Regional Citizens' Advisory Council

Selected Scientific & Technical Reports 2018

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 contains only scientific and technical reports and is not a complete list of PWSRCAC reports.

A complete list of reports can be found here: http://www.pwsrcac.org/resources/reports-documents/

Photo by Jeremy Robida

MARINE INVASIVE SPECIES

Marine Bioblitz 2016: Re-assessing marine invasions in Valdez, Prince William Sound, Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Bioblitz%202016%20Re-assessing%20marine%20invasions%20in%20Valdez,%20Prince%20William%20Sound,%20Alaska.pdf

Smithsonian Environmental Research Center. July 2017.

Abstract

Biological invasions by non-indigenous species (NIS) are a major force of change in coastal marine ecosystems around the world. Relatively few NIS are known from Alaska's waters to date, compared to other regions, but many NIS occur below Alaska and have been spreading northward. While invasions are a significant and growing concern for Alaska, detection of newly arriving NIS is especially challenging for the region, due to the extensive shoreline and limited resources available.

Several methods show great promise to enhance detection capability for particular "target" taxa with modest cost. First, citizen or public participation in NIS detection can be highly effective, when the target species is relatively large, conspicuous, and easily recognized (from other species). Second, genetic tools offer the opportunity to screen for multiple known target species simultaneously, without detailed morphological analyses.

The purpose of this project was to help advance citizen science and genetic methods to detect target NIS in Prince William Sound (PWS), building on a significant body of previous work by Prince William Sound Regional Citizens' Advisory Council (RCAC) and the Smithsonian Environmental Research Center (SERC) along with various partners. Specifically, we conducted (1) a bioblitz and training event for detection of target NIS by citizen scientists in Valdez and (2) training for RCAC staff to collect zooplankton samples for detection of target NIS using genetic tools. We detected one NIS (previously known for the PWS) during this event and initiated zooplankton sampling for genetic analyses. We recommend both citizen science and genetic tools as key components, and part of a broader strategy, for long-term NIS monitoring and detection in PWS.

Status of International and Domestic Regulations on Installation and Use of Ballast Water Management Systems

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Status%20of%20international%20and%20domestic%20regulations%20on%20installation%20and%20use%20of%20ballast%20water%20management%20systems%20-%202017.pdf

Danielle Verna. February 2017.

Introduction

Ballast water is globally recognized as a dominant transport vector of nonnative aquatic species, representing a significant threat to the environmental and economic health of coastal areas worldwide.

As such, management of ballast water is a longstanding, heavily researched, and evolving field (Bailey et al. 2015). The International Maritime Organization (IMO) has led efforts for decades to control the negative effects of unmanaged ballast water transfer at the international scale. Domestically, the United States Coast Guard (USCG) and the United States Environmental Protection Agency (EPA) have led similar efforts at the federal level. In recent years, regulations have transitioned toward implementing numeric limits of organism concentration in ballast water discharge based on size class. These limits will primarily be met with the use of shipboard management systems. Following is a brief review of the regulations and guidelines related to the installation and use of ballast water management systems by the IMO and US federal entities, summarized in Table 1.

Marine Analysis of Federal and State Ballast Water Management Policy as it Concerns Crude Oil Tankers Engaged in Coastwise Trade to Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Analysis%20of%20federal%20and%20state%20ballast%20water%20management%20policy%20as%20it%20concerns%20crude%20oil%20tankers%20engaged%20in%20coastwise%20trade%20to%20Alaska%20-%202017.pdf

Danielle Verna. January 2017.

Abstract

The ballast water of ships is regulated with an aim to minimize or prevent the introduction of aquatic nonnative species. In the United States, ballast water is regulated at the federal level by the United States Coast Guard (USCG) and Environmental Protection Agency (EPA) as well as by several state programs. Regulations by federal and state agencies are at times overlapping and conflicting. For example, 'crude oil tankers engaged in coastwise trade' were exempted from ballast water management activities by the National Invasive Species Act of 1996, and therefore all subsequent USCG regulations. However, the EPA began to regulate these vessels under the Clean Water Act in 2008. On the west coast, California does not provide such an exemption and in general has more stringent standards than federal entities. Washington also enforces state-specific regulations though they differ from California. This paper reviews the current, and when available proposed, federal and state ballast water regulations on the west coast of the United States as they pertain to the behavior of vessels discharging to Prince William Sound, Alaska; namely, tankers engaged in the transfer of crude oil from the terminus of the Trans-Alaska Pipeline System at the Alyeska Terminal in Port Valdez.

Update: Analysis of Crude Oil Tanker Ballast Water Data for Valdez & Prince William Sound, Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/952.431.160229.VernaBWTdata.pdf

Danielle Verna. February 2016.

Executive Summary

This report describes ballast water data reported by crude oil tankers arriving to Valdez and Prince William Sound, Alaska, from 2005 through 2015. The analysis includes the following:

- Annual number of vessels that discharged ballast water
- Annual volumes of ballast water discharge
- Annual volumes of dirty ballast water discharge (2010 – 2015)
- Ballast water source locations
- Ballast water management locations
- Ballast water management rates
- Ballast water management methods

Between 2005 and 2015, 23 crude oil tankers reported discharging 87,855,788 metric tons of ballast water to Valdez and Prince William Sound. The majority of ballast water was sourced from locations on the west coast of the United States such as Puget Sound, WA, and San Francisco Bay, CA, resulting in 96% coastwise ballast water discharge. The remainder (4%) was sourced from distant locations such as Hawaii and Singapore. Of the 34% of ballast water that was reported to be managed, flow-through ballast water exchange was the preferred method (67%), followed by empty-refill exchange (29%), and alternate methods (4%).

Trends in data should be considered in the context of changes in policy during the time period. For example, the Environmental Protection Agency's 2008 Vessel General Permit (VGP) significantly influenced the management and recordkeeping requirements for crude oil tankers engaged in coastwise trade. The 2008 VGP went into effect in Alaska on February 6, 2009.

Analysis of Crude Oil Tanker Ballast Water Data for Valdez & Prince William Sound, Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Analysis%20of%20Crude%20Oil%20Tanker%20Ballast%20Water%20Data%20for%20Valdez%20and%20Prince%20William%20Sound,%20Alaska.pdf

Danielle Verna. April 2014.

Executive Summary

This report describes ballast water source and management data reported by crude oil tankers arriving to Valdez and Prince William Sound, Alaska from 2005 through 2012. The analysis includes the following:

- Annual number of vessels that discharged ballast water
- Annual volumes of ballast water discharge
- Ballast water source locations
- Ballast water management locations
- Ballast water management rates
- Ballast water management methods

Between 2005 and 2012, 18 crude oil tankers reported discharging 54,642,270 metric tons of ballast water to Valdez and Prince William Sound. The majority of ballast water was sourced from locations on the west coast of the United States, such as Anacortes, WA, Benicia, CA, and Bellingham, WA, resulting in 97% coastwise ballast discharge. The remainder (3%) was sourced from distant locations such as Hawaii and Singapore. Of the 28% of ballast water that was reported to be managed, flow-through

ballast water exchange was the preferred method (71%), followed by empty-refill exchange (27%), and alternate methods (2%).

Trends in data should be considered in the context of changes in policy during the time period. For example, the Environmental Protection Agency's 2008 Vessel General Permit (VGP) significantly changed the management and record keeping requirements for crude oil tankers involved in coastwise trade. The VGP went into effect in Alaska on February 6, 2009.

Marine Invasive Species Technical Support– Quantitative Survey of Nonindigenous Species (NIS) in Prince William Sound: Plankton

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/November%202013%20-%20Quantitative%20Survey%20of%20Nonindigenous%20Species.pdf

Jon Geller, Moss Landing Marine Laboratory; Greg Ruiz, Smithsonian Environmental Research Center. November 2013.

Introduction

Invasions by non-native species are a major force of change in coastal marine ecosystems around the world that is increasing over time. Most non-native species in marine systems are known from temperate latitudes in coastal waters, and especially bays and estuaries, where (a) over 100 non-native species can occur in a single estuary, and (b) the detection rate for new invasions is increasing at an exponential rate (Cohen and Carlton 1998, Ruiz et al. 2000). While relatively few non-native species richness (number) are known at high latitudes, this is also changing as a result of human-aided transport and climate change (Ruiz and Hewitt 2009, Ruiz et al. 2011).

Critical to any attempt to reduce or remediate invasions is the ability to detect and quantify the occurrence of non-native species and especially changes over time (Ruiz and Carlton 2003). Such measures provide vital information about the vectors (transfer mechanisms) involved and the efficacy of management strategies to minimize new incursions.

In addition, detection of new incursions may also be used for control or eradication efforts to reduce unwanted ecological, economic, or human-health impacts.

Non-native species may occur in any habitat, including man-made structures (docks, floats, boats), natural hard substrata, on other organisms (as symbionts), in sediments, and the water column as plankton.

To date, the most comprehensive assessments of invasions have sought to sample many different habitats with diverse methods.

Yet, plankton communities consist of holoplankton and the planktonic larval stages of species (native and non-native) from all habitats, and sampling the plankton may serve as a single, integrative method to detect a large subset of species from all habitats.

Although plankton is relatively easy to obtain, compared to other types of samples, it is among the most difficult to analyze morphologically. The small size of planktonic organisms makes identification challenging, and larval stages of most organisms lack prior description.

Genetic analysis of plankton may allow us to overcome this historical limitation, since existing technology can be used to detect species without relying on morphology. Moreover, plankton communities may be particularly amenable to metagenomic approaches, wherein bulk samples of the entire community can be characterized rapidly. Specifically, with metagenomic analysis of plankton, many thousands of individual organisms can be concentrated in a small volume, unlike most benthic samples, to identify gentoypes present.

In this project, we used a metagenomic approach to characterize plankton from Prince William Sound (PWS), Alaska,with particular attention on detection of non-native species for both holoplankton and meroplankton (larvae of benthic species)

Marine Invasive Species Technical Support Quantitative Survey of Nonindigenous Species (NIS) in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Marine%20Invasive%20Species%20Technical%20Support%20%E2%80%93%20Quantitative%20Survey%20of%20Nonindigenous%20Species%20%28NIS%29%20in%20Prince%20William%20Sound%20-%20July%202012.pdf

Greg Ruiz, Smithsonian Environmental Research Center; and Jon Geller, Moss Landing Marine Laboratory. July 2012.

Introduction

To date, relatively few nonindigenous species (NIS) have been detected in coastal marine waters of Alaska compared to other regions of North America (Ruiz et al. 2000, 2011a). For Prince William Sound (PWS) in particular, this apparent low level of NIS is somewhat surprising, given the large influx of ballast water biota (and potential influx of hull fouling biota, which has not yet been assessed) associated with oil tankers arriving to PWS (McGee et al. 2006). Most of these tankers arrive from ports in the western U.S., including California (Long Beach and San Francisco Bay/Estuary) and Washington (Puget Sound), where hundreds of NIS are now are documented, providing regular transfers of biota from these source ports (Hines & Ruiz 2000). Further, available evidence suggests many of these NIS that can tolerate environmental conditions in Alaska and are capable of establishing populations in PWS (Zabin et al. 2009, deRivera et al. 2011).

Characterizing Risk Associated with Vessel Fouling and Nonindigenous Species in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/risk_with_vessel_fouling_and_nis.pdf

Jeffery Cordell and Elizabeth Sosik. School of Aquatic and Fishery Science; University of Washington and Maurya Faulkner and Chris Scianni California State Lands Commission. October 2009.

