons (PAHs) and their alkyl homologs (i.e., predominant petroleum PAHs) in the toxicity test solutions, (7) testing Pacific herring larvae, an urchin species, and a calanoid copepod under subarctic conditions of temperature and salinity, (8) assessing the potential for photoenhanced toxicity by incorporating a limited exposure to sunlight or simulated natural sunlight, and (9) incorporating a bioaccumulation endpoint by measuring PAH accumulation in copepod tissue. Refinements in the preparation of oil dosing solutions, exposure and light regimes, and analytical chemistry should increase the utility of the test results for interpreting the toxicity of chemically dispersed oil and making risk management decisions regarding dispersant use under subarctic conditions.

Chemical Dispersants

Review of Monitoring Protocols for Dispersant Effectiveness

http://www.pwsrcac.org/docs/d0001800.pdf

Merv Fingas, Environment Canada. August 2003.

Abstract

This paper is a review of field monitoring of the effectiveness of oil spill dispersants. The purpose of monitoring is to determine if a dispersant application was relatively effective or not. The most common protocol now is the NOAA SMART monitoring protocol. The protocols currently consist of visual criteria and

often include a surface monitoring program consisting of using in-situ fluorometers to gauge the relative effectiveness of a dispersant application. This report points out that there are many false positives and false negatives with both monitoring techniques. These can be overcome by paying attention to the science and technology. Twenty-eight considerations related to the monitoring of dispersants are discussed.

Monitoring by visual or fluormeter means can only yield an estimate of the relative effectiveness of a dispersant application. Specifically, the monitoring produces an estimate of whether the effectiveness of an application is ineffective or somewhat effective. The methods described in this report cannot give degrees or percentages of effectiveness.

It is recommended that a screening test of the dispersant effectiveness be carried out before any test application of the dispersant. This test should show a dispersion of about one-half of the oil. It is suggested that the prime monitoring technique for actual dispersant application is visual. Extensive work is required to produce visual monitoring guidelines and visual aids.

Assessment of the Phototoxicity of Weathered Alaska North Slope Crude Oil to Juvenile Pink Salmon

http://www.pwsrcac.org/docs/d0002300.pdf

Mace G. Barron, P.E.A.K. Research. December 2, 2003.

Executive Summary

Alaska North Slope (ANS) crude oil is known to have greater toxicity to aquatic organisms in the presence of ultraviolet radiation (UV) compared to toxicity determined in tests performed under standard laboratory lighting with minimal UV. This photoenhanced toxicity of ANS crude oil has only been demonstrated in small translucent organisms, including shellfish embryos, larval and juvenile crustaceans, and larval Pacific herring. Pink salmon are known to be sensitive to ANS crude oil toxicity when chronically exposed as embryos, but in the environment the eggs are shielded from UV during development. Fry and juvenile life stages of pink salmon may be exposed to UV during emergence and migration to the ocean, but their sensitivity to phototoxicity has never been reported. The objective of this study was determine if weathered ANS crude oil would be phototoxic to juvenile pink salmon under conditions of short-term exposures to high levels of oil that may occur during an oil spill, and environmentally relevant levels of UV in natural waters.

Two toxicity tests were performed to determine whether ANS crude oil was likely to be phototoxic to juvenile pink salmon. In Test 1, two separate groups of juvenile pink salmon were assessed that differed in oil exposure in the parental generation to evaluate susceptibility that may be attributed to heritable changes caused by prior oil exposure. Test 1 fish were exposed to several water concentrations of oil followed by exposure to sunlight UV in clean water. Toxicity was evaluated by monitoring mortality and behavioral impairment. In Test 2, a single high oil concentration was evaluated with sunlight UV exposure during the oil exposure. In addition to mortality and

Chemical Dispersants

behavioral observations, fish gills were assessed for indications of sublethal tissue damage because gills are the most likely site of action for phototoxicity in pigmented juvenile fish.

Fish in the highest treatments of both Tests 1 and 2 exhibited melanosis (darkening of pigment), less mobility, reduced startle response, erratic swimming, and loss of equilibrium. These responses were typical of the acute narcotic toxicity of petroleum. Gills from fish in Test 2 had elevated levels of hydroperoxides in oil-only, UV-only, and oil+UV treatments compared to control fish, which was indicative of increased lipid peroxidation in gill tissue. There was no indication of photoenhanced toxicity as assessed by elevation of mortality, behavioral impairment, or gill lipid peroxidation in oil+UV treatments.

The results of this study indicate that pink salmon are at less risk from photoenhanced toxicity compared to early-life stages of several other Alaska species. Phototoxicity could occur under conditions of higher UV exposure, but additional research is not currently recommended as a high priority.

Weather Windows for Oil Spill Countermeasures

http://www.pwsrcac.org/docs/d0002500.pdf

Merv Fingas, Environment Canada. January 2004.

Abstract

Oil spill countermeasures are affected by weather such that, in some cases, these countermeasures cannot continue under adverse weather conditions. A literature review was carried out to determine if there were data related to the performance of all countermeasure techniques under varying weather conditions. Although the literature did not provide any quantitative guides for the performance of countermeasures under varying weather conditions, data could be extracted to enable assessment of changes in their performance related to weather conditions. Many estimates or traditional limits are found in the literature, but these vary considerably and may not be useful.

Wind and wave height are the most important factors influencing countermeasures. These two factors are related and, given sufficient time for the sea to become 'fully-arisen', can be inter-converted. These factors must sometimes be considered separately, however, so that specific weather effects can be examined. Other weather conditions affecting countermeasures include currents and temperature. Currents are the critical factor for certain countermeasures such as booms. Temperature primarily affects the performance of dispersants and has been shown to have only minimal effect on other countermeasures. Formation of ice, however, is a problem with most countermeasures.

The effects of weather on other countermeasure methods have been summarized.

Heated Oil and Under-Reported Dispersant Volumes Mar MMS/Exxon Cold Water Dispersant Tests at Ohmsett

http://www.pwsrcac.org/docs/d0001600.pdf

PWSRCAC. July 2004.

Executive Summary

The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has recently discovered that the ANS crude oil used in most of the 2002 Dispersant Effectiveness Tests in Cold Water conducted at Ohmsett was heated far above ambient water temperature (32 degrees F) immediately before being dispersed with Corexit 9527 and 9500. This heating (as high as 115 degrees F) was not identified in the Final Report but was only recently discovered in handwritten daily test logs.

The 2003 Final Report and daily test logs do not record any oil temperatures whatsoever. However, in a video clip, weathered ANS crude oil is shown being distributed at a viscosity that indicates that it is far above ambient water temperature.

In addition to the unreported oil heating, the Dispersant-to-Oil Ratios (DORs) reported in the 2002 Final Report account for only 40% of the dispersant shown in the daily test logs to actually have been used in the tests. This underreporting of dispersant volumes continued in the 2003 Cold Water Tests.

Currently, MMS is using these same protocols to correlate "indirect" observations of dispersant effectiveness in field trials with "direct" observations in their test tank.

Dispersants, Salinity and Prince William Sound

http://www.pwsrcac.org/docs/d0002000.pdf

Merv Fingas, Environment Canada. December 2004.

Abstract

This paper is a summary of the effects of water salinity on chemical dispersion, especially those effects related to effectiveness. Surfactants are the active ingredient in dispersants. The surfactant is more lipophilic, or oil-loving, in freshwater and increases in hydrophilicity (or water-loving) as the salinity rises. The stability of the resulting droplets is also dependent on salinity. This is due to the increasing ionic strength of the water as salinity rises. As the salinity rises above a certain point, which depends on the particular type of surfactant, this increased force results in more surfactant molecules leaving the oil drop entirely. While the theoretical possibility of freshwater dispersants exist, the stability of dispersions in less saline waters would be less.

This report reviews several older dispersant tests. Data from these tests were separated from more recent data because older testing procedures and analytical methods are not as accurate as today's methods. Newer testing is reviewed as well. This testing is marked by the use of analysis by chromatography and very strict

protocols in operating the dispersant tests themselves. These tests are marked by having standard deviations less that 10% and often less than 5%.