Executive Summary

Little is known about the organisms associated with the hulls of ships entering the coastal waters of Alaska, but fouling biota on ship's hulls elsewhere have been shown to be diverse and contain species

that are not native to many of the regions visited by the ships. An initial step in assessing the potential risk of invasions by non-indigenous species (NIS) associated with ship's hulls is to characterize vessel arrivals with regard to risk factors such as voyage history, time spent in port, vessel type, and the distribution and nature of shipping intensity among ports. Another information-gathering step is to summarize information about hull cleaning and maintenance practices of major vessel types that comprise potential vectors for NIS. This information can be used to evaluate the scale of risk of introductions by fouling organisms among vessel types, routes, and ports, and can help identify regions likely to contribute NIS. This approach can help to focus subsequent efforts targeting specific risk factors. Understanding hull fouling associated invasion risk ultimately requires measuring biota associated with hulls. This type of analysis can range from low resolution data gathered from archived hull maintenance video to comprehensive remote-operated vehicle or diver surveys (the latter can include physical samples of fouling communities), but costs for these kinds of analyses increase as the data quality and quantity increases. Thus, analyzing shipping patterns, hull maintenance practices, and the pros and cons of various hull fouling sampling methods can help prioritize how to focus more intensive and comprehensive sampling efforts. In this report, we examine these factors, with particular regard to Prince William Sound, Alaska.

Tunicate: Northward Spread, Diversity, Source, and Impact of Non-Native Tunicates in Alaska: Establishing a Monitoring and Education Network

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/impact_of_non_native_tunicates.pdf

PIs Sarah Cohen, Greg Ruiz; Associated key personnel: Dr. Chela Zabin, Karen Alroy, Verena Wang. September 2008.

Overview

We have achieved our project goals, both in establishing a network of sites (to provide baseline measures) and in using genetic tools to characterize botryllid tunicates invasive to Alaska in comparison to global population samples. These two core elements have laid the groundwork to effectively evaluate the status of introduced botryllids that are found, now and in the future, in Alaskan waters. Toward this end, we have completed extensive collections and genetic analyses of botryllids along western North America (and especially Alaska). Simultaneously, we have experienced a high level of interest, enthusiasm, and participation in the citizen science network, which shows great promise as a low-cost platform to advance diverse education and research goals. We are now working with our partners/collaborators to establish a sustained citizen network to track changes in the geographic distribution and abundance of these tunicates, and possibly other groups, with particular focus on northward spread of non-native species to Alaska.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Aquatic%20Bioinvasion%20Workshop%20Report.pdf

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

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/Biological%20Invasions%20in%20Alaska%E2%80%99s%20Coastal%20Marine%20Ecosystems,%202006.pdf

Gregory M. Ruiz, Tami Huber, Kristen Larson, Linda McCann, Brian Steves, Paul Fofonoff & Anson H. Hines, Smithsonian Environmental Research Center. 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.

Ballast Water Exchange: Efficacy of Treating Ships' Ballast Water to Reduce Marine Species Transfers and Invasion Success?

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/efficacy_of_treating_ballast_water.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 in Prince William Sound deliver approximately 17 million cubic meters of non-oily ballast water annually. Tankers that arrive in Prince William Sound from politically foreign ports are required to undergo mid-ocean ballast 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 tankers 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 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/wp-content/uploads/filebase/programs/nis/broad_scale_nis_monitoring.pdf

Catherine E. deRivera, Greg Ruiz, Jeff Crooks, Kerstin Wasson, Steve Lonhart, Paul Fofonoff, Brian Steves, Steve Rumrill, Mary Sue Brancato, Scott Pegau, Doug Bulthuis, Rikke Kvist Preisler, Carl Schoch, Ed Bowlby, Andrew DeVogelaere, Maurice Crawford, Steve Gittings, Anson Hines, Lynn Takata, Kristen

Larson, Tami Huber, Anne Marie Leyman, Esther Collinetti, Tiffany Pascot, Suzanne Shull, Mary Anderson, Sue Powell, Smithsonian Environmental Research Center, National Estuarine Research Reserve System, National Marine Sanctuary Program. 2005.

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 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.

Projecting Range Expansion of Invasive European Green Crabs (Carcinusmaenas) to Alaska: Temperature and Salinity Tolerance of Larvae

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/nis/expansion_range_of_european_green_crabs.pdf

Anson H. Hines, Gregory M. Ruiz, Natasha Gray Hitchcock, Catherine deRivera, Smithsonian Environmental Research Center. February 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 10oC 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.

Public Comment Regarding the Draft NPDES Permit for BWTF at Alyeska Marine Terminal

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/pwsrcac_public_comment_on_amt_draft_npdes_permit.pdf

James R. Payne, William B. Driskell, Mace G. Barron, Joseph A. Kalmar, Dennis C. Lees. June 2003.

Overview

In overview, the operators of the BWTF are tasked by regulation to stay within proscribed limits of pollutant effluent concentrations and to do no significant harm to the environment of Port Valdez. According to results from 28 years of Alyeska's Environmental Monitoring Program (AEMP), the operators appear to have essentially succeeded in their task. Discharged oil concentrations are reported at very low levels and with the exception of the localized changes to infauna and elevated stress in fish near the diffuser, no significant harm to the environment has been documented. However, the PWSRCAC review finds that the data are, in places, inconclusive in supporting this assessment. Since 1977, various environmental parameters, including physical, chemical, and biological concerns, have been the focus of the AEMP. Many sites or parameters were examined for a few years and then dropped when they seemed to imply an ineffective technique, no harm to the environment, or no exceedance of limits. In hindsight, some of those decisions may have been made with inadequate information and optimistic confidence.

DISPERSANTS & HYDROCARBON TOXICITY

A Review of Literature Related to Oil Spill Dispersants (Technical Version), June 2017

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/Synthesis%20of%20Dispersant%20Literature%20Fingas%202017.FNL.pdf

Merv Fingas. June 2017.

This report is a review of the literature on oil spill dispersants published through May 2017. The report identifies and focusses on recent advances in all topics of dispersion and focusses on dispersant effectiveness, toxicity, and biodegradation. There are three 'issue pillars' for dispersants: effectiveness, toxicity and biodegradation. Effectiveness includes the focus that dispersants must be highly effective to meet the stated objectives of protecting wildlife on the water surface and keeping oil from the shoreline. Secondly, the toxicity of the dispersed oil and the dispersant itself must not lead to environmental damage above and beyond that of undispersed oil. Finally, the biodegradation of oil should be aided and not hindered by the application of dispersants.

A Review of Literature Related to Oil Spill Dispersants, (General Version) September 2017

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/A%20Review%20of%20Literature%20Related%20to%20Oil%20Spill%20Dispersants,%20September%202017.pdf

Merv Fingas, edited by Nuka Research and Planning Group. September 2017.

This report summarizes the literature related to oil spill dispersants through May 2017. It synthesizes key findings to address issues of relevance to the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC). It is the fourth in a report series begun in 2002, in which the author has periodically reviewed the dispersant literature dating back to 1999 for PWSRCAC. As such, this report builds on these previous studies, and includes summary discussion of the past reports in this series.

A Review of Literature Related to Human Health and Oil Spill Dispersants 2014-2018, April 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/A%20Review%20of%20Literature%20Related%20to%20Human%20Health%20and%20Oil%20Spill%20Dispersants,%202014-2018.pdf

Merv Fingas. April 2018.

Several human health studies relating to dispersants (typically Corexit 9500A) and dispersants with oil were carried out. An important series of studies was carried out by performing epidemiological studies on workers employed during the Deepwater Horizon spill. One set of studies was performed on US Coast Guard workers by comparing workers assigned to the Deepwater Horizon to those not working on the Deepwater Horizon spill. These studies indicate that there is an issue with nose, throat and breathing problems for those exposed to dispersants or dispersant-treated oil. Separate studies show that dispersants promote the formation of nano-aerosols by as much as two orders-of- magnitude. These nano particles may be the source of the respiratory irritation noted in the several epidemiological studies of dispersant exposure.
Prince William Sound Dispersants Monitoring Protocol: Implementation and Enhancement of SMART (Special Monitoring of Applied Response Technologies)

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/Dispersants%20Monitoring%20Protocol%20-%20July%202016.pdf

PWSRCAC Guidance Document. July 2016.

Purpose

The primary purpose of dispersant monitoring is to provide feedback about effectiveness and potential adverse impacts to inform the decision to apply, or continue applying, dispersants. A secondary purpose is to evaluate the potential biological toxicity from the application.

This document outlines a dispersants monitoring protocol that builds on the SMART protocol, providing two levels of effectiveness monitoring as well as a detailed biological monitoring component. It also specifies additional pre- and post-spill monitoring activities to complement field testing during a dispersant application, and identifies existing sources of long-term monitoring and environmental data for Prince William Sound that may inform dispersant use and monitoring. This protocol can be applied by the Unified Command to inform decisions about whether to initiation or continue dispersant application. This document was developed with the intent to enhance the available information to support decision-making by working within the existing response framework.

Review of the 2015 Alaska North Slope Oil Properties Relevant to Environmental Assessment and Prediction

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/500.431.160601.MFrvwANSprops.pdf

Merv Fingas Spill Science. June 2016.

Abstract

This paper is a summary of several oil parameters and the spill behavior of the 2015 Alaskan North Slope sample as provided to Environment Canada. Environment Canada analyzed the sample provided to them by PWSRCAC for environmental and physical parameters. The essential parameters included in the 2015 analysis are the oil viscosity, density, and emulsion formation. Oil spill modeling and prediction are important facets of oil spill preparedness. The most important estimation and modeling algorithms are that for oil spill emulsification, evaporation, chemical dispersibility and those that might be used to predict other countermeasures such as mechanical recovery and burning. Oil spill modeling relies on algorithms that require a number of oil property inputs The 2015 sample of ANS oil was found to be similar to the North Slope oils analyzed in 2013 but different from those in the more distant past. It was much lighter and less viscous than those much older samples, but similar to the 2009 and 2013 samples. The environmental behavior parameters of evaporation, emulsification and dispersibility were predicted. These show that they are similar and indicative of a medium oil. The new ANS is a medium oil that does not form emulsion, is dispersible and evaporates to an extent.

Physical Properties, Behaviour and Composition of Alaskan North Slope 2015 Crude Oil

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/500.431.160511.ANSproperities.pdf

Environmental Canada. May 2016.

Introduction

One sample was received from Prince William Sound Regional Citizens' Advisory Council for analysis of physical properties and simulated behaviour testing. Upon arrival, the sample was stored in a dark cold room at 2ºC. Upon reception, the sample was weathered by rotary evaporation (see method of preparation below) to form simulated evaporatively weathered oils without chemical oxidation. The percentage of mass lost by evaporation was monitored. Table 1 summarizes the original sample and the three evaporatively weathered fractions which were prepared.

Hydrocarbon Research Internship

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/500.431.160501.InternHCResearch.pdf

Seth Suydam. May 2016.

Summary

Samples of Alaska North Slope crude oil (ANS) were obtained by the Prince William Sound Regional Citizen's Advisory Council in 2015 and sent to Environment Canada for analytical testing. Testing results indicated no major changes in ANS properties from the last time ANS underwent testing in 2013. The 2015 sample did not emulsify under lab conditions, except in cases of extreme weathering. Based on testing results, approximately 12% by mass of ANS will evaporate within 40 minutes immediately after a spill occurs, 25% will evaporate within 24 hours, and 36% will evaporate within 30 days. The viscosity and density of the 2015 sample both increased as evaporation occurred. Scientific literature indicates reduced dispersant effectiveness for ANS at viscosities exceeding 1000 cP. Based on testing results, this could take anywhere from 2 - 5 days for the 2015 sample depending on weather conditions. As a general rule, crude oil having a density heavier than 20 degrees API is considered unignitable for in-situ burning. Based on test results this might take 1-2 days for the 2015 sample. Test results also indicated mechanical recovery will likely not be compromised provided appropriate skimming equipment is used under workable weather conditions. The figure below illustrates general rules of thumb regarding oil spill response methods for ANS, based on 2015 testing results from Environment Canada. Colder temperatures could shorten windows of opportunity, especially for burning and dispersants. All spill parameters are weather dependent. These timeframes are merely estimates and actual response times will vary depending on environmental conditions.

Polar Compounds in Alaska North Slope Oil and Other Oils: A Literature Survey and Synthesis

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/959.431.160201.PolarCompLitSurv.pdf

Merv Fingas Spill Science. February 2016.

Abstract

Polar compounds as found in oils are hydrocarbon compounds containing nitrogen, sulphur or oxygen. Measurement of the presence of these compounds in oils can be carried out using sophisticated analysis techniques, however quantification and separation of compounds is very difficult and will remain a problem for many years to come. Characterization of polar compounds in oils is at a state of infancy and little polar analysis for Alaska North Slope oil has been carried out to date.

In order to measure the toxicity of a specific compound or class of compounds, separation is needed. Separation is very difficult and in many cases, beyond the scope of today's technology. An alternative has been to synthesize the compound of concern and then test its toxicity. This approach ignores the matrix in which the compound is usually present and the compound of interest may be not bioavailable when present in the actual oil, due to its solubility in oil. Highly polar compounds are likely not present in produced oils such as ANS due to the polar compound's high water solubility. Compounds with moderate or less polarity are typically more soluble in oil than water. Similarly, highly polar compounds produced by biodegradation or photooxidation would be diluted in water during a spill.

The aquatic toxicity of polar compounds compared to aromatic compounds has been tested by using evaporative weathering. Aromatic compounds, particularly that of the 2 to 3 ring polyaromatic hydrocarbons (PAHs), are fairly well-established as the primary toxic component of oils. Polar compounds are soluble in water and thus may pose another source of toxicity. Evaporative weathering tests where photooxidation is not involved, in which some of the low molecular weight compounds and PAHs are lost from the oil, is thought to be one test of the comparison of polar compound toxicity compared to that of the PAHs. These tests show that polar compounds are generally less-aquatically-toxic than the 2 to 5-ring PAHs. Another test that has been performed is that of physical separation of oil components. In these type of tests, polar compounds have again been shown to have less aquatic toxicity that the PAHs in the same oil. Both tests have obvious limitations in that there are many compounds involved.

Naphthenic acids are polar compounds found in many oils and have been studied more extensively than other polar compounds. The lower-molecular weight naphthenic acids are more toxic than the high molecular weight acids, corresponding somewhat to the water solubility differences. Many low-molecular-weight naphthenic acids may not be in Alaskan and other oils that have been contacted with water as some of these compounds are more soluble in water and would largely be stripped out of the oil phase.

The data presented show that while there is little data for Alaskan oils, there is more data on other oils, which serve to scope out the problem of polar compounds in oils and serve as a model of what the compounds and their toxicity might be in Alaskan oils. Currently, it appears that polar compounds in Alaskan oils are generally of low toxicity.

Polynuclear aromatic hydrocarbons in Port Valdez shrimp and sediment

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Polynuclear%20aromatic%20hydrocarbons%20in%20Port%20Valdez%20shrimp%20and%20sediment%20-%20January%202015.pdf

Mark G. Carls, Larry Holland, Erik Pihl, Marilyn A. Zaleski, John Moran, and Stanley D. Rice. January 2015.

Abstract

Small amounts of crude oil hydrocarbons enter the waters of Port Valdez from discharge from the terminal's ballast water treatment facility. Subsistence shrimp fishermen wanted to know if shrimp caught in Port Valdez were safe to eat, so the Council commissioned a report through Auke Bay Lab to provide information about hydrocarbon levels found in shrimp harvested in Port Valdez. While the report conclusions show hydrocarbons accumulate to the greatest degree in shrimp eggs, the overall takeaway message from the study is hydrocarbon tainting of shrimp muscle (the part usually consumed) is well below that which is considered to pose a human health risk. Researchers, however, suggested further study to determine whether the hydrocarbon levels detected in the eggs have an effect on the shrimp's development.

Toxicity of Chemical Dispersants in Alaskan Whales

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Toxicology%20of%20Chemical%20Dispersants%20in%20Alaskan%20Whales%202014.pdf

John Pierce Wise, Sr., Ph.D. University of Southern Maine. November 2014.

Abstract

There have been two major oil crises in United States history, the 1989 Exxon-Valdez oil spill in Alaska and the 2010 Deepwater Horizon Oil Rig explosion in the Gulf of Mexico. The aftermath of both of these events resulted in immediate and severe impacts on wildlife and humans. However, there is still not a full understanding of the long term effects these spills had on wildlife. These events drew attention to the need for toxicological experiments to better understand the impact of oil and the chemicals used to disperse the oil on wildlife species. Of particular interest are the effects on whales as they are air breathing, warm-blooded mammals that nurse their young and can most closely represent humans in the ocean. Whales are important species in food webs, are one of the major bases of ecotourism, are charismatic species that capture the attention of the public at large and can integrate all possible routes of exposure to dispersants in the environment (air, water and food). Consequently, they make excellent models to use for studying the threats and consequences of oil and dispersant exposure. There is very little laboratory-based data regarding the toxicity of these substances in marine mammals. Thus we sought to determine the toxicity of Alaskan oil, dispersants, and chemically dispersed oil in whales. We found that dispersants are cytotoxic and genotoxic to sperm whales but not genotoxic to humpback cells. In addition, we found that oil induced genotoxic effects in whale cells and adding dispersants increased the toxicity of the oil.

A Review of Literature Related to Oil Spill Dispersants

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/A%20Review%20of%20Literature%20Related%20to%20Oil%20Spill%20Dispersants,%202011-2014.pdf

Merv Fingas. June 2014.

Abstract

This report is a review of the literature on oil spill dispersants published from 2011 to June 2014. The report identifies and focusses on recent advances in dispersant effectiveness, toxicity, and biodegradation. Other topics such as behavior and fate are also covered.

The prime motivation for using dispersants is to reduce the impact of oil on shorelines, but the application must be successful and effectiveness high. As some oil would come ashore, discussion remains on what effectiveness is required to significantly reduce the shoreline impact. A major issue is the actual effectiveness during spills so that these values can be used in estimates for the future. The second motivation for using dispersants is to reduce the impact on birds and mammals on the water surface. The benefits of using dispersants to reduce impacts on wildlife still remain unknown. The third motivation for using dispersants is to promote the biodegradation of oil in the water column. The effect of dispersants on biodegradation is still a matter of dispute. Some papers state that dispersants inhibit biodegradation, others indicate that dispersants have little effect on biodegradation. Recent papers, however, confirm that inhibition is a matter of the surfactant in the dispersant itself and factors of environmental conditions. It is clear, on the basis of current literature that the surfactants in some of the current dispersant formulations can inhibit biodegradation.

Effectiveness remains a major issue with oil spill dispersants. It is important to recognize that many factors influence dispersant effectiveness, including oil composition, sea energy, state of oil weathering, the type of dispersant used and the amount applied, temperature, and salinity of the water. The most important of these is the composition of the oil, followed closely by sea energy. It is equally important to note that the only thing that is important is effectiveness on real spills at sea. Oil spill dispersions themselves are not stable and dispersed oil will de-stabilize and rise to the surface. Half-lives of dispersions may be between 4 to 24 hours.

The results of dispersant toxicity testing are similar to that found in previous years, namely that dispersants vary in their toxicity to various species, however, dispersant toxicity is sometimes less than the toxicity of dispersed oil. Of the recent toxicity studies of dispersed oil, many researchers found that chemically-dispersed oil was more toxic than physically-dispersed oil. Some researchers found that the cause for this was the increased PAHs, typically about 10 to 100 times, in the water column. Others noted the increased amount of total oil in the water column. Few researchers noted that the toxicity of chemically-dispersed oil was roughly equivalent to physically-dispersed oil.

The interaction of droplets, particularly chemically-dispersed droplets appears to be an important facet of oil fate. High concentrations of sediment will have significant effect on dispersed oil droplets and the formation of stable OMAs (Oil-Mineral-Aggregates). OMAs appear to be stable over time and sink slowly and sediment on the bottom.

Embryonic crude oil exposure causes cardiac hypertrophy and reduced aerobic performance in juvenile pink salmon and Pacific herring

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Embryonic%20crude%20oil%20exposure%20causes%20cardiac%20hypertrophy%20and%20reduced%20aerobic%20performance%20in%20juvenile%20pink%20salmon%20and%20Pacific%20herring.pdf

John P. Incardona, Mark G. Carls, Larry Holland, Tiffany L. Linbo, David H. Baldwin, Mark S. Myers, Karen A. Peck, Mark Tagal, Stanley D. Rice, and Nathaniel L. Scholz.

Abstract

The 1989 Exxon Valdez disaster exposed the embryos of pink salmon and Pacific herring to weathered crude oil in shoreline habitats throughout Prince William Sound. The Pacific herring population collapsed four years later. The role of the oil spill, if any, in the forage fish decline has remained one of the most prominent unanswered questions in modern natural resource injury assessment. Studies subsequent to the spill identified disruption of heart morphogenesis as a major impact of polycyclic aromatic hydrocarbons (PAHs) derived from crude oil. Here we show that pink salmon and herring embryos exposed transiently to trace levels of Alaskan crude oil develop cardiac abnormalities that lead to permanent changes in heart anatomy and physiological performance. When assessed after 7 to 10 months of growth in clean water, both species showed reduced aerobic capacity and common changes in cardiac morphology, including evidence of ventricular hypertrophy. Therefore, the Exxon Valdez oil spill likely impacted pink salmon and herring more than previously appreciated. Moreover, the particular sensitivity of herring embryos to PAHs suggest that the catastrophic collapse of the Prince William Sound population may have been caused in part by delayed mortality due to developmental cardiotoxicity. These findings extend our understanding of the long-term impacts of oil spills, and apply also to more chronic inputs of PAH pollution to aquatic systems from land-based runoff and other sources.

Analysis of Oil Biodegradation Products

http://www.pwsrcac.net/committees/sac/agendas/documents/931AnalysisofOilBiodegradationProductsmodified.pdf

Merv Fingas, Spill Science. June 2013.

Abstract

Oil that has undergone biodegradation or photooxidation, contains oxygenated compounds. These compounds cannot be analysed by standard extraction and gas-chromatographic methods. Conventional methods do not analyse for polar compounds and would not count them in the analyticalresults. Studies have shown that highly oxidized oil, including that undergoing biodegradation and photooxidation, is not properly analyzed by conventional techniques. Conventional analytical techniques may miss as much as 75% of the oil mass. Similarly for biodegradation analysis, conventional techniques may overstate biodegradation by as much as four times.

Five possible analytical solutions to this problem are suggested and include; thin layer chromatography, derivitization and then GC analysis, FTIR, NMR and HPLC. The latter two techniques are typically applied to only the separated polar fractions of the oil. These techniques are in their infancy and much more work needs to be carried out.

The biodegradation pathways of oil compounds are largely unknown. Biodegradation steps are known only for a few of the thousands of compounds in oils. Analytical methods for many of the biodegradation products are also absent or need development. The situation is very complex and only

extensive research over dozens of years will improve the knowledge. The first step will be a generalized analysis step that includes most oxygenated compounds.

Toxicity Effects of Dispersed Alaska North Slope Oil on Fish

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Toxicity%20Effects%20of%20Dispersed%20Alaska%20North%20Slope%20Oil%20on%20Fish%20-%20Final%20Report,%20March%202013.pdf

Centre for Offshore Oil, Gas and Energy Research (COOGER); Bedford Institute of Oceanography Department of Fisheries and Oceans Dartmouth, Nova Scotia, Canada. March 2013.

Executive Summary

This report describes the experiments conducted by research groups located at the St. Andrews Biological Station, Gulf Fisheries Centre, Bedford Institute of Oceanography; and Queen's University.