The conclusions are discussed in this report

A Survey of Tank Facilities for Testing Oil Spill Dispersants

http://www.pwsrcac.org/docs/d0021700.pdf

Merv Fingas, Environment Canada. May 2005.

Abstract
This report is a survey of tank facilities that could be used for testing oil spill dispersants. The report begins with considerations for tank testing, followed by a list of requirements for tank testing, and data is then provided on a number of potential tanks.

There are many issues related to conducting dispersant tests in large tanks. These have been detailed in previous studies and are summarized in this report.

In compiling this report, a survey of tanks was carried out. Most of the information came from the Internet or by contacting individuals. The tanks that were found to meet most of the criteria are the Texas A&M SERF tank at Corpus Christi and, to a lesser degree, the new EPA/BIO tank at Dartmouth, Nova Scotia.

Sixty tanks are listed in this report. The most significant ones are listed and summarized and the tanks of particular interest are noted. Caution must be exercised in using any of these tanks as there may be extensive work and cost in establishing mass balances, wave energy studies, and procedures to clean the tank or replace the water.

A Review of the Emulsification Tendencies and Long-term Petroleum Trends of Alaska North Slope (ANS) Oils and the "White Paper on Emulsification of ANS Crude Oil Spilled in Valdez."
http://www.pwsrcac.org/docs/d0024800.pdf

Merv Fingas, Environment Canada. August 2005.

Abstract
This paper reviews three topics: the potential for formation and the stability of water-in oil states (emulsions) of Alaska North Slope (ANS) oils, the change in the lightness or heaviness of these oils, and the report prepared by S.L. Ross Environmental Research Ltd. on these first two topics.

A review of the emulsification of Alaskan North Slope oils shows that these oils do not typically form entrained water-in-oil or stable emulsions. After weathering, however, many of these oils will form meso-stable emulsions, which are not as stable and have a lifetime of less than 3 days.

Overall, it is concluded that both the potential for formation of meso-stable emulsions and the stability of these emulsions will decrease if the current trend in petroleum properties continues.

The comparison and analysis of the oil analytical and properties data show apparent trends in the nature of the ANS oils. Most indicators show that the mix that constitutes ANS oil is becoming lighter, probably due to the mix of crude oils added to the start of the pipelines. It is important to note that the sampling points, sampling times, and other conditions of the feed and pipeline operations were not always recorded. The important indicators of distillation data, chemical composition, viscosity, and density show a general increase in the lightness of ANS oils. The amount of volatile organic compounds (VOCs) in the oil is rising. Despite indicators that the oil is becoming lighter, the resins are rising somewhat. This indicates that the oil may become lighter but more resiny.

The comparison of the data shows several considerations about the analytical data and conclusions presented in the report on ANS oils prepared by S.L. Ross Environmental Research Ltd. Several crucial parameters to consider when making decisions about oil behaviour and emulsification are missing from the report, including standard distillation data, standard emulsification procedures, and SARA and VOC analyses. Several data points varied considerably from the data in the literature including flash point, density, pour point, oil-air interfacial tensions, distillation data, and viscosity measurements. The emulsification data was quite different and could not be related to the data in the literature. None of the important concepts or references about emulsification was included in the report. Despite this, the report does indicate that the oil is becoming lighter and may thus be less prone to emulsification.

Stability and Resurfacing of Dispersed Oil

http://www.pwsrcac.org/docs/d0026200.pdf

Merv Fingas, Environment Canada. November 2005

Abstract

It is well known that chemically dispersed oil destabilizes after the initial dispersion. There is an extensive body of literature on surfactants and interfacial chemistry, which includes an abundance of experimental data on the tropic as well as many theoretical approaches to it. This report will summarize both the data and the theory. The phenomenon of resurfacing oil is the result of two separate processes: destabilization of an oil-in-water emulsion and desorption of surfactant from the oil-water interface which leads to further destabilization.

The destabilization of oil-in-water emulsions such as chemical oil dispersions is a consequence of the fact that not all emulsions are thermodynamically sable. Ultimately, natural forces move the emulsions to a stable state, which consists of separated oil and water. What is important is the rate at which this occurs. An emulsion that stays sufficiently stable until long past its practical use consideration may be said to be kinetically stable. Kinetic stability is a consideration when describing

an emulsion. An emulsion is said to be kinetically stable when significant separation (usually considered to be half or 50% of the dispersed phase) occurs outside of the usable time.

There are several forces and processes that result in the destabilization and resurfacing of oil-in-water emulsions such as chemically dispersed oils. These include gravitational forces, surfactant interchange with water and subsequent loss of surfactant into the water column, creaming, coalescence, flocculation, Ostwald ripening and sedimentation.

Another important phenomenon when considering the stability of dispersed oil is the absorption/desorption of surfactant from the oil/water interface. This process, as well as its importance, is discussed in this report.

This report provides examples of studies and models in all the processes as well as data from experiments and calculations. Data shows that for a dilute solution such as chemically dispersed oil spill, half-lives would vary from 2 to 24 hours, with a tipical

Prince William Sound Regional Citizens' Advisory Council Dispersant Use Position Paper

http://www.pwsrcac.org/docs/d0001300.pdf

PWSRCAC. May 2006.

After years of observing dispersant trials, dispersant effectiveness monitoring, advising and sponsoring independent research regarding chemical dispersant use, it is the position of the Prince William Sound Regional Citizens' Advisory Council (the Council) that dispersants should not be used on Alaska North Slope crude oil spills in the waters of our region. Until such time as chemical dispersant effectiveness is demonstrated in our region and shown to minimize adverse effects on the environment, the Council does not support dispersant use as an oil spill response option. Mechanical recovery and containment of crude oil spilled at sea should remain the primary methodology employed in our region.

Observers' Report: MMS Cold Water Dispersant Tests, Ohmsett Testing Facility, 28 February-3 March 2006.

http://www.pwsrcac.org/docs/d0028000.pdf

Elise DeCola, Nuka Research and Planning Group; Merv Fingas, Environment Canada. June 2006.

Executive Summary

This report, which was prepared for the Prince William Sound Regional Citizens' Advisory Council (PWS RCAC), contains the authors' observations from four days of cold water dispersant testing at the Ohmsett facility in February‐March 2006. This report provides an overview of the testing and general observations of the PWS observer team. A companion report, entitled "Analysis of Oil Spill Dispersant Effectiveness Testing at Ohmsett," provides a technical analysis of the experimental design and testing protocols.

The purpose of the tests was to repeat cold water dispersant testing that had been conducted in 2002 and 2003, in response to criticism from the National Academies of Science (NAS), the Prince William Sound Regional Citizens' Advisory Council (PWS RCAC), and others regarding some of the test parameters for these earlier cold water dispersant trials. The PWS RCAC observer team attended the tests to monitor several issues of concern, which were outlined in a letter from PWS RCAC to the MMS (Appendix B to this report): (1) heating of oil; (2) artificial weathering of oil, (3) use of booms in testing field; (4) re-surfacing of oil; (5) tank contamination; (6) use of oils which are not typically transported; (7) herding using fire hoses; and (8) uncontrollable natural factors.

PWS RCAC's concerns regarding the test oils were not addressed in these trials. The Alaska crude oils tested were obtained directly from the production facilities on the North Slope, rather than in Valdez at the terminus of the Trans-Alaska pipeline. Therefore, the test oils vary in composition from oil that might actually be spilled in Prince William Sound. Because the Ohmsett facility is open to the elements, the impact of uncontrollable natural forces continues to be a concern.

In addition to these issues, the PWS RCAC noted several additional concerns regarding the experimental design and interpretation of results from these trials. These include: the inability to derive effectiveness values in the absence of mass balance calculations; the impact of residual dispersant and surfactant in the tank during the test period; the practice of spraying dispersants immediately after the oil is applied and before any appreciable slick can form; and the fact that the dispersant-to-oil ratio used in the tests was significantly higher than the 1:20 dosage recommended for use in U.S. waters.

Chemical Dispersants

Oil Spill Dispersant Effectiveness Testing in OHMSETT: February-March 2006

http://www.pwsrcac.org/docs/d0030200.pdf

Merv Fingas, Environment Canada and Elise DeCola, Nuka Research & Planning. October 2006.