Environmental conditions, such as water temperature and salinity, may affect the toxicity of chemically and mechanically dispersed crude oil when accidental spills occur. Impacts of oil spills on local fish populations will also vary depending on the relative sensitivities of resident species and stocks. The objectives of the herring studies conducted by the Gulf Fisheries Centre were to: 1) determine the influence of rearing temperatures (7, 10 and 15ºC) and salinities (7.5, 15 and 30‰) on the toxicity of Arabian Light (ALC) to Atlantic herring (Clupea harengus)embryos; 2) determine if different species (Atlantic vs.Pacific herring [Clupea pallasii]) and spawning stocks (spring vs. fall spawning Atlantic, British Columbia vs. Alaska Pacific) of herring embryos respond similarly to chemically and mechanically dispersed crude oils; and 3) compare the toxicity of three crude oils (ALC; Alaska North Slope, ANS; Mediterranean South American, MESA). Toxicity was assessed from survival-to-hatch, length-at-hatch and the prevalence and severity of developmental abnormalities, incorporated into the blue sac disease severity index (BSD SI), in herring exposed throughout the embryo stage. All end-points assessed indicated greater toxicity of ALC when Atlantic fall embryos were reared at 7°C compared to 10 or 15°C. This increased toxicity at a low rearing temperature did not appear to result from dispersant effectiveness or PAH solubility as expected but to cold stress, increased exposure duration or reduced metabolic processes. Lower salinities (7.5 and 15‰) seemed to increase ALC toxicity by increasing PAH concentrations in these rearing salinities, likely resulting from higher PAH solubility. Atlantic herring were found to be more sensitive than Pacific herring. Within species, sensitivity differences were detected between stocks of Pacific herring, with herring from Alaska being more sensitive than herring from British Columbia.

Toxicity Effects Of Dispersed Alaska North Slope Oil on Fish - Final Report, March 2013- Appendices A-H

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Toxicity%20Effects%20of%20Dispersed%20Alaska%20North%20Slope%20Oil%20on%20Fish%20-%20Final%20Report,%20March%202013-%20Appendices%20A-H.pdf

Ingestion and Effects of Dispersed Oil on Marine Zooplankton

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/Ingestion%20and%20Effects%20of%20Dispersed%20Oil%20on%20Marine%20Zooplankton%20-%20January%202013.pdf

Richard Lee, Skidaway Institute of Oceanography. January 2013.

Introduction

In the past, dispersants have sometimes been applied to oil spills to break up the slicks to help mitigate shoreline oiling. The formation of underwater plumes of dispersed oil after oil slicks are treated with dispersants has important implications for zoo plankton populations within these plumes. Zooplankton in such underwater plumes can be exposed to hydrocarbon concentrations as high as 200 ppm, while water concentrations from untreated spills are in the ppb range (Clayton et al., 1993; Lichtenthaler and Daling 1985). Figure 1 diagrams formation of a plume after an oil slick is treated with dispersant followed by ingestion of dispersed oil droplets by herbivous zooplankton. The predicted movement and hydrocarbon concentrations of a submerged plume of Alaska North Slope crude oil after dispersant application to a slick is shown in Fig. 2. The very uneven distribution of oil after an oil spill, results in zooplankton being exposed to high concentrations of both dispersant and dispersed oil after dispersant is applied to an oil spill.

During the release of large amounts of oil by the Deepwater Horizon incident approximately 6.4 million liters of Corexit 9500 were applied. As discussed below, there are reports and papers showing that Deepwater Horizon oil was taken up by Gulf of Mexico zooplankton. In light of the large amount of dispersant used it seems likely that much of this ingested oil was in the form of dispersed oil.

This review discusses the ingestion and effects of dispersed oil on zooplankton and fish larvae, the different types of surfactants used in dispersants with possible effects on zooplankton, gaps in research and priority areas for future research on effects of dispersed oil on zooplankton.

Scientific Issue Paper on the Use of Dispersants in the Deepwater Horizon Spill

http://www.pwsrcac.org/programs/environmental-monitoring/dispersants/bp-deepwater-horizon-spill/

PWSRCAC.

The council has significant concerns regarding the first response use of dispersants in the BP Deepwater Horizon spill in the Gulf of Mexico. Huge and unprecedented amounts of dispersants were applied via deep-water injection, a tactic that is unproven and potentially harmful. In the words of one federal official, "This is just a giant experiment going on and we're trying to understand scientifically what this means." (i)

The council's concern is so strong because this process set a bad precedent and the risk exists that independent scientific analysis, multi-year in nature, will not start promptly enough to document the impacts of this unprecedented use of dispersants. Therefore the council has decided to offer recommendations on the subject. The council's concern is compounded by the risk that the lack of timely independent analysis will allow broad, general claims to be made about the success of the

dispersants applications, when none are readily apparent or can be proved scientifically. It will be important to see independent, verifiable quantitative data on dispersant effectiveness relative to the BP Deepwater Horizon spill.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/review_of_alaska_related_osd_literature.pdf

Merv Fingas, Environmental Technology Centre, 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.

A Review of Literature Related to Oil Spill Dispersants Especially Relevant to Alaska 2002-2008

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2009-01-22/3_03_attachment_b.pdf

Merv Fingas, Spill Science. September 2008.

Executive Summary

The literature on oil spill dispersants between 2001 and 2008 is extensive, consisting of more than 300 papers. A bibliography is included and updated annually. The prime motivation for using dispersants is to reduce the impact of oil on shorelines. To accomplish this, the dispersant application must be highly successful and effectiveness high. As some oil would come ashore, there is much discussion on what effectiveness is required to significantly reduce the shoreline impact. A major issue that remains is the actual effectiveness during spills so that these values can be used in estimates for assessment and models.

The second motivation for using dispersants is to reduce the impact on birds and mammals on the water surface. As the NAS committee (2006) on dispersants notes, little or no research on this has been carried out any time since the 1980's. The benefits or deleterious effects of using dispersants to reduce impacts on wildlife still remain unknown.

The third motivation for using dispersants is to promote the biodegradation of oil in the water column. The effect of dispersants on biodegradation is still a matter of discussion. There are a number of contradictory papers stating that dispersants inhibit biodegradation others indicate that dispersants have little effect on biodegradation. The most recent papers, however, confirm that inhibition is a matter of the surfactant in the dispersant itself and the factors of environmental conditions. What is very clear at this time is that the surfactants in some of the current dispersant formulations can either inhibit or leave biodegradation unaffected. In recent studies it was never shown that dispersants clearly enhanced biodegradation. Further, there are issues about the biodegradability of the surfactant themselves and this fact can confound many tests of dispersed oil biodegradation. An important issue that rarely is discussed is that oil degrading bacteria, largely live on the water surface, where they would feed on similar natural hydrocarbons in the absence of spills. Another serious question is that of time scale. Biodegradation takes place over weeks, months and years compared to dispersion half-lives of 12 to 36 hours.

During the time period covered by this review, the U.S. National Academy of Sciences published a review of dispersants. This report is summarized here and contains many useful insights, summaries and recommendations.

PWSRCAC Dispersants Research Paper Database

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/Dispersants-Research-Database-Complete-to-2018.xlsx

PWSRCAC.

An annually updated database of dispersants research papers.

Prince William Sound Regional Citizens' Advisory Counci Dispersant Use Position Statement

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/dispersant_use_position_statement.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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/cold_water_dispersant_test_ohmsett.pdf

Elise DeCola, Nuka Research and Planning Group, Merv Fingas, Environmental Technology Centre, Environment Canada. May 2006.

Executive Summary

This report, which was prepared for the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) 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 Ohmsett Observer Report for PWS RCAC 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.

Oil Spill Dispersant Effectiveness Testing in OHMSETT February – March 2006

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/osd_effectiveness_testing_in_ohmsett.pdf

Merv Fingas, Environment Canada, and Elise Decola, Nuka Research and Planning Group. May 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.

A Survey of Tank Facilities for Testing Oil Spill Dispersants

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/osd_testing_survey.pdf

Merv Fingas, Environmental Technology Centre, Environment Canada. May 2005.

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/wp-content/uploads/filebase/programs/environmental_monitoring/review_of_emulsification_tendencies.pdf

Merv Fingas, Environmental Technology Centre, 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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/stability_and_resurfacing_of_dispersed_oil.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 sufactants 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 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 stable. 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 that 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 2-24 hours, with a typical average value of 12 hours.

Weather Windows for Oil Spill Countermeasures

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/weather_windows_for_oil_spill_countermeasures.pdf

Merv Fingas, Environmental Technology Centre, 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 Dispersants Volumes Mar MMS/Exxon Cold Water Dispersant Tests at Ohmsett

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/heated_and_under_reported_oil_ohmsett.pdf

Merv Fingas, Environment Canada. 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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/dispersants_salinity_and_pws.pdf

Merv Fingas, Environmental Technology Centre, 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 exists, 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.

Field Notes and Taped Observations from the OHMSETT Heavy Oil Dispersant Trials

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ohmsett/notes_and_observations_for_ohmsett_trials.pdf

James R. Payne, Ph.D., Payne Environmental Consultants, Inc. October 2003.

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 (CD). This final report contains all the time/date-stamped figures referenced in the earlier report (compiled in Appendix A in the order called out in the text) along with additional data from SL Ross that were not available at the time the original report was prepared.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/evaluation_of_croserf_test_methods.pdf

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

Review of Monitoring Protocols for Dispersant Effectiveness

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/review_of_dispersant_monitoring_protocols.pdf

Merv Fingas, Environmental Technology Centre, 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 a 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. 28 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/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/phototoxicity_of_crude_oil_to_salmon.pdf

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

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/white_paper_on_osd_large_tanks.pdf

Merv Fingas, Environmental Technology Centre, 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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/toxicity_and_crude_oil_to_herring.pdf

Mace G. Barron, P.E.A.K. Research, Mark G. Carls, Jeffrey W. Short, Stanley D. Rice, NOAA/NMFS, Auke Bay Laboratory. February 2002.

Executive 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 CorexitR 9527 either present or absent. CorexitR 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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/report_on_dispersant_testing_as_ohmsett.pdf

Stan Jones, Prince William Sound Regional Citizens' Advisory Council. 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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/white_paper_on_osd_field_testing.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 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 resolve around good chemistry, physics and understanding of the process involved.

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/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/effectiveness_of_corexit.pdf

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

The effect of various states of weather: no weather, 205 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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/potential_for_photoenhanced_toxicity_in_alaska.pdf

Mace G. 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. Dose response 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.

ENVIRONMENTAL MONITORING

September 2017 Berth 5 Oil Spill - Sampling Results and Interpretations, April 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/dispersants/2017%20Berth%205%20Oil%20%20Spill_051718_final.pdf

James R. Payne, Ph.D. & William B. Driskell. April 2018.

On 21 September 2017, an estimated 150 gallons of Alaska North Slope (ANS) crude oil were accidentally released during crude oil loading arm leak testing at Berth 5 of the Alyeska Marine Terminal. As part of the post-spill monitoring efforts, mussels were collected from the same 3 Port Valdez stations annually sampled as part of the PWSRCAC Long Term Environmental Monitoring Program (LTEMP). Collections at Saw Island (SAW) adjacent to Berth 5, Jackson Point (JAC) east of Berth 3, and Gold Creek (GOC) across the port occurred on Sept 29-30 and again, as a follow up, 70 days later on Dec 7-9, 2017 (Figure 1). Two of the sampling sites, SAW and JAC, bracket the shoreline of the release location with the Saw Island site immediately adjacent (west) of Berth 5 (Figure 2). The GOC reference site is 6 km across the Port. This report describes and illustrates the pre- and immediate post-spill hydrocarbon signatures plus the state of recovery in Port Valdez mussels 70 days after the spill.

Winter Species in Prince William Sound, Alaska 1989-2016 Final Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/Winter%20Species%20in%20Prince%20William%20Sound,%20Alaska,%201989-2016.pdf

Prince William Sound Science Center. September 2016.

Abstract

We conducted a literature search and developed a bibliography of research conducted on biological resources during winter in Prince William Sound (PWS) since the 1989 Exxon Valdez oil spill. The literature search returned 133 unique results documenting the presence of 188 species, including 61 zooplankton, 1 mollusk, 1 echinoderm, 7 crustaceans, 61 fish, 50 birds, and 6 mammal species. However, the species list included with the bibliography is by no means a comprehensive list of all

species present in PWS during winter. We were unable to find any published studies or reports documenting sea cucumbers, sea urchins, jellyfish, octopus, and several marine mammal species known to occur in PWS throughout the year. Our bibliography is useful for identifying sensitive biological resources in the Sound and can be used as a tool to inform and update oil spill contingency plans.

Literature Survey: Effects of Hydrocarbons on Mussel Genomics

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/Effects%20of%20Hydrocarbons%20on%20Mussel%20Genomics%20-%20December%202015.pdf

Brenda Ballachey, Lizabeth Bowen, Shannon Waters, A. Keith Miles. December 2015.

Abstract

Industrial activities in coastal areas throughout the world have heightened concerns over degradation of marine environments, including contamination resulting from oil and gas development. Petroleum hydrocarbons have long been recognized to have genotoxic effects, with exposures leading to a range of effects including mutations and cancer. Effects of petroleum exposure have been extensively studied for decades; however, in recent years there have been major advances in new technologies for elucidating the genome and measuring alterations in expression of specific genes in response to contaminant exposure. Herein we provide a review of the literature on developing genomic technologies for the detection of genotoxic effects in mussels and other bivalve species, with a focus on effects of petroleum hydrocarbons. This review was compiled at the request of the Prince William Sound Regional Citizens Advisory Committee. In addition to this review document, we have assembled an annotated list of relevant references including those within this document and additional ones that are not cited here. These references are provided in a separate format (excel file).

Tanker Pollutant Loading to the Prince William Sound Airshed

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/air_quality/Tanker%20Pollutant%20Loading%20to%20the%20Prince%20William%20Sound%20Airshed%20-%20December%202015.pdf

Starcrest Consulting Group, LLC. October 2015.

Introduction

This study quantifies the reductions in crude tanker's air pollution emissions resulting from the implementation of federal and international regulations. The primary regulation that is reducing ship emissions in Prince Williams Sound is the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships Annex VI (MARPOL Annex VI) and its amendments, under which the North American Emissions Control Area (ECA) was established. Prince William Sound is within the North American ECA, which has both fuel sulfur content requirements and advanced oxides of nitrogen (NOx) standards for marine diesel engines on ships with a keel laid date on or after 1 January 2016. In this study, the emissions reductions are estimated as a result of the lower sulfur fuel requirements and the NOx marine diesel engine standards applicable to the fleet calling Prince Williams Sound.

Analysis of SAFETUG Wave Spectra with Respect to PWS Wave Conditions- Project Report

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2010-09-16/4_08_presentation.pdf

John French, Tom Kuckertz, Steve Lewis, and Stan Stephens. September 2010.

General

PWSRCAC's participation in the Maritime Institute of the Netherlands' (MARIN) joint industry projects, SAFETUG I and II, has produced considerable quantities of data and tug information that are of interest to PWSRCAC. The SAFETUG Data Analysis Project was formed to analyze the SAFETUG data and information and to report the findings with respect to their applicability to the Prince William Sound (PWS) tug escort system to the Board. By forming a project broadly representative of board members, committee members, and staff, it is expected that the SAFETUG data analysis project will enhance understanding of SAFETUG and its applicability to accomplishing PWSRCAC's mission of "citizens promoting environmentally safe operation of the Alyeska terminal and associated tankers."

The SAFETUG I and II, joint industry efforts, were devoted to testing the ability of Voith water tractors (VWTs) and azimuthing stern drive tugs to perform escorting and berthing operations. The tests were performed with real tugs on the open water (North Sea) and using scale models in wave tanks at MARIN. In accordance with the testing of physical systems, energy with specific properties is used to excite the system (i.e. the VWT and ASD tugs and models) and the behavior of the system with respect to the excitation is observed. Actual North Sea testing had to use sea conditions found at the time and place of the test; however, wave tank tests could be done using a wide variety of controlled or simulated "sea states" with which to test scale model tugs. PWSRCAC is interested in answering the following question: "Are the waves with which the SAFETUG studies were conducted the same as might reasonably be found in Prince William Sound and the Gulf of Alaska?" To answer this question we will compare the wave spectra used in the SAFETUG testing to the wave conditions in Prince William Sound and the Gulf of Alaska.

Review of the North Slope Oil Properties Relevant to Environmental Assessment and Prediction

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2010-09-16/4_05_attachment_a.pdf

Merv Fingas, Spill Science. June 2010.

Abstract

This paper is a summary of several oil parameters and the spill behaviour of the new

Alaskan North Slope sample as provided to Environment Canada. The essential parameters included in the new analysis are the oil viscosity, density, SARA analysis and distillation curve. Additional data are desirable including: PAH content, naphthalene content, C12-C18 content, and sulfur content.

Oil spill modeling and prediction are important facets of oil spill preparedness. The most important estimation and modeling algorithms are that for oil spill emulsification, evaporation, chemical dispersibility and those that might be used to predict other countermeasures such as recovery and burning. Oil spill modeling relies on algorithms that require a number of oil property inputs.

The new sample of ANS oil was found to be atypical of North Slope oils from the past. It was much lighter and less viscous than any previous samples. The environmental behaviour parameters of evaporation, emulsification and dispersibility were predicted. These show that they are similar but more indicative of a light oil than previous ANS samples.

Saline Layering in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/saline_layering_in_pws.pdf

Prince William Sound Science Center, Musgrave Oceanographic Analysis. October 2010.

Summary

From profiles of conductivity, temperature and depth provided by Prince William Sound Science Center (PWSSC) to Musgrave Oceanographic Analysis (MOA), we analyzed the mixed layer depth (MLD), the potential energy of mixing, and the salinity and temperature in the upper layers of Prince William Sound (PWS) by season and region. We defined the MLD as the depth at which a change from the surface density (expressed as) of 0.125 kg m-3 has occurred. As a better measure of the potential for mixing of the upper ocean, we calculated the potential energy of mixing to a depth of 10 m, the minimum depth over which dispersed oil is expected to mix. The results of this analysis show that the MLD is shallowest in the summer and deepest in the winter.

The seasonal potential energy reflects the seasonal MLD with greatest values in summer and smallest values in winter. Near-surface salinity is lowest in the summer when freshwater runoff is greatest and near-surface temperature is greatest in summer.

Generally, in the periphery of the sound the MLD is less, the potential energy of mixing in the top 10m is greater, and the salinity is less than in the central sound and the Gulf of Alaska. The temperature in the periphery of the sound, relative to the temperature in the central sound and Gulf of Alaska, depends on season. In winter it is less and in summer it is greater.

Prince William Sound RCAC Environmental Monitoring Program Preliminary Review

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2009-05-07/3_02_attachment.pdf

Joel H. Reynolds, Ph.D.; Nick R. Braman. October 2007.

The Prince William Sound Regional Citizen's Advisory Council (RCAC) established the Long Term Environmental Monitoring Program (LTEMP) in 1993 with the overarching goal of "…identify[ing]

present and potential future adverse impacts on the ecosystem of Prince William Sound (PWS) and the Gulf of Alaska (GOA) …as a consequence of oil transportation," (KLI 1993).

The LTEMP provides the monitoring component for a larger adaptive management program for oil transportation system in PWS (KLI 1993). Periodic peer review is required to maintain an effective long-term monitoring program (MacDonald and Smart 1993, Lovett et al. 2007) as aspects of the program naturally tend to change through time, both in terms of explicit evolution driven by past findings, a sign of program success, and implicit changes in objectives, strategies, and protocol components, such as analytical procedures. This appears to be the first explicit review of LTEMP as an effective long-term monitoring program.

Aquatic Noise Pollution from Oil Tankers and Escort Vessels in Prince William Sound, its Effects and Impacts on the Marine Environment of the Sound: Literature Search from 1980 to Present

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/aquatic_noise/aquatic_noise_report.pdf

Ann E. Bowles, Ph.D., Stefanie K. Graves, HUBBS-SEAWORLD RESEARCH INSTITUTE. October 2007.

Introduction

This report summarizes the available literature on the effects of anthropogenic (human-made) aquatic noise on the marine environment of Prince William Sound, Alaska (PWS, the Sound).

Of particular interest are measured and potential effects of noise from vessel traffic associated with the Trans-Alaska Pipeline System (TAPS), including oil tankers and their tug escorts, the Alyeska Pipeline Service Company (APSC) Ship Escort Response Vessel System (SERVS).

Other vessel traffic, such as cruise liners, fishing vessels, recreational boating, and scientific research vessels, were considered during the review because they have the potential to contribute significantly to the noise environment in PWS.

The review covers literature from approximately 1980 to the present (2007). Sections below review what is known about noise produced by various activities in PWS, describe briefly what is known about sound transmission in PWS, and outline possible effects on marine mammals and fish. The final section reviews what is known about the contribution of TAPS traffic to the overall noise environment in the Sound, the possible effects it may have on threatened and endangered marine mammals and fish, and recommends steps that could be taken to obtain information needed to further document effects.

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/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/ltemp_ecology_of_tidal_flat_communities.pdf

Sean P. Powers, Mary Anne Bishop, Erika Clesceri, Department of Marine Sciences, University of South Alabama, Dauphin Island Sea Lab. 2006.

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 bisect 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 Delta 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 (C) and nitrogen (N), which are both essential elements for growth.

Reference Oils Report and Errata for Reference Oils Report

Reference Oils Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/ltemp_kinnetic_laboratories_reference_oils_report.pdf

Errata for Reference Oils Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/ltemp_errata_for_kinnetic_laboratories_report.pdf

Kinnetic Laboratories, Inc. March 2006.

Introduction

The Prince William Sound Regional Citizens' Advisory Council (RCAC) is an independent organization that was formed in 1989 in response to the T/V Exxon Valdez oil spill (EVOS). The RCAC was later certified under the Federal Oil Pollution Act of 1990. Operating under a contract with Alyeska Pipeline Service Company, the RCAC acts to minimize the environmental impacts associated with the terminal and the oil transportation tanker fleet. The RCAC's mission includes the performance of research designed to help understand and evaluate environmental impacts associated with oil transportation, including baseline research conducted prior to another spill event. 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).

PWSRCAC Long Term Environmental Monitoring Program (LTEMP) Annual Reports

LTEMP monitors environmental impacts of the operations of terminal facilities and crude oil tankers in the Prince William Sound region. Mussel tissue is monitored for petroleum hydrocarbons at 10 specific sites in Prince William Sound. Results are summarized in the following annual reports.

2017 LTEMP Monitoring Report

2015 LTEMP Monitoring Report

2008-2013 LTEMP Monitoring Report

2008-2012 LTEMP Monitoring Report

2006-2008 LTEMP Monitoring Report

2005-2006 LTEMP Monitoring Report

2004-2005 LTEMP Monitoring Report

2003-2004 LTEMP Monitoring Report

2002-2003 LTEMP Monitoring Report

2002-2003 LTEMP Report, Table of Contents and Executive Summary

2000-2002 LTEMP Report

2000-2002 LTEMP Report Appendix A

2000-2002 LTEMP Report Appendices B and C

2000-2002 LTEMP Report Appendix D

1999-2000 LTEMP Report

1998-1999 LTEMP Report

1997-1998 LTEMP Monitoring Report

1993-1996 LTEMP Report

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/hydrotox/accumulation_of_polycyclic_aromatic_hydrocarbons.pdf

Mark G. Carls, Jeffrey W. Short, James Payne, Marie Larsen, Josie Lunasin, Larry Holland, Stanley D. Rice, NOAA, National Marine Fisheries Service, Auke Bay Laboratory, Payne Environmental Consultants, Inc. 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.

Port Valdez Sediment Coring Program Final 2004 Monitoring Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/sediment_coring_program_final_monitoring_report.pdf

Mark A. Savoie, Janet M. Savoie, John H. Trefry, Carrie M. Semmler, Debra W. Woodall, Robert P. Trocine, James M. Brooks, and Tom McDonald, Kinnetic Laboratories, Inc., Florida Institute of Technology, Department of Marine & Environmental Systems, 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 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.

Assessing Transport and Exposure Pathways and Potential Petroleum Toxicity to Marine Resources in Port Valdez, Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/Assessing%20Transport%20and%20Exposure%20Pathways,%202001.pdf

James R. Payne, William B. Driskell, Mace G. Barron, Dennis C. Lees. December 2001.