Abstract

This paper is a review of some recent dispersant testing at OHMSETT. These tests were designed to measure the effectiveness of dispersant on Alaskan oils at low temperatures. The oil and water temperatures were close to the freezing point.

Ten dispersant tests were observed, 5 dispersant tests and 5 control tests. The dispersant tests showed good initial dispersion and subsequent observation showed much of the oil from these tests re-surfaced, about half within about one to two hours and most of it by next morning.

The testing method was viewed with respect to concerns raised earlier from observing and analyzing other tests. First, a report sponsored by PWS RCAC, had raised 18 concerns about dispersant tank testing. The following are 18 critical factors, identified in an earlier study, that need to be considered and included in any test for measuring the effectiveness of dispersants in a tank in order for that test to achieve useful results.

Prince William Sound Regional Citizens' Advisory Council, Long Term Environmental Monitoring Program: 2002-2003 LTEMP Monitoring Report.

http://www.pwsrcac.org/docs/d0003001.pdf

James R. Payne, William B. Driskell, Jeffrey W. Short. November 2003.

Executive Summary

After reviewing the LTEMP 2002-2003 results, we have concluded that the intertidal sites monitored by the LTEMP program are currently extremely clean. With the exception of the Alyeska Marine Terminal (AMT) site and, to a lesser extent, the Gold Creek (GOC) site in Port Valdez, the regional sites do not show elevated concentrations of hydrocarbons from either Alyeska Marine Terminal operations and discharges, or oil transportation activities within Prince William Sound (PWS). Even at AMT and GOC, where PAH and AHC contaminants from the AMT Ballast Water Treatment Facility (BWTF) are detected, the measured concentrations are probably not environmentally significant.

A large part of this report covers two main topics: 1) reevaluating historic trends and analytic issues and 2) the inter-calibration of laboratory analyses (since the program has now changed from GERG to Auke Bay Lab (ABL) for chemical analyses).

In summary, because the typical hydrocarbon contaminant concentrations measured in mussel tissues outside Port Valdez are so low (often at or below method detection limits), detailed trend analyses are confounded by background levels, spurious events, and historic data-quality issues. Nevertheless, portions of the historic dataset are internally consistent with known pollution events, observed seasonal changes, and plausible transitions to the current low oiling levels.

With the possible exception of the 1997-1998 timeframe, the LTEMP program appears to be on-track with high-quality, high-sensitivity data with a good record of detected events. These are the hallmarks of a good monitoring program. The LTEMP data have also proven invaluable as a corroborating data set in acquiring a much more in-depth perspective of the trends and behavior of oil contaminants in the region.

2003-2004 LTEMP Monitoring Report.

http://www.pwsrcac.org/docs/d0002800.pdf

James R. Payne, Ph.D., William B. Driskell, and Jeffrey W. Short, Ph.D. April 18, 2005.

Executive Summary

The overall results from this year are very similar to last year's. After reviewing the current LTEMP 2003-2004 results, we have concluded that the intertidal sites monitored by the LTEMP program are still extremely clean. With the exception of the Alyeska Marine Terminal site and, to a lesser extent, the Gold Creek site in Port Valdez, the regional sites do not show elevated concentrations of hydrocarbons from either Terminal operations and discharges, or oil transportation activities within Prince William Sound (PWS). Even at Alyeska Marine Terminal and Gold Creek, where PAH and AHC contaminants from the Alyeska Marine Terminal Ballast Water

Treatment Facility (BWTF) are detected, the currently measured concentrations are small and suggest that PWS is not heavily contaminated from ongoing anthropogenic activities.

As noted last year, the monitoring aspect is functioning smoothly. In general, when actual spills or other episodic hydrocarbon inputs occurred, the LTEMP mussel tissue and sediment results detected the event; for example, after the 1994 *T/V Eastern Lion* oil spill, the 1997 BWTF sheening event, the 1994 mussel-bed cleaning activities on Disk Island and sediment-cleansing-trials at Sleepy Bay. At the other survey sites, the background levels were extremely low and generally near or below the laboratory method detection limits (MDL). When the signal levels are so low, it is easy to pick up spurious noise (real or artifacts) from the clean samples. To a small degree, there have been problems with laboratory artifacts with the historic LTEMP data (discussed in depth last year).

The LTEMP program appears to be on-track with high-quality, high-sensitivity data with a good record of detected events. These are the hallmarks of a good monitoring program. The LTEMP data have also proven invaluable as a corroborating data set in acquiring a much more in-depth perspective of the trends and behavior of oil contaminants in the region. Taken together, the TPAH and TSHC values and the associated histogram plots (or fingerprints) do not show the "ubiquitous" background contamination reported throughout much of PWS by Exxon's consultants (Boehm et al., 2003). The station locations from the Exxon studies and LTEMP are from different areas, but clearly, the LTEMP data in no way suggest that PWS is heavily contaminated from past and ongoing anthropogenic activities.

Accumulation of Polycyclic Aromatic Hydrocarbons by Neocalanus Copepods in Port Valdez, Alaska.

http://www.pwsrcac.org/docs/d0020500.pdf

Mark G. Carls,1 Jeffrey W. Short, et. al. August 2005.

Abstract

Tankers involved in the transport of Alaska North Slope (ANS) crude oil to ports along the west coast of the United States are loaded with seawater as ballast during their return trip to the Alyeska Marine Terminal in Port Valdez, Alaska. As part of these ongoing operations, approximately 10,000,000 gallons of treated ballast-water are discharged daily from the Ballast Water Treatment Facility (BWTF) in Port Valdez. To determine if the treated ballast water effluent affects the zooplankton community, polynuclear aromatic hydrocarbon (PAH) concentrations in water, suspended particulate material (SPM), and *Neocalanus* copepods were determined throughout Port Valdez and in Prince William Sound (PWS) in April 2004. Petrogenic PAH were detected in Port Valdez *Neocalanus* (0.607 to 1.28 µg/g dry weight). Because concentrations in tissue were smaller than those known to cause harm to calanoid copepods by factors of at least 14, current total PAH (TPAH) levels in Port Valdez are probably not injurious to the zooplankton community. *Neocalanus* may acquire PAH from water and or SPM, yet TPAH concentrations in these compartments were below method detection limits (MDL), further suggesting the potential for damage is unlikely.

At current rates of discharge into Port Valdez, ballast-water effluent likely has little effect on the plankton community and does not pose a significant toxic risk.

Characterization of Energy and Potential Contaminant Pathways in Subarctic Estuarine Habitats: Ecology of Tidal Flat Communities of the Copper River Delta, Alaska

http://www.pwsrcac.org/docs/d0026100.pdf

Sean P. Powers, Mary Anne Bishop, and Erika Clesceri. 2006.

Introduction

Vast expanses of intertidal sand/mudflats serve as a critical link in the food web of nearshore biological communities in many coastal areas of Alaska. The rich abundance of benthic invertebrates residing within the sediments of intertidal flats and the large network of subtidal channels that bisects these flats provide a significant prey resource for numerous species of fish, crabs, birds and marine mammals. One of the largest expanses of intertidal mud/sand flats occurs in the Copper River Edlta and southeastern Prince William Sound (Orca Inlet). The estuarine nature of this system results in mixing of nutritional sources from riverine, estuarine and marine ecosystems, which fuel secondary productivity. Here, we investigated linkages between riverine and oceanic influences and the nutritional baseline for mudflat food webs in the Copper River Delta and Hartney Bay in Southeastern Prince William Sound, using stable isotopes of naturally occurring carbon and nitrogen, which are both essential elements for growth.

Port Valdez Sediment Coring Final Report 2004

http://www.pwsrcac.org/docs/d0024500.pdf

Kinnetic Laboratories, Inc. in association with Florida Institute of Technology and TDI brooks International, Inc. January 2006.