Abstract

Review of the data from a long-term hydrocarbon-monitoring program at the Alyeska Marine Terminal and a nearby control site suggests Alaska North Slope (ANS) crude oil residues from the terminal's ballast water treatment plant (BWTP) have accumulated in the intertidal mussels within the port. Fortunately, the polynuclear aromatic hydrocarbon (PAH) and saturated hydrocarbon (SHC) levels measured in sediments and mussel tissues and the estimated water-column levels are low and unlikely to cause deleterious effects. From the signature of analytes, we were able to discriminate between particulate- (oil droplet) and dissolved-phase signals in the water column and then correlate those signals with seasonal uptake of hydrocarbons in mussels and with absorption in herring eggs (from other studies). These findings give new insight into the transport and exposure pathways in Port Valdez. The results also suggest a surface microlayer mechanism may be responsible for seasonal transport of ANS weathered oil residues from the BWTP diffuser to intertidal zones to the north and west of the terminal. The possibility of concentrated contaminants in a surface microlayer combined with the potential for photoenhanced toxicity should be considered in future investigations of potential impacts in Port Valdez.

2001 Port Valdez Monitoring- Final Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/ltemp_port_valdez_monitoring.pdf

Michael H. Salazar, Jeffrey W. Short, Sandra M. Salazar, James R. Payne. February 2002.

Introduction

The Prince William Sound Regional Citizens' Advisory Council (RCAC) is concerned whether or not petroleum hydrocarbons from the ballast water treatment facility (BWTF) of the Alyeska Pipeline Service Company's Valdez Marine Terminal are present in the water column outside the National Pollutant Discharge Elimination System (NPDES) permit mixing zone. If they are present, to what extent and have they exceeded the limits that are recognized to have harmful effects on marine organisms. Michael Salazar and Sandra Salazar (Applied Biomonitoring), Jeffrey Short (National Oceanographic and Atmospheric Administration (NOAA) Auke Bay Lab), and James Payne (Payne Environmental Consultants, Inc.) conducted an integrated monitoring study in the winter/spring of 2001 to address these concerns. The study was based on three state-of-the-art sampling methodologies: caged mussels, plastic membrane devices (PMDs), and large-volume water samples (LVWSs). Chemical fingerprinting was used to identify the source of detected hydrocarbons. The main goal of the study was to obtain sufficient data to allow RCAC to formulate substantive recommendations for testing requirements for the NPDES permit to be issued in 2002.

Caged Mussel Pilot Study Port Valdez Alaska 1997

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/ltemp/ltemp_caged_mussel_study_from_applied_biometering.pdf

Applied Biomonitoring. February 1999.

A caged mussel pilot study was conducted between February and April, 1997 in Port Valdez, Alaska. The purpose of this study was to determine the feasibility of using transplanted mussels to monitor effluent from the Ballast Water Treatment Facility (BWTF) at a depth of 70 meters, where mussels are not normally found. A total of 2100 Pacific blue mussels (Mytilus trossulus) were transplanted from the intertidal zone in Anderson Bay to 7 stations in the vicinity of Alyeska's BWTF effluent diffuser for a period of 56 days.

The three most important questions to be answered by this study were the following:

- Will the mussels survive?
- Will the mussels grow?
- Will they accumulate chemicals associated with the BWTF effluent?

OIL SPILL PREVENTION AND RESPONSE

Final Report: PWSRCAC Contract #6531.16.01, "Weather Buoy Demonstration Project," August 15, 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/weather/Weather%20Buoy%20Demonstration%20Project.pdf

Prince William Sound Science Center. August 15, 2018.

The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has long had an interest in the successful operation and maintenance of weather buoys installed in Prince William Sound (PWS). There have been multiple instances where weather buoys have failed and they have not been serviced in a timely manner. Committee members and PWS mariners have questioned the location of the West Orca Bay buoy and many believe the buoy should have been installed in a location closer to Naked Island. There was also a desire to transmit near real-time weather data via Automated Identification System (AIS) so it would be immediately available to vessels in the area. The goal of the project was for PWSRCAC to work with the Prince William Sound Science Center (PWSSC) and Micro Specialties Inc. to develop and install a weather buoy at 60.667469N 147.186615W near Naked Island. Data would be disseminated in near real-time via the internet (and if possible, by AIS).

Circulation in Port Valdez, Alaska measured by Lagrangian Drifter Experiments, towed acoustic Doppler current profiler and hydrographic profiles in June and September 2016, and March 2017, March 22, 2108

http://www.pwsrcac.org/observer/new-tech-improves-knowledge-water-circulation-port-valdez/

Prince William Sound Science Center. March 22, 2018.

The Prince William Sound Science Center (PWSSC) conducted a study of circulation for the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) to describe and quantify the currents within Port Valdez, Alaska, and to address concerns regarding the potential dispersal of contaminants, such as spilled oil, within the fjord basin. PWSRCAC felt this research would help the oil spill response community to understand the fate and transport effects of oil, gather specific decision making information related to chemical dispersant use, and assist with prioritization and tactics related to sensitive area protection strategies. The knowledge gained from this study would also aid in designing and validating any future models of oil movement and general circulation applied to Port Valdez, including the oil spill contingency and response (OSCAR) model, the general NOAA oil modeling environment (GNOME) and regional ocean modeling system (ROMS).

Final Report: Hinchinbrook Entrance Wind and Wave Extremes, November, 20, 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/Hinchinbrook-Entrance-Wind-Wave-Extremes.pdf

Tetra Tech Canada Inc. November 20, 2018.

The Port of Valdez ships about 500,000 barrels per day of crude oil by means of sea-going tankers. An identified risk to this marine shipping is the possibility of a tanker losing power as it passes through Hinchinbrook Entrance, about 74 nautical miles from Valdez. One of the risk-reducing measures currently in place is the use of tanker escort vessels (powerful tug boats) that could keep a stricken tanker off the coast, and possibly tow it to safety. Tetra Tech Canada Inc. (Tetra Tech) was retained by the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) to conduct a study that better defines weather related conditions at Hinchinbrook Entrance and their effects on the feasibility of efficient and safe rescue operations by these tanker escort vessels, by defining the frequency and duration of conditions under which the escort vessels could not operate. Such conditions are defined as closure conditions, during which a tanker is not allowed to pass through Hinchinbrook Entrance.

Comparison of Capabilities Between Prince William Sound Emergency Towing Package and IMO/SOLAS Emergency Towing Package for Tankers

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/Comparison%20of%20Capabilities%20Between%20Prince%20William%20Sound%20Emergency%20Towing%20Package%20and%20IMO-SOLAS%20Emergency%20Towing%20Package%20for%20Tankers%20-%202017.pdf

Little River Marine Consultants. August 2017.

Introduction

Little River Marine Consultants were retained by Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) under Contract Number 8020-16-01 to conduct a of comparison of capabilities between Prince William Sound Emergency Towing Package, the IMO/SOLAS Emergency Towing Package for Tankers, and other requirements applicable to tankers operating in Prince William Sound.

Prince William Sound Oil Spill Recovery Optimization Analysis

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/756.431.170201.NukaROA.pdf

Nuka Research and Planning Group, LLC. February 2017.

Abstract

The marine oil spill recovery system in Prince William Sound is well established. The Prince William Sound Regional Citizens' Advisory Council commissioned a study to analyze potential options to increase oil recovery by optimizing both the open-water and nearshore on-water recovery systems based there. A suite of publically-available and custom-built oil spill response models was applied to a hypothetical oil spill of Alaska North Slope crude to first assess the extent to which recovery systems are currently optimized and then explore options to enhance recovery. After examining the extent to which the systems are currently optimized, modifications to the large, open-water recovery systems focused on increasing their capacity to encounter oil, while modifications for the smaller nearshore systems sought to increase their capacity to recover oil. Systems with disc skimmers performed best overall, particularly when the transfer of recovered fluids from primary to secondary storage was considered. The

advantages of disc skimmers would apply to other types of oleophilic skimmers. Decanting mini-barges did not increase oil recovery for the nearshore system, but decanting did enable the open-water Valdez Star to skim longer and collect more oil. The results of this study can be used to inform potential real-world modifications, which, if deemed feasible by responders, will necessitate real-world testing and training.

Ship Simulation and Mariner Study of the Maritime Implications for Tank Vessels Utilizing Potential Places of Refuge, Mid-Prince William Sound Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/Ship%20Simulation%20and%20Mariner%20Study%20of%20the%20Maritime%20Implications%20for%20Tank%20Vessels%20Utilizing%20Potential%20Places%20of%20Refuge,%20Mid-Prince%20William%20Sound%20Alaska%20-%202017.pdf

Safeguard Marine, LLC. January 2017.

Executive Summary

Purpose: The purpose of this study is to assess the capability of tank vessels (tanker) in distress utilizing Mid–Prince William Sound Potential Places of Refuge (PPOR) that were determined in the Prince William Sound Subarea Contingency Plan. This study does not examine PPOR Knowles Head Anchorage, because it is currently utilized as an anchoring site for tankers. North Smith Island, Outside Bay, and McPherson as identified by the Contengency Plan are all examined.

Methods: This study utilized 16 interviews with local subject-matter experts and stakeholders, as well as 34 ship bridge simulations under the operation of professional mariners. Interview questions focused on three Mid-Prince William Sound PPOR, and simulations included a fourth alternative PPOR in the proximity to North Smith Island.

Recommendation 1. Both North Smith Island and the alternative location at North Smith Island should not be considered a viable PPOR as simulations of tankers consistently grounded.

Recommendation 2. Outside Bay should not be considered a viable PPOR for tankers as it is too close to a ten fathom curve, and does not provide a safe swing area for tankers at anchor.

Recommendation 3. McPherson Bay is a viable PPOR for tankers. The site allows enough swing area for tankers at anchor, and provides some protection from the majority of environmental conditions.

Recommendation 4. The PPOR identified in the Prince William Sound Subarea Contingency Plan in North and South Prince William Sound should be similarly assessed for their capability to provide potential refuge for tankers in distress.

Prince William Sound Oil Surrogates Workshop

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/oil_simulants/708.431.170101.PWSSurrogatesWG.pdf

Nuka Research and Planning Group, LLC. January 2017.

Abstract

This report summarizes the process and outcomes from the 2016 Prince William Sound Oil Surrogates Workgroup. The workgroup was convened to establish consensus among spill response professionals and regulators regarding the release of oil surrogate materials to support oil spill response training and exercises in the Prince William Sound region. The workgroup met four times over a nine month timeframe, and a subset of the workgroup held an additional two meetings to develop an exercise plan for an equipment deployment in Passage Canal, near Whittier that would incorporate the use of two surrogates: peat moss and wood chips. The exercise, which was scheduled for September 2016, was eventually cancelled due to contracting issues associated with the indemnification of spill responders. Despite this fact, the workgroup was successful in addressing the study questions that PWSRCAC set out for this project, which included: arriving at consensus about the usage of a surrogate for an onwater exercise; documenting the process; selecting one or more appropriate substances to release; establishing parameters for the release; and identifying any hurdles or unanswered questions generated through this process.

Satellite-Based Pollution Monitoring in Prince William Sound Final Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/900.431.160101.SatBasedMonitor.pdf

C-CORE. January 2016.

Introduction

Prince William Sound (PWS) on the southern coast of Alaska is characterized by high volumes of marine traffic both commercial (oil tankers, fishing vessels) and recreational. The ability to detect potential pollution events is vital for the area's environmental and economic integrity. The Regional Citizens' Advisory Council (RCAC) was formed to promote environmentally safe pipeline and tanker operations throughout PWS and its adjacent waters. In an effort to support RCAC's mandate, this project was carried out to demonstrate the utility of satellite surveillance for environmental monitoring in PWS. Using freely available radar imagery from the recently launched Sentinel-1 mission, emphasis was placed on detecting potential oil slicks as well as large vessels transitioning PWS on their way to and from the Port of Valdez.

A Review of Best Available Technology (B.A.T.) for a Sentinel Tug Stationed at Hinchinbrook Entrance

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/A%20Review%20of%20Best%20Available%20Technology%20for%20a%20Sentinel%20Tug%20Stationed%20at%20Hinchinbrook%20Entrance.pdf

Robert Allan Ltd. January 2014.

Introduction

Robert Allan Ltd. was retained by the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) in December 2012 (Contract No. 8010.12.01) to conduct a broad review of the current Best Available Technology (B.A.T.) in Escort Tug technology worldwide, and to perform a Gap Analysis of the tugs within the SERVS Fleet against that current B.A.T.. As an adjunct to that report, a review of the requirements for a "Sentinel Tug" to be stationed at Hinchinbrook Entrance was also requested. It was agreed that this topic should be treated in isolation from the broader Escort Tug B.A.T. study, and hence this report constitutes the findings of this separate Sentinel Tug study.

Surface-washing Agents: An Update 2013

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/non-dispersing_response_technologies/Surfacewashing%20Agents%20or%20Beach%20Cleaners%20by%20Merv%20Fingas%20-%202013.pdf

Merv Fingas, Spill Science. 2013

Abstract

Surface washing agents or beach cleaners or shoreline cleaning agents, are formulations containing surfactants and are designed to remove oil from surfaces such as shorelines. The desired mechanism is that of detergency rather than dispersion. These agents generally have properties different from dispersants and are of typically lower aquatic toxicity, do not disperse oil except at higher mixing energies and are applied quite differently than dispersants. Surface washing agents are typically applied on oil stranded on beaches during low-tide phases and then the oil is removed using low-pressure water and directed toward an oil recovery area.

Testing on surface washing agents has been limited and was usually carried out in the laboratory. Application on real spilled oil has been carried out with some documentation. Older use of dispersants showed that there was increased beach penetration. Newer specifically-formulated surface washing agents, have been used without these or other adverse effects.

Tests show that several surface washing agents will disperse oil if high mixing energy is applied. These dispersions are relatively unstable and will largely revert within 24 hours.

The aquatic toxicity of surface washing agents varies widely. Some effective products have high effectiveness and low toxicity, thus toxicity concerns are not as great as with some other treating agents.

This version of the report reviews the old work and updates the topic until 2013.

Review of Solidifiers: An Update 2013

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/non-dispersing_response_technologies/Review%20of%20Solidifiers%20An%20Update%202013%20by%20Merv%20Fingas.pdf

Merv Fingas, Spill Science. 2013.

Abstract

This paper is a review and update of oil spill solidifiers and summarizes data on solidifier effectiveness, composition, and application.

The prime motivation for using solidifiers is to recover very small oil spills or to protect wildlife. A major issue is the actual effectiveness or advantage over sorbents or mechanical recovery. Once solidifiers are used, other recovery methods are difficult, if not impossible. Use of skimmers is precluded once oil is treated with solidifiers.

There are three types of solidifiers, polymer sorbents (not truly solidifiers), cross-linking agents and polymers with cross-linking agents. Each type has unique characteristics. Polymer sorbents, common at this time, simply adsorb oil into spaces between polymers. Oil is only held by weak forces into these spaces. Strictly speaking, these products should be classified as sorbents. Cross-linking agents form chemical bonds between molecules in the oil. Polymers with cross-linking agents also form chemical bonds. Reaction time and reactivity are issues. Some solidifiers react so quickly that they solidify the first oil they contact and may form a crust on the oil surface. This prevents solidifier from reaching underlying oil. Other proposed solidifiers react so slowly that they are not of use. Some agents will cross-link or react with other materials such as oil boom, docks and other organic materials.

Another motivation for using solidifiers is to reduce the spread of oil and protect wildlife and receptor areas. To accomplish this, the solidifier application must be well targeted and effectiveness high. Furthermore, the recovery of the solidified oil must occur rapidly and efficiently. Recent solidifier use on very small and thin spills near shore have been reported as effective. Past tests on the use of solidifiers offshore have not had the same success. Solidifiers might be best restricted to small spills on water near shore. Land-based spills might be treated, however there are several data gaps on this type of application.

Only limited effectiveness testing has been carried out on solidifiers, mostly in the past.
Laboratory testing requires re-examination. More laboratory work is needed on the stability of solidified oil and other aspects of the solidifier issue.

Few environmental studies have been done on solidifiers. Data gaps include: the fate and effects of solidifiers and solidified oil in the environment, toxicity other than aquatic toxicity, the biodegradation of solidifiers and solidified oil, the long term fate and effects of solidified oil in landfills, studies on mixing of solidifiers with oil (by type), and studies of optimal application of agent and recovery of solidified oil. Further studies on the applicability of the technology and its limitations are advised.

Review of Oil Spill Herders

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/environmental_monitoring/non-dispersing_response_technologies/Review%20of%20Oil%20Spill%20Herders%20by%20Merv%20Fingas%20-%202013.pdf

Merv Fingas, Spill Science. 2013.

Abstract

Herding agents are surfactant mixtures or singular surfactants, used to drive thin slicks of oil to a desired location or to push slicks together so that they can be collected or burned. Herding agents contain a surfactant which has a spreading pressure greater than that of oil. Historically these agents were not used to any extent. Recently they have been tested as agents which may assist the burning of oil in ice situations. The idea is that the herding agents may push the oil together to yield burnable thicknesses in those cases where it is too thin to burn.

Herding agents have limitations such as they are not useful in any but calm conditions and the limitation is that only about a 3 mm slick can be herded together. Further, the herding effect diminishes with time as the surfactants dissolve slowly or adhere to solid objects in their path. Action is probably limited to about one hour. Herding agents would be used by spraying them around the slick to compress the slick inward. At this time, herding agents are not approved for use in the USA nor are they common commercial products.

A Review of Best Available Technology in Tanker Escort Tugs

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/A%20Review%20of%20Best%20Available%20Technology%20in%20Tanker%20Escort%20Tugs.pdf

Robert Allan Ltd. November 2013.

Introduction

Robert Allan Ltd. was retained by the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) under Contract Number 8010.12.01, dated November 12, 2012, to provide an assessment and professional opinion on the capabilities and performance of the present SERVS escort tug fleet in comparison to the "Best Available Technology" (BAT) available worldwide in this specialized field of ship design and engineering today.

There have been dramatic developments and significant improvements in escort tug design in the past decade. The SERVS tugs; specifically the ETT Class Voith Water Tractors and the PRT Class Azimuthing Stern Drive (ASD) tugs, are now both approaching fifteen years of age and while certainly not old in ship years they do pre-date many of the more innovative developments in escort tug technology of the past decade. It is therefore appropriate to see how these vessels compare to the best escort tugs currently available; identify where there may be gaps in capability; and to identify how the present vessels might be altered to match current BAT as closely as possible.

In this context it is useful to identify precisely what is meant by "Best Available Technology" (BAT) in the context of escort tugs. That definition is contained in the Alaska Department of Environmental Conservation (ADEC) Regulation 18 AAC 75.455(k)(3), as follows:

"Technology identified under 18 AAC 75.425(e)(4)(A) [as BAT] will be evaluated using the following criteria, if applicable:

> (A) whether each technology is the best in use in other similar situations and is available for use by the applicant;

(B) whether each technology is transferable to the applicant's operations;

(C) whether there is a reasonable expectation each technology will provide increased spill prevention or other environmental benefits;

(D) the cost to the applicant of achieving best available technology, including consideration of that cost relative to the remaining years of service of the technology in use by the applicant;

(E) the age and condition of the technology in use by the applicant;

(F) whether each technology is compatible with existing operations and technologies in use by the applicant;

(G) the practical feasibility of each technology in terms of engineering and other operational aspects; and

(H) whether other environmental impacts of each technology, such as air, land, water pollution, and energy requirements, offset any anticipated environmental benefits."

However 18 AAC 75.425(e) speaks more to spill response than to spill prevention through escorting. Nonetheless the broad BAT policy objectives described above can also be used to describe escort tug technology.

This report describes the evaluation process undertaken to conduct this BAT review, and provides the requested assessment of the SERVS tug fleet.

Escort Winch, Towline, and Tether System Analysis

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/escort_winch_towline_and_tether_system_analysis.pdf

Robert Allan Ltd. August 2012.

Introduction

Robert Allan Ltd. was retained by PWSRCAC under Contract Number 8570.12.01 to conduct an investigation into the nature of the towing systems in use aboard the existing escort tugboats in use within the Ship Escort Response Vessel System (SERVS) in Valdez, Alaska, and to determine how those systems compare to what can be considered as the current Best Available Technology (BAT) in escort towing systems worldwide.

This summarizes the findings of our research and investigations into this subject.

Fishing Vessel Owner Meeting, 2011

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/fishing_vessel_training/2011_fishing_vessel_owner_meeting.pdf

PWSRCAC. March 2011.

Prince William Sound Regional Citizens' Advisory Council's (PWSRCAC) purpose in hosting this meeting was to engage with representatives from the fishing vessel (FV) spill response program and dialogue on the overall health and well-being of that program. It had been a year since the program faced major hurdles, and PWSRCAC felt it was important to engage with fleet representatives. At the meeting start, PWSRCAC explained to participants that the end goal was to provide recommendations for improving the program to Alyeska/SERVS based on the concerns and comments from the meeting.

OSRI Balloon-Based Spill Surveillance System Operations and Testing Results

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/balloon_based_oil_spill_surveillance_system/osri_balloon_surveillance_system_operations_and_test_results.pdf

W. Scott Pegau. June 2011.

This document is designed to describe in more detail the use and operation of a balloon surveillance system. A system was purchased by the Prince William Sound Science Center (PWSSC) in 2009 for the purpose of testing its applicability for oil spill surveillance. The original concept for the system was an output of a workshop titled, "Hydrocarbon sensors for oil spill prevention and response" (http://www.pws-osri.org/publications/Hydrocarbon%20Sensors.pdf) that was jointly sponsored by the Oil Spill Recovery Institute (OSRI) and the Alliance for Coastal Technology. The desire was to develop a system to provide aerial observation capability within a response fleet. The tethered balloon system was chosen because it has simpler permitting requirements and operations needs than unmanned aerial vehicles (UAV). This document focuses on the system owned by the Prince William Sound Science Center with discussion about other systems as applicable. There are other vendors of balloons and camera systems. Some additional information on alternative systems is provided in the section on selection criteria later in this document. This document builds upon the operation manual provided by the manufacturer, a lessons-learned document from Brian Green of Alaska Clean Seas related to testing done with him, and lessons learned from other deployments. It benefited from the input of all parties involved in the testing in particular, Brian Green (ACS), Jeremy Robida (PWSRCAC), and Regina Ward (BP Exploration Alaska).

A Review of Double Hull Tanker Oil Spill Prevention Considerations

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_prevention_planning/double_hull_tanker_review.pdf

Elise DeCola, Nuka Research and Planning Group. December 2009.

Executive Summary

Over the past twenty years, the US oil tanker fleet, including those vessels involved in the Trans-Alaska Pipeline System (TAPS) trade in Prince William Sound (PWS), has undergone major engineering and structural improvements to comply with federal and international standards requiring that new oil tankers be constructed with double hulls, while older single hull vessels are phased out of US and international fleets.

Double hull tankers have traditionally been viewed as offering a higher level of oil spill prevention as compared to single hull construction, because the outer, double hull of the vessel can be penetrated without causing a release of cargo. Several studies have demonstrated that the rate of oil outflow from a double hull tanker involved in a grounding or hull breach is generally less than from other tanker designs. Practical experience supports these studies, as there have been a number of incidents where a double hull tanker's outer hull has been breached, but pollution has been avoided by the containment afforded by the intact inner hull.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/oil_spill_response_gap/2008_non-mechanical_response_gap_estimate.pdf

Nuka Research and Planning Group, LLC. April 2008.

Executive 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.

Response Gap Estimates for Two Operating Areas in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/oil_spill_response_gap/mechanical_response_gap_estimates.pdf

Nuka Research and Planning Group, LLC. February 2007.

Executive 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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/role_of_human_factors_in_vessel_oil_spills.pdf

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

Executive Summary

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/wp-content/uploads/filebase/programs/oil_spill_prevention_planning/weather_data/wind_comparisons.pdf

Richard M. Brown, Micro Specialties, Inc. and Orson P. Smith. 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).