Abstract

Sediment cores were collected from eight locations in the vicinity of the Alyeska Marine Terminal(AMT), Port Valdez, and surrounding waters in order to construct a history of any hydrocarbon contamination that may have occurred due to the ballast water treatment plant (BWTP) discharge, AMT operations and associated tanker traffic, and other anthropogenic sources. Sediment ages and sedimentation rates were determined using the man-made radionuclides Cesium137 in tandem with excess Lead210. Detailed polycyclic aromatic and saturate hydrocarbon analyses were also performed on each core for source identification, weathering, and for correlation with historic events that have occurred in Port Valdez over the last 50 to 100 years. Sedimentation rates were found to be fairly high throughout the study area, ranging from a low 0.2 to 0.4 centimeters/year (cm/yr) offshore of Gold Creek to a high of approximately 1.5 cm/yr offshore of Lowe River. Accumulations of relatively high levels of weathered polycyclic aromatic and saturated hydrocarbons were found in the vicinity of the AMT that were sourced to Alaska North Slope crude and the BWTP discharge. Clear evidence was also seen in the vicinity of the AMT of construction

Environmental Monitoring

activities, of hydrocarbon contamination from the 1964 Great Alaskan Earthquake, and of a submarine sediment slide that had occurred in the vicinity of the AMT, most likely during the 1964 Earthquake. Other Port Valdez sites indicated low level background' hydrocarbon concentrations throughout the historic record with no evidence of anthropogenic inputs. Sediment from Galena Bay exhibited a very different hydrocarbon pattern from that seen in Port Valdez, with a strong un-weathered petrogenic signature which would indicate coal or other source rock, a high prevalence of biogenic sources, and no evidence of hydrocarbon accumulations from anthropogenic sources.

Reference Oils Report and Errata for Reference Oils Report

http://www.pwsrcac.org/docs/d0029900.pdf

http://www.pwsrcac.org/docs/d0030000.pdf

Kinnetic Laboratories, Inc. March 2006.

Introduction

The goal of the reference oils program, as required by the contract, was to compare chemical analyses of sediment samples performed at the National Marine Fisheries' Auke Bay Laboratory (ABL) with similar analyses performed by Texas A&M's Geochemical and Environmental Research Group (GERG) to supplement data and interpretation provided by these two laboratories in support of the RCAC's Long- Term Environmental Monitoring Program (LTEMP). LTEMP, which was first implemented in 1993, was designed to provide long-term baseline measurements of hydrocarbon levels and sources in sediments and indigenous blue mussels at program sites within the areas of Prince William Sound (PWS) and the Gulf of Alaska represented by the RCAC. The objective of the Reference Oil Project was to provide additional information on the background signatures previously seen during the LTEMP by investigating relative sources of hydrocarbons in the sediments rather than comparing absolute concentrations of those hydrocarbons between samples or laboratories.

This report describes the results of chemical analyses performed on portions of sediment samples collected in 2000 by ABL personnel for a separate project entitled "Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of the Exxon Valdez Spill Area". This project, referred to herein as the Yakataga Project, was funded by the EVOS Trustees to be performed by the National Oceanographic and Atmospheric Association (NOAA), the U.S. Geological Survey (USGS), and Payne Environmental Consultants. For the Reference Oils Project, samples collected for the Yakataga Project were analyzed independently by ABL and GERG. Descriptive and limited data analysis here is performed as called for by the contract in light of the draft manuscript entitled "A Direct Assessment of Hydrocarbon Contributions from Native Coals and from Seep Oils to Marine Sediments of the Northern Gulf of Alaska" (Short, personal communication, 2005). Of the four sample analyzed by both laboratories for the Reference Oils Project, only two were reported in the manuscript by Short (2005).

2004-2005 LTEMP Monitoring Report

http://www.pwsrcac.org/docs/d0032000.pdf

James R. Payne, Ph.D., William B. Driskell, Jeffrey W. Short, Ph.D., and Marie L. Larsen. November 2006.

Abstract

The Long Term Environmental Monitoring Program (LTEMP) has been sampling mussels (and some sediments) twice annually at ten sites in Port Valdez, Prince William Sound, and nearby Gulf of Alaska sites since 1993. Samples are analyzed primarily for polycyclic aromatic and saturated hydrocarbons (PAH and SHC). New indices have been developed to quantify the proportions of a hydrocarbon signal into dissolved, particulate/oil, and pyrogenic phases. After 1999, a decreasing trend appears in total PAH (TPAH) with current values below 100 ng/g dry weight (and many below 50 ng/g). Most currently measured samples reflect a predominantly dissolved-phase signal. This new low in TPAH likely represents ambient background levels. Furthermore, peaks and lows in total PAH trends and the similarities of the hydrocarbon signatures portray regional-scale dynamics. The five inner Prince William Sound sites have similar composition and behave similarly and yet are different from the three Gulf of Alaska sites. The two Port Valdez sites are primarily influenced by the treated ballast water discharge from the Alyeska Marine Terminal. An unreported diesel spill was detected in 2004 at Gold Creek, Port Valdez.

Field Test Report: Coherent UHF Radar for Ice Detection

http://www.pwsrcac.org/docs/d0005700.pdf

C-CORE. June 2003.

Introduction

The Regional Citizens' Advisory Council (RCAC), of Valdez, Alaska, has a mandate to provide enhancements in the detection of navigation hazards—particularly icebergs—in the traffic lanes of Prince William Sound. It is widely recognized that the detection of growlers and bergy bits under moderate to high sea states, or in pack ice, is outside the capabilities of current marine radar technologies. The C-CORE Coherent UHF Radar has been developed with funding from RCAC as an important component in an ice warning system to help fulfill their ice management responsibilities.

The coherent radar is intended for the detection of small targets in the presence of significant clutter caused by rough seas or pack ice. A prototype system was brought to Valdez, Alaska, in April 2003, for a field evaluation. The radar utilizes stepped frequency modulation (SFM) as a means of transmitting a low-power, wide-pulse signal to achieve a resolution similar to traditional high-power, narrow-pulse systems. Enhanced signal processing is possible due to the coherent nature of the design, thereby permitting novel approaches to target detection in the presence of clutter. The UHF radar was designed to operate in two frequency ranges for comparison—L-band (750MHz - 800MHz) and S-Band (2400MHz – 2450MHz). Custom, narrow beamwidth waveguide antennas were also designed to aid in target isolation. A PC graphical user interface (GUI) provided control over all features of the radar and maintained records for every radar transmission.

The objectives of the field program, which extended over a period of two weeks, were to: evaluate the effectiveness of SFM; perform comparisons between L-band and S-band; evaluate the custom waveguide antenna design; and, investigate the usefulness of the radar as a complement to the existing SeaScanä system that has been installed and is now operating on Reef Island. The field program took place aboard the research vessel Auklet in order to quickly move to the location of prospective radar targets. Installation aboard this vessel went smoothly, and the support of this vessel for further work is highly recommended.

Oil Spill Prevention and Response

Review of Oil Spill Responses on Moderately-Sized Spills in US Waters from 1993-2000

http://www.pwsrcac.org/docs/d0002600.pdf

Elise DeCola, Nuka Research and Planning Group. 2004.

Introduction

PWSRCAC posed 4 research questions comparing the efficacy of dispersant use and mechanical response for nearshore oil spills in US waters.

1. Conduct a review of nearshore oil spill responses on moderately sized oil spills (500 to 4,000 barrels) in the United States since 1993.

2. The review shall categorize responses by type: mechanical, dispersants, in situ burning, or a combination of the responses on any one spill.
3. The review shall include the best estimate of efficiency for each of the responses used on each specific spill. For example, what percentage of the oil was removed using mechanical means only, what percentage of the oil was dispersed into the water column using chemical dispersants, etc.
4. The review shall also note the offshore responses in the United States since 1993, including a characterization of the response options, but not the detailed efficacy analysis.

This document addresses those questions, with some variations based on the limitations of the data set used for statistical and qualitative analysis.

PWSRCAC's position on in-situ burning

http://www.pwsrcac.org/docs/d0007300.pdf

PWSRCAC. 2004.

Basic Position

Of the various response options, PWSRCAC endorses mechanical recovery as the primary response strategy. PWSRCAC recognizes that there may be times when in situ burning in Prince William Sound and the Gulf of Alaska may be appropriate but only after mechanical recovery has been ruled out as the primary strategy. Generally, in order to achieve conditions for in situ burning, oil must first be contained with boom or by barriers such as ice or remote shorelines and the slick thick enough to insulate itself from the underlying water. This depth is 2-3 millimeters2. If the oil is contained with boom, oil can be removed by mechanical means under any weather conditions compatible with booming operations. Burning should never hinder an on-going mechanical recovery operation. Therefore, any window in which to consider burning in open water conditions may have limitations. However, PWSRCAC does acknowledge that in situ burning may be useful in high latitude waters where other techniques may not be possible due to the physical environment (extreme low temperatures and pack ice conditions), or the remoteness of the impacted area.

Proposed Approach to Downstream Planning for Nearshore Response and Sensitive Areas Protection Outside Prince William Sound

http://www.pwsrcac.org/docs/d0010000.pdf

Nuka Research and Planning Group, LLC.
October 2004.

Summary

The need for downstream planning in the Prince William Sound/Gulf of Alaska region is clear. As demonstrated during the Exxon Valdez oil spill, a major oil spill in Prince William Sound has the potential to impact coastlines and communities in “downstream communities” in the Cook Inlet and Kodiak regions, or subareas. Yet, the oil spill planning system that has evolved in the

State of Alaska does not sufficiently plan for an oil spill that originates in one Subarea of the state but impacts other subareas in the downstream spill path.

Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has raised the issue of downstream response planning during past public review cycles for the Prince William Sound Tanker Plan. However, major gaps still exist in the public and industry plans that define how an oil spill response would proceed in the event that a Prince William Sound tanker spill once again spread beyond the geographic bounds of the Sound. This report focuses on the obvious planning gaps in the current system, recommends a process for developing a Downstream Response Plan to fill those gaps, and includes as an appendix a draft Downstream Response Plan.

This report includes a model downstream Response Plan to facilitate discussion of how such a plan might be developed for the Prince William Sound/Gulf of Alaska region. The Gulf of Alaska downstream scenario is based on realistic assumptions, and it factors in the realities and constraints that would impact a spill response of this scale.

PWSRCAC developed the model Downstream Plan to foster discussion among stakeholders, state and federal agencies, responders, planholders, and other interested parties. PWSRCAC hopes that the final Downstream Planning document format, contents, and scope will reflect the broad input of all interested parties. The final plan should be incorporated into the existing Subarea Contingency Plans for Prince William Sound, Cook Inlet, and Kodiak.

Combining the Firehouse Model and Community-based Response Teams for an Improved Regional Oil Spill Response System in Alaska

http://www.pwsrcac.org/docs/d0022800.pdf

Nuka Research and Planning Group, LLC and MAC Services - Leadership & Management Consulting. October 2004.

Forward

This report was initially published as a concept paper, intended to foster discussion of the future of the "Firehouse" model for oil spill response and community-based response teams in Alaska. The concept paper was developed through a joint effort between the Prince William Sound and Cook Inlet Regional Citizens Advisory Councils. The concepts and models were presented as an entrée into a meaningful dialogue about the future of the oil spill response system in Alaska. The report was published on the Internet and broadly distributed through the Alaska oil spill response community, to invite the readers to join in the challenge of maintaining and improving Alaska's spill response system during times of declining oil production and revenues. A one-day workshop was scheduled for September to allow interested parties to gather to discuss these topics, and to develop steps and commitments to move the concept into the next level of implementation.

Unfortunately, the results of feedback on the proposed concept made it clear that further consideration and work on this project, as is, would likely be futile. Therefore, the September workshop was cancelled, and further work on this project has been suspended. The remainder of this paper describes the concept as presented to the target audience of spill response professionals, agency representatives, and stakeholders, and concludes with the results of the feedback process.

Community Oil Spill Response Forum

http://www.pwsrcac.org/docs/d0022700.pdf

Nuka Research and Planning Group, LLC.
October 17, 2005.

Executive Summary

Since their inception, Prince William Sound Regional Citizens' Advisory Council (RCAC) and Cook Inlet RCAC have promoted the development of the concept of *community-based oil spill response* (COSR) in their respective regions. COSR consists of local citizens responding to oil spilled in the waters upon which they rely for income, recreation, and subsistence. There are currently three organized COSR teams in the Price William Sound/Cook Inlet area.

The Community Oil Spill Response Forum held in Anchorage, Alaska on January 14, 2005 convened a cross-section of stakeholders to review the status of existing COSR teams and share information about past and future COSR-related efforts.

Participants included representatives of state and federal agencies, local harbor facility staff, oil spill response organizations (OSROs), existing COSR teams, and other community-level organizations.

After reviewing the history and status of community-based response in Alaska, the group produced several consensus statements, all agreeing that the current system is inadequate in its response to small spills which are often associated with unregulated spillers. Further, they agreed that improved capacity for community-based response could ameliorate the situation. In so agreeing, however, the group was operating under a very general understanding of the term "community-based," and not necessarily referring specifically to the COSR team model, but rather a combination of resources, including harbor facility staff and local OSRO residents working for OSROs.

Several important pieces of information were exchanged, especially about existing US Coast Guard and Alaska Department of Environmental Conservation programs that support community-based spill response. Areas requiring further investigation and clarification were also identified, such as insurance coverage for collaborative response from one community to another, and liability issues for responses outside harbor areas. Training, personnel, and small-scale spill response costs were raised repeatedly as the primary challenges facing local responders.

The Forum concluded with a sense of both accomplishment and much work to be done. Participants reported that they would return to their home communities and organizations with useful information from the day, and requested an annual gathering to continue to improve communications among them. Further, the

participants developed a list of action items, ranging from a press release about the event to setting up a voluntary roster of trained responders throughout Alaska.

SERVS' Fishing Vessel Program Meeting

http://www.pwsrcac.org/docs/d0027900.pdf

PWSRCAC. December, 2005.

Overview

On December 8, 2005, the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) hosted a meeting with fishing vessel captains participating in the SERVS' fishing vessel (F/V) program. The objective of this meeting was to get direct feedback from some of the participants in the SERVS' fishing vessel program regarding how the program was working. The fishermen were asked to address areas that were working well and areas that could be improved within the SERVS program.

Fishermen were selected from most of the communities that are represented by the PWSRCAC Board of Directors which are communities impacted by the EXXON VALDEZ oil spill. Fishermen participating in the meeting were from Kodiak, Seldovia, Homer, Seward, Whittier, Cordova, and Valdez. Also in attendance were PWSRCAC Board Members, Oil Spill Prevention and Response Committee (OSPR) members, PWSRCAC staff members, and an Alaska Department of Environmental Conservation representative. By design, no fishing vessel administrators (FVAs) were invited to the meeting and SERVS was not asked to attend in order to allow the fishing vessel captains to speak freely and candidly.

This report closely follows the meeting agenda. Each topic discussed at the meeting is covered and the general responses from the fishermen are provided.

Response Gap Methods

http://www.pwsrcac.org/docs/d0027800.pdf

Nuka Research and Planning Group, LLC. May 2005.

Introduction

Sometimes oil is transported in tank vessels at a time when no mechanical oil spill response is possible, due to environmental conditions such as weather and sea state. The term Response Gap is used to refer to such conditions. In Prince William Sound (PWS), Closure Limits preclude outbound laden tanker transits when conditions at Hinchinbrook Entrance exceed 15 foot seas or 45 knot winds. However, these conditions represent safe operating limits for the tankers themselves, and do not necessarily reflect the limits to mechanical oil spill recovery systems. In Prince William Sound, the Response Gap exists for the range of conditions between the upper limits of mechanical recovery systems and the Hinchinbrook Closure Limits.

Prince William Sound (PWS) Regional Citizens' Advisory Council (RCAC) has commissioned a study to determine the frequency and duration of any Response Gap that exists in Prince William Sound. This Methods Report is the first deliverable in this study. RCAC has developed this Methods Report to solicit feedback on the proposed methods, data, and analyses that will be used to quantify the Response Gap. This report describes the data sources and analytical methods to be used in the study. RCAC will consider all input and comments received on these proposed methods before finalizing the methodology.

An Assessment of the Role of Human Factors in Oil Spills from Vessels

http://www.pwsrcac.org/docs/d0028900.pdf

Elise DeCola and Sierra Fletcher, Nuka Research & Planning Group, LLC. August 2006.

Abstract

Human factors - either individual errors or organizational failures - have been reported to cause as much as 80% of oil spills and marine accidents. Improvements to oil spill prevention technologies, tanker design, and systems engineering are often cited, along with improved regulatory oversight, as contributors to a general decline in the number of marine oil spills over the last decade. Yet, oil spills and industrial accidents continue to occur. This is due, in part, to the fact that human and organizational errors continue to occur despite, or sometimes because of, improved technologies.

The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) commissioned this report to consider the role of human factors in oil spills, the relationship between technological improvements and human factors, and complementary prevention measures that may further reduce the risk of oil spills attributed to human or organizational errors. The fundamental research question addressed in this report is: Where should we focus prevention efforts to reduce oil spills from tankers that are caused by human factors?

The study of human factors is based on the acknowledgement that human characteristics and behaviors are intrinsically linked with the functioning of the technology people design, build, maintain, and operate. The human-technology relationship works in both directions, though. Not only do humans impact the functioning of our technology, but technology can also influence human decisions and actions. This report considers the complex nature of human-technological interactions in the context of spills from crude oil tankers and considers the potential implications of technological improvements, including the ongoing phase-in of double hulled, redundant tankers, to the overall risk of oil spills from tankers.

This report presents general concepts related to human error, human factors, and accident causality by synthesizing published literature that considers the types of human errors and underlying human factors that commonly cause oil spills or accidents. In an attempt to relate root causes to prevention strategies that target

human factors, this report reviews oil spill and marine accident data compilation and analysis practices in the US and internationally. Prevention programs and voluntary practices that target human factors are reviewed, and recommendations presented for linking spill prevention to human factors data and analysis.

Comparison of Wind Measurements at Nuchek Heights, Hinchinbrook Island, and at Seal Rocks NOAA Data Buoy in Hinchinbrook Entrance, Alaska
http://www.pwsrcac.org/docs/d0032900.pdf

Richard M. Brown, Micro Specialties, Inc. and Orson P. Smith, PE, Ph.D. December 2006.

Introduction

Concurrent hourly average wind speeds and directions from data collection stations on shore at Nuchek Heights and at sea by the NOAA Seal Rocks data buoy were compared during the period from 1600 on 23 August 2004 to 1700 on 18 February 2006 Alaska Standard Time. Archived data records from both stations were retrieved and clipped to the specified time period. Data gaps or clearly anomalous recordings were set to zero so that complete time series of exactly the same length (12315 points) were available for analysis. Wind speeds were converted to statute miles per hour (mph).

Response Gap Estimates for Two Operating Areas in Prince William Sound

http://www.pwsrcac.org/docs/d0034200.pdf

Nuka Research and Planning Group, LLC. February 2007.

Summary

Over the past 16 years, technological advancement in oil spill response systems, preparedness programs, and environmental monitoring have contributed to more proficient oil spill response operations in Prince William Sound (PWS). Yet, there are still times when oil is being shipped through PWS but environmental conditions, such as wind, waves, temperature, and visibility, preclude effective spill response operations. The PWS Response Gap is this window between the point of maximum mechanical response capacity and the established weather-based closure limits (15-foot seas or 45-knot winds at Hinchinbrook Entrance).

Prince William Sound Regional Citizens' Advisory Council (RCAC) has commissioned a study to identify and determine the frequency of the Response Gap in two areas of Prince William Sound. A Methods Report, describing the proposed methods, data, and analyses to be used in this study, was developed, reviewed, and approved in April 2006.

To quantify the Response Gap for PWS, this study began by assembling historical datasets of the environmental factors known to affect the open-water mechanical response system used in PWS. Datasets were developed for two of the operating areas in PWS: Central PWS and Hinchinbrook Entrance. Each dataset contained observations

related to four environmental factors: wind, sea state, temperature, and visibility (limited to daylight and darkness). These datasets were used in a "hindcast" to evaluate how often environmental conditions exceed the maximum response operating limits while Hinchinbrook Entrance closure limits were not reached.

Nuka Research and Planning Group, LLC. April 2008.

Non-mechanical Response Gap Estimates for Two Operating Areas in Prince William Sound

http://www.pwsrcac.org/docs/d0046700.pdf

Summary

Technological, planning, and environmental monitoring improvements over the past two decades have greatly enhanced the ability to respond to an oil spill in Prince William Sound. The "response gap" is the window between the upper limits of the response system (in terms of environmental conditions) and the conditions at which Hinchinbrook Entrance is closed to laden tankers.

Nuka Research and Planning Group, LLC (Nuka Research) developed a methodology to estimate the response gap by comparing response limits for dispersant and in-situ burning tactics to environmental conditions data from 2000-2005.

Nuka Research then used a Response Gap Index to estimate how often a specific response tactic would be effective in a particular operating area. When one environmental factor would preclude a response completely, or two environmental factors would compromise a response, then a response is judged not possible for that time period.

Nuka Research then compared the results of these response gap estimates with the results of the *mechanical* response gap estimate for the same two operating areas of Prince William Sound.

Numerous factors challenged this analysis, including the lack of clearly established operating limits for both dispersants and in-situ burning. Also, factors additional to the environmental observations used in this analysis impact the effective application of both response methods. Other factors include the type of oil, type of dispersant or ignition method, oil viscosity and weathering, dispersant dosage and droplet size, ice, and precipitation. Because of these other factors, the results of this study should not be used to determine when or when not to implement the dispersant or in-situ burning tactics.

Capstone Engineering Services, Inc. January 2004.

Oil Spill Prevention and Response

Fire Hazard Assessment for Valdez Crude Tank Internal Floating Roofs

http://www.pwsrcac.org/docs/d0012300.pdf

Introduction

During 2003, the Valdez Marine Terminal (VMT) Strategic Reconfiguration study team was tasked by Alyeska's Executive Team and Alyeska's Owners to perform conceptual engineering to identify changes that would lead to a significant increase in the operating efficiency of the Valdez Marine Terminal (VMT). As of January 2004, the study team was in the process of completing the Conceptual Engineering phase.

One basic concept proposed by the study was to eliminate the existing flue gas and vapor handling processes, and replace them with a system that requires fewer and less complex operations, and is a less maintenance-intensive system. An alternative which would eliminate these processes is the installation of internal floating roofs (IFRs) in the tanks. Floating roof tanks are the industry standard for storage of volatile organic liquids with vapor pressures below 11.1psi.

Pursuing this alternative, the Strategic Reconfiguration study team has proposed that the existing crude oil tank storage system be converted to an internal floating roof (IFR) tank system. In order for the alternative to be viable, two essential criteria were established for the Reconfiguration team:

- The new design for the internal floating roof tank must meet or exceed the current level of safety and system integrity.
- The revised VMT system reliability and proration risks must be fully understood.

From Tankers to Tissues—Tracking the Degradation and Fate of Oil Discharges in Port Valdez, Alaska

http://www.pwsrcac.org/docs/d0012500.pdf

Braddock and Justin Bailey, University of Alaska; and Jeffrey W. Short, NOAA/NMFS. 2005.

Abstract

The Alyeska Pipeline Service Company (APSC) Ballast Water Treatment Facility (BWTF) at the terminus of the Trans-Alaska Pipeline in Port Valdez, Alaska, treats and discharges an average of nine million gallons per day of oil-contaminated ballast water offloaded from the tankers utilizing the Port. This study quantifies the fractions of benzene, toluene, ethylbenzene, and xylene(s) (BTEX), polycyclic aromatic hydrocarbons (PAH), and saturated hydrocarbons (SHC) being removed at different stages of treatment inside the terminal and evaluates the relative importance of abiotic (aeration) versus microbial processes. Evaporation is the dominant removal mechanism for BTEX, lower-molecular-weight SHC, and possibly the naphthalenes in the dissolved air flotation (DAF) cells/weirs and in the Splitter Box distributing DAF effluent to the biological treatment tanks (BTTs). Within the BTTs, microbial degradation of BTEX is

very efficient and essentially complete midway through the tanks. During the warmer months, SHC biodegradation within the BTT tanks is also very rapid, but PAH biodegradation is only partially complete before the effluent is discharged into Port Valdez, a sill-constricted, subarctic fjord. Both SHC and PAH biodegradation are limited within the BWTF during colder months. Alkylated PAH homologues that make up the discharged oil signal have been tracked via mussel and sediment samples from the Long-Term Environmental Monitoring Program (LTEMP) that has detected accidental discharges as well as the seasonally-controlled transport of BWTF-sourced dissolved- and particulate/oil-phase fractions throughout the Port.

Valdez Marine Terminal Non-tank Corrosion Abatement Study

http://www.pwsrcac.org/docs/d0011400.pdf

Coffman Engineers. February 2005.

Executive Summary

In the spring of 2004, Coffman Engineers, Inc. *(CEI)* was commissioned by the Prince William Sound Regional Citizen's Advisory Council *(PWSRCAC)* to investigate the non-tank corrosion issues at the Valdez Marine Terminal *(VMT)*.

CEI was given six goals and objectives to establish scope and direction for the study.
1) Identify the extent to which non-tank corrosion issues exist at *VMT*.
2) Qualitatively assess Alyeska's efforts to address corrosion issues at the *VMT*.
3) Verify that Alyeska Pipeline Service Company *(APSC)* has procedures in place to identify and to address non-tank corrosion issues.
4) Verify that maintenance schedules are sufficiently frequent to address the recurring non-tank corrosion issues.
5) Verify that appropriate standards regarding non-tank corrosion issues are in use at *VMT* and that these standards drive appropriate maintenance and inspection schedules.
6) Verify that permitted (either by standard or custom) levels of non-tank corrosion are acceptable and that inspection schedules are sufficiently frequent and thorough such that all existing corrosion will be identified and will not exceed the permitted levels.

It was found that some non-tank corrosion issues do exist at the *VMT*, but they have either been repaired and are under monitoring, or they are being monitored and are not currently at the point where repair is required. As pertains to regulatory issues, the inspection and corrosion mitigation program meets or exceeds regulatory requirements, with one exception. The required (by 49 CFR 195.589) current site plan of cathodic protection (CP) systems showing anodes, rectifiers, protected structures, and neighboring bonded structures is not to scale or of sufficient detail to act as a project design aid during demolition/construction of existing/new structures and CP systems. See item #9 in the Recommendations section for further detail.

In some instances, Alyeska has taken the initiative and acted beyond recommendations in order to mitigate a situation. Objective 2 contains many items where a good effort has been noted.

Hydrocarbon Biodegradation in the Ballast Water Treatment Facility

http://www.pwsrcac.org/docs/d0012400.pdf

Alyeska Marine Terminal. Payne Environmental Consultants. May 2005.

Abstract

The Ballast Water Treatment Facility (BWTF) at the terminus of the Trans-Alaska Pipeline in Port Valdez, Alaska, currently treats and discharges an average of nine million gallons per day of oil-contaminated ballast water offloaded from the tankers utilizing the Port. This study quantifies the fractions of benzene, toluene, ethylbenzene, and xylene(s) (BTEX), polycyclic aromatic hydrocarbons (PAH), and saturated hydrocarbons (SHC) being removed at different stages of treatment inside the terminal and evaluates the relative importance of abiotic (aeration) versus microbial processes.

2006 Fire Report, Alyeska Terminal

http://www.pwsrcac.org/docs/d0029600.pdf

Loss Control Associates, Inc. August 2006.

Summary

VMT Fire Brigade readiness and capability has improved based on comparisons with observations made during past visits. The stability gained from increased fire fighter personnel retention has strengthened fire team ability. Consistent training and increased familiarity with VMT operations has resulted in increased awareness of hazards and protective measures. The support from volunteer fire brigade personnel to supplement full time fire fighters during emergencies is essential for successful outcomes in controlling emergencies. The support of VMT management to actively support volunteer fire fighters by allowing personnel to attend training activities and to respond to emergencies has increased VMT Fire Brigade overall capability for handling emergencies. Alyeska management has also actively supported volunteer and paid staff attendance at the Texas A&M Fire school. This training has focused on tactics and fire control methods specifically tailored to the VMT facility.

The most noticeable change observed during this visit is the Valdez Fire Department active coordination and interaction with the VMT Fire Brigade. The Valdez FD is actively committed to support VMT during fire emergencies, a major improvement in coordination between these departments. Training of volunteer and paid municipal fire fighters jointly with VMT personnel at terminal drills and exercises and participation at

the Texas A&M Fire School has increased the ability of the municipal fire department to support VMT emergency operations should a major fire event occur.

Terminal fire protection systems have been fully integrated into the VMT Maintenance program. The systems are inspected and tested to meet NFPA Standards, such as NFPA 25, *Inspection, Testing and Maintenance of Water Based Fire Protection Systems*. Non-water based systems (for example, fire extinguishers and dry chemical systems) are inspected and tested based on requirements in the appropriate NFPA inspection and testing requirements and manufacturers recommendations. A review of sample Project Manager (PM) reports determined that the program is very complete. An examination of comments in the PM reports from fire system mechanics and personnel shows that the results of tests and inspections are documented in a complete and thorough manner. Testing and inspection of foam system piping and "spiders" in the crude tanks were also a potential concern due to a change to an annual inspection schedule. A review of records demonstrated that foam "spiders" are being properly flushed to maintain readiness for foam application. Detailed notes on the system flushing records showed that the systems are not being adversely affected by tank bottoms and the change to an annual frequency is not anticipated to result in blockage of the piping systems.

Rock Slope Stability of the VMT

http://www.pwsrcac.org/docs/d0039900.pdf

Terry R. West and Kyu Ho Cho. September 2007.

Executive Summary

The primary purpose of this project was to evaluate the stability of rock slopes of the VMT during potential earthquake conditions. Field reconnaissance and a detailed fracture survey of the rock slopes were conducted by Dr. Terry R. West and his associates in July and August 2006.

During the fracture survey more than 300 discontinuity values were measured in the field. The discontinuity data were measured on those relatively critical slopes including the Ballast Water Treatment Plant ("BWT Slope"), the Power House and Vapor Recovery Plant ("PVR Slope"), the West Manifold Building ("WM Slope"), the West Tank Farm Slope ("WTF Slope"), and the East Tank Farm Slope ("ETF Slope"). Discontinuity data were also obtained from the less critical slopes including the Power House Road Slope, the Tea Shelter Slope, and the rock quarries located on the southern portion of the VMT site.

Using these fracture data and existing rock cut information available at the time of this investigation, an analysis of rock slope stability was conducted using kinematic and factor of safety (deterministic) methods. Because of the uncertainty of the information, the probability of failure method was also employed to evaluate the stability of the VMT slopes in this study. Assumptions concerning rock mass strengths were made based on the literature and experience of the authors.

Based on the kinematic and kinetic analyses, it is anticipated that the external loading conditions equal to $0.7H_w/H_{slope}$ or equal to pore pressure of $0.6H_w/H_{slope}$ with 0.1g of horizontal acceleration will cause the BWT Slope to become unstable. For the PVR Slope, the external loading conditions equal to $0.85H_w/H_{slope}$ or equal to pore pressure of $0.8H_w/H_{slope}$ with 0.1g of horizontal acceleration or $0.55H_w/H_{slope}$ with 0.2g of horizontal acceleration may cause the PVR Slope to become unstable. For the West Manifold Slope, the external loading conditions equal to $0.35H_w/H_{slope}$, and the external loading conditions equal to pore pressure of $0.15H_w/H_{slope}$ with 0.1g of horizontal acceleration may cause the West Manifold Slope to become unstable. For the East Tank Farm Slope, the external loading conditions equal to $0.7H_w/H_{slope}$ or the external loading conditions equal to pore pressure of $0.45H_w/H_{slope}$ with 0.1g of horizontal acceleration may cause the East Tank Farm Slope to become unstable. For the West Tank Farm Slope, the external loading conditions equal to $0.65H_w/H_{slope}$ or the external loading conditions equal to pore pressure of $0.5H_w/H_{slope}$ with 0.1g of horizontal acceleration may cause the East Tank Farm Slope to become unstable. Details concerning drainage holes at VMT were not provided for this study. These data are required along with rock bolt distributions in order to perform a more precise evaluation of slope stability for the site.

To reduce the risk of the existing slopes at this time, the ditches above the rock slopes should have steep enough grades to avoid water-ponding to prevent infiltration of ponded water which can increase pore pressures. Also, it is recommended that any cracks at the top of the slope be sealed with grout or asphalt. It is also recommended that the piezometers which are clogged in the VMT slopes be regularly cleaned and measured frequently to monitor pore pressures. It is also recommended that more rock bolts be installed in the areas where the existing rock bolts are loosened and where rock bolts have not been installed following a further study to establish these details. Finally, a contingency plan should be developed to address an increase in pore pressure due to increased precipitation, as higher pore pressures could lead to slope instability.

Earthquake, Landslide and Tsunami Hazards in the Port Valdez area, Alaska

http://www.pwsrcac.org/docs/d0039800.pdf

Alaska Begét Consulting. September 2007.

Executive Summary

The 1964 earthquake demonstrated that the Valdez area is subject to enormous earthquakes and coeval tsunamis. The geologic record of prehistoric earthquakes and tsunamis in the Valdez area has not previously been studied.

Historic and prehistoric paleotsunami deposits were identified during this study at sites near Shoup Bay, at Saw Island in the Valdez Marine Terminal, and at a site near Solomon Gulch. Paleotsunami deposits are distinctive sediments found in certain geologic settings that record deposition by large prehistoric tsunamis. Large tsunamis are usually coeval with great earthquakes, and the history of tsunamis in the Valdez area is interpreted as a proxy record of past great earthquakes. Multiple accelerator mass spectrometry radiocarbon dates and conventional radiocarbon dates indicate major prehistoric earthquakes also created large tsunamis in the Valdez area ca. 950-1000 yr B.P., ca. 3800 yr BP. and ca. 4300 yr BP. A large landslide near the VMT dated to 5800 yr BP may have been triggered by a still older earthquake.

The tsunami dated to ca. 950-1000 yr BP was higher and affected a larger inland area at the eastern end of Port Valdez than the historic 1964 tsunami. The 950-1000 yr BP tsunami was probably caused by submarine landslides from the Shoup Bay Moraine and the Valdez Glacier Stream and Lowe River fan deltas. Some of the extensive submarine landslide deposits on the floor of Port Valdez appear to pre-date the 1964 earthquake, and may be correlative with the 950-1000 yr BP event. The tsunamis at 3800 and 4300 yr BP may also have been larger than the 1964 event, but were not as large as the 950-1000 yr BP event. The 950-1000 yr BP earthquake may have been significantly larger than the 1964 earthquake. Little could be determined about the magnitude of a possible earthquake that may have caused a large landslide dated to 5800 yr BP.

Prior estimates of seismic hazards in the Valdez area have been based on an assumption that future earthquakes will resemble the 1964 event, and an educated guess that such events will recur only every few thousand years. The actual duration between great earthquakes in the Valdez area has apparently varied between ca. 500-2800 years, with some previous earthquakes and tsunamis being larger than the 1964 event. The discovery and documentation of records of four great earthquakes within the last 4300 years and possibly as many as five earthquakes in 5800 years shows that the duration of quiet intervals between large earthquakes in the Valdez area is variable and can be shorter than assumed in prior seismic safety evaluations. Even assuming a repeat of the shortest interval found between prehistoric earthquakes, another giant subduction zone earthquake similar to the 1964 event is unlikely to occur for hundreds of years. A small but real possibility exists, however, that a local earthquake on a different fault or a large but distant earthquake might cause submarine landslides and generate dangerous local tsunamis in Port Valdez.

Coping with Technological Disasters: A User Friendly Guidebook

http://www.pwsrcac.org/docs/d0001001.pdf

PWSRCAC. December 2004.

Foreword

The purpose of the "Community Response to Technological Disasters" guidebook is to help community officials and individuals throughout a region affected by a technological disaster recognize, identify and mitigate the adverse psychological effects associated with these events. Although natural disasters occur more often, technological, or man-made, disasters tend to have a greater, more profound emotional impact on people.

Technological disasters can disrupt an ecosystem for many years and tend to disrupt the psychological well being of communities for long periods of time.

Technological disasters, such as the 1989 Exxon Valdez oil spill, disrupt communities on multiple levels. The most obvious and tangible disruptions occur when the flow of goods, routine services, and jobs are adversely impacted. These visible disruptions can be measured and monitored and usually goods and services can be restored in a fairly reasonable length of time. However, there are other often ignored, poorly defined, poorly understood, intangible adverse impacts stemming from a technological disaster. These include initial negative mental health impacts and chronic long-term psychological and physical impacts.

Long after the initial response has ended and the local government has returned to routine day-to-day operations, adverse psychological impacts associated with disaster continue to erode the social fabric of the community. Results of Exxon Valdez oil spill studies indicate that mental health impacts still persist 10 years post-spill. These impacts include disruption of family structure and unity, family violence, depression, alcoholism, drug abuse and psychological impairment. The extent of chronic mental health patterns appears to be correlated to the extent that a community is dependent on its natural resources for survival. As such, Native and non-Native fishing and subsistence-based communities are at higher risk for elevated levels of chronic psychological stress associated with technological disasters.

It is hoped that this guidebook will become an assessment tool and road map. It enables communities and individuals alike to understand what a technological disaster is how it differs from a natural disaster, what to expect during the disaster, and in the years following the event. This guidebook tells you where to find help.

Coping with Technological Disasters: Appendices

http://www.pwsrcac.org/docs/d0001002.pdf

The Profitability and Economic Viability of Alaska North Slope and Associated Pipeline Operations

http://www.pwsrcac.org/docs/d0014100.pdf

Richard A. Fineberg/Research Associates. April 27, 2005

Introduction

Despite high oil prices, some observers believe that continued aggressive petroleum development on Alaska's North Slope is not assured. Based on government documents, company reports, other trade publications, press reports and interviews with state analysts, industry experts and tax specialists, this report uses two principal modes of analysis to summarize public information on the profitability and economic viability of North Slope operations, including the associated pipelines systems: (1) long-term financial analysis, utilizing standard industry economic measurements such as rate of return, profitability ratios and net present value; and (2) estimation of the annual revenue North Slope operations and the associated pipelines generates for the operators, the state and the federal governments.

Prince William Sound Risk Assessment Overview

http://www.pwsrcac.org/docs/d0013500.pdf

Dr. Martha Grabowski. June 30, 2005.

Abstract

Risk assessment in marine transportation is an enterprise that has been undertaken for many years. The purpose of this document is to provide an overview of risk assessment, particularly in marine transportation, and to present recommendations for a new or updated risk assessment in Prince William Sound, Alaska. First, an overview of the current state of risk assessment science is presented, followed by a summary of maritime risk assessments that have been undertaken after 1996. Challenges associated with risk assessment in distributed, large-scale system are discussed, along with the particular challenges of risk assessment in marine transportation. Given these considerations, recommendations for a new and/or updated risk assessment in Prince William Sound are then presented. The document concludes with a summary and recommendations for next steps.

Effectiveness of Citizen Involvement

http://www.pwsrcac.org/docs/d0026000.pdf

Linda Robinson, PWSRCAC. June 2006.

Abstract

Citizen involvement in oil transportation was discussed before the 1989 Exxon Valdez Oil Spill (EVOS). After the EVOS, the Oil Pollution Act of 1990 (OPA 90) added mandatory funding by industry for a citizens' group to provide oversight of the Alyeska Pipeline Service Agency terminal and associated tankers. Currently the

Other

Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) fills that role. This volunteer organization represents communities and interest groups that were affected by the EVOS.

This paper discusses the history of this organization, the structure and funding of the council, and provides an overview of its projects and research. Some of the successes involving citizen input include a requirement that all tankers going into Prince William Sound be double hull by 2015; a world class system of tugs escorting tankers in Prince William Sound; installation of an ice-detection radar on a small island near the site of the EVOS; a guidebook for communities affected by manmade disasters; identification of nearshore locations that should be the first to be protected in the case of another spill; and an installation of a system to capture crude oil vapors when tankers take on cargo. Some current projects being undertaken include invasive species that can be transported in the ballast water of tankers, efficacy of dispersants, soil contamination at the tanker loading site, emission of hazardous air pollutants from ballast water treatment processes, and continual review of contingency plans.

Citizen involvement in industry that affects their community is on the rise with other organizations being formed in Washington State as well as in Europe. This paper offers a discussion of the importance of citizens working with industry, and one example of how it is done.