Community Oil Spill Response Forum Final Report

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_prevention_planning/Community%20Oil%20Spill%20Response%20Forum%20Final%20Report.pdf

Nuka Research and Planning Group, LLC. October 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 Prince 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/wp-content/uploads/filebase/programs/oil_spill_response_operations/fishing_vessel_training/december_2005_servs_fishing_vessel_training_program.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/wp-content/uploads/filebase/programs/oil_spill_response_operations/oil_spill_response_gap/mechanical_gap_response_methods.pdf

Nuka Research and Planning Group, LLC. May 2006.

Executive Summary

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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/review_of_oil_spill_responses_1993-2000.pdf

Elise DeCola, Nuka Research and Planning Group.

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.

The data set sampled clearly illustrated that the actual mechanical recovery amounts recorded for spills to US waters during the mid to late 1990s tend to exceed the 10% to 30% efficacy range often cited by oil spill planning professionals.

Prince William Sound Regional Citizens' Advisory Council In Situ Burning Position Paper

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/pwsrcac_position_on_insitu_burning.pdf

PWSRCAC. November 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/wp-content/uploads/filebase/programs/oil_spill_prevention_planning/c-plan_tanker/Proposed%20Approach%20to%20Downstream%20Planning%20for%20Nearshore%20Response%20&%20Sensitive%20Areas%20Protection%20Outside%20PWS..pdf

Nuka Research and Planning Group, LLC. October 2004.

Executive 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/wp-content/uploads/filebase/programs/oil_spill_prevention_planning/combining_fire_house_and_community_response_teams.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.

Field Test Report: Coherent UHF Radar for Ice Detection

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/ice_detection/coherent_uhf_radar_for_ice_detection.pdf

C-CORE. June 2003.

Executive Summary

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 beam width 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.

VALDEZ MARINE TERMINAL

Secondary Containment Liner Integrity Evaluation, Valdez Marine Terminal Valdez, Alaska, October 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/Secondary-Containment-Liner-Integrity-Evaluation.pdf

Geosyntec Consultants, Inc. October 2018.

This report provides recommendations by Geosyntec Consultants, Inc. (Geosyntec) for evaluating the integrity of the secondary containment systems for the East Tank Farm at the Valdez Marine Terminal (VMT) located in Valdez, Alaska. The VMT is operated by the Alyeska Pipeline Service Company (APSC) and is designed to store and load crude oil transported to the facility via the Trans-Alaska Pipeline System. This report was prepared for Prince William Sound Regional Citizens' Advisory Council (PWSRCAC), a non-profit corporation aimed at promoting the environmentally safe operation of the VMT, in accordance with Professional Services Agreement 5052.18.01 between PWSRCAC and Geosyntec.

2013-2017 Valdez Marine Terminal Water Quality Data Review, September 25, 2018

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/water_quality/2013-2017%20Valdez%20Marine%20Terminal%20Water%20Quality%20Data%20Review.pdf

PWSRCAC. September 25, 2018.

The purpose of this report is to provide information that will help identify potential or actual problems pertaining to the operation and maintenance of the Valdez Marine Terminal's (VMT) Ballast Water Treatment Facility (BWTF) and Sewage Treatment Plant (STP). This report is intended to help inform the Terminal Operations and Environmental Monitoring (TOEM) Committee's review of the VMT's water quality permit, which is currently in the process of being renewed. The information provided herein focuses on water quality data gathered and reported by Alyeska Pipeline Service Company (Alyeska) to the Alaska Department of Environmental Conservation (ADEC) and the U.S. Environmental Protection Agency (EPA) from 2013-2017. The current water quality permit was originally valid for that period of time, although an extension of that permit has been granted by ADEC while it is being renewed (such permit extensions are common and allowable under ADEC regulations). The VMT's water quality permit was last renewed in 2012, became effective in 2013, and expired on December 31, 2017, but is still in force per the previously mentioned ADEC-granted extension (U.S. EPA, 2012).

Review of Piping Inspection Program at the Valdez Marine Terminal

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/piping/Review%20of%20Piping%20Inspection%20Programs%20at%20the%20Valdez%20Marine%20Terminal%20by%20Dynamic%20Risk.pdf

Dynamic Risk Assessment Systems, Inc. November 2014.

Executive Summary

This report is an assessment of the current and planned inspection programs for crude oil transport piping sections located at the Valdez Marine Terminal (VMT). It seeks to verify that all corrosion issues potentially affecting piping integrity are being identified, characterized and resolved in a timely fashion, because a considerable portion of the crude oil transport piping at the VMT has not been subjected to internal inspection to validate piping integrity since construction. The report evaluates Alyeska inspection programs as they pertain to piping at the VMT and how these programs compare to industry standards and practices.

Remote Control of VMT

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/remote_control_of_vmt/Remote%20Control%20Of%20Valdez%20Marine%20Terminal%20-%202014.pdf

Hisey and Associates, LLC. February 2014.

Executive Summary

This report describes the history and development of the project and discusses the policies, practices, and procedures Alyeska made available for review relating to the remote control of the VMT. It presents a synopsis of the applicable regulations and recognized industry standards and best practices related to control system operation and management. PWSRCAC is specifically interested in understanding the possible risks associated with the remote operation of VMT assets from Alyeska's Operations Control Center (OCC) located in Anchorage.

Wave-Induced Delays in Cargo Transfer at Valdez Marine Terminal – Berth 4

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/2012%20Wave-induced%20Delays%20in%20Cargo%20Transfer%20at%20Valdez%20Marine%20Terminal%20Berth%204%282%29.pdf

Maria Kartezhnikova, Orson Smith and Peter Olsson. December 2012.

The Valdez Marine Terminal on the south side of Port Valdez in Prince William Sound, Alaska, occasionally experiences extreme easterly winter winds that either render oil boom deployed around a moored tanker to be overtopped by waves or prevent the safe deployment of the boom on arrival of a tanker. Either contingency results in disruption of oil transfer with the threat of overwhelming storage capacity at the terminus of the trans-Alaska oil pipeline. Investigations of long-term wind data measured

in Port Valdez, the east-west-oriented fjord on which the Valdez Marine Terminal is located, revealed that easterly winds on the south side by the terminal are typically stronger than on the north side where winds are recorded for public archives. Recorded wind data was not available on the south side of Port Valdez and installation of a recording anemometer in the vicinity of the terminal is recommended. Alternatives investigated to reduce oil transfer disruptions during extreme easterly winds include positioning an ocean tug upwind (with or without a barge) as a wave barrier, temporary and permanent deployment of harbor-type floating breakwater, and deployment upwind of an extra oil boom as a partial wave barrier.

Deployment of harbor-type breakwater is not recommended due to risk of rigid units and attached mooring lines accidentally floating downwind against the operational oil boom, the tanker, and the terminal structure. Operational tests of a tug and barge dynamically positioned upwind and deployment of an additional oil boom upwind are recommended.

The worst-case scenario of a Trans-Alaska Pipeline shut-down can be avoided by assuring that sufficient storage capacity remains in service at VMT, such that cessation of oil transfer to tankers in severe weather can be occasionally accommodated. The measures recommended above will also serve in the undesirable event that a spill accidentally occurs at the berth and severe weather arises when containment depends on the effectiveness of the boom surrounding the tanker and berth.

Corrosion Survey of Valdez Marine Terminal

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/2012%20Corrosion%20Survey%20of%20Valdez%20Marine%20Terminal.pdf

R. Heidersbach. December 2012.

Objectives

The objectives of this project include:

- Review recent corrosion-related projects and reports associated with VMT.
- Review appropriate State of Alaska, US government, and international standards associated with corrosion control.
- Review APSC procedures as they relate to corrosion to insure compliance with the appropriate guidelines listed in section 2.3.2 above.
- Visit the Valdez Marine Terminal to determine if the appropriate corrosion control monitoring and inspection procedures are in effect.
- Because of the nature of the PWSRCAC charter, all of the work on this project emphasized corrosion control as it might affect hydrocarbon (crude oil and associated by-products) releases into the environment.
- While the VMT operates a power plant and other facilities that can corrode, the emphasis for this project was on the following equipment, the corrosion of which could result in releases of crude oil or associated chemicals into the environment:
    - Crude oil piping systems
    - Crude oil storage tanks 6

- Oily water piping systems
- Vapor recovery systems
- Above ground storage tanks
- Berth structures and pilings

The emphasis on this project was on procedures, and no attempt was made at detailed corrosion inspection of the VMT. We did, however, note corrosion whenever we saw it, and this report does discuss those instances of corrosion noted during our visit to the VMT.

It was expected that corrosion-related inspections and maintenance would be underway by other contractors while the DRI team was at the terminal, and this was the case. We tried to minimize any disruption of these inspections or repair efforts.

Valdez Marine Terminal Tank Secondary Containment System Catalytically Blown Asphalt (CBA) Liner Integrity Review and Testing Options

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2012-09-20_board_meeting/4-06---Attachment%20B%20-%20PWSRCAC%20letter%20to%20Alyeska%20regarding%20the%20VMT%20Tank%20Secondary%20Containment%20System%20Cataytically%20Blown%20Asphalt%20Liner%20Integrity%20Review%20and%20Report.pdf

PWSRCAC. August 2012.

The following summarizes initial research completed on the Catalytically Blown Asphalt (CBA) liners installed as part of the Valdez Marine Terminal (VMT) Secondary Containment System. This research includes an initial assessment of the type and suitability of a CBA liner for use as a secondary containment liner in a petroleum storage tank farm and options for permeability testing.

Review of EPA Draft Permit, Fact Sheet, and Other Documents for Proposed Reissuance of Valdez Marine Terminal NPDES Wastewater Discharge Permit

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/epa_reissuance_documents_review_for_vmt_discharge_permit.pdf

James R. Payne, William B. Driskell, Joseph A. Kalmar. March 2012.

Executive Summary

The overall objective of the Ballast Water Treatment Facility (BWTF) is to recover oil from ballast water and to treat runoff from rainfall and snowmelt, crude storage draws, and miscellaneous site process waters introduced through the Industrial Wastewater Sewage System (IWSS) prior to discharge. Since the last NPDES issuance, the BWTF has undergone a significant reduction in volumes processed which has necessitated a system redesign. In short, the system has been redesigned with surplus capacity (10MGD for the current 2MGD flow).

The proposed NPDES permit is essentially a renewal of permissions, with modest modifications to previously permitted operations, to continue discharging treated ballast water. But with onsite waste products becoming equal or more dominant in proportion to the (now cleaner) ballast water, we don't know what to expect or to be monitoring for. Oily ballast water will comprise only 25-55% of the future influx and the onsite IWSS influents are likely to be much more variable in composition than the consistently-oiled ballast water. We suggest a special study to characterize the effluent stream from the redesigned system under various flow and seasonal conditions to more fully understand the BWTF constituents and treatment efficacy.

Redundant Communications Between: OCC and VMT- Project Report

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2008-09-18/4_03_attachment.pdf

PWSRCAC. 2008.

General

In response to a series of pending requests for information on redundancy of control communications between a remotely located Operational Control Center (OCC) and controlled assets at the Valdez Marine Terminal (VMT), Alyeska personnel and contractors held a meeting on April 7, 2008 at 10:00 a.m. in the Anchorage OCC (AT&T Building on Government Hill) for the purpose of discussing the requested information with PWSRCAC staff. The attendees at this meeting were Barry Roberts, Paul Liddell (SCADA expert), Morgan Henrie, Gregg Knutsen, Rod Mitchell (SCADA expert), Jarid Kling, others from Alyeska plus Tom Kuckertz from PWSRCAC.

This report consists of a (1) description of the communications network topology; (2) description of communications assets; (3) discussion of communications and control redundancy; (4) discussion of designed-in redundancy; (5) examination of design and testing documents; and (6) a summary.

Seismic Re-Engineering of the Valdez Marine Terminal (VMT)

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/seismic_reengineering_vmt.pdf

Terry R. West, Ph.D., P.E. and Kyu Ho Cho, Ph.D., P.E. December 2008.

Introduction

The second phase of this work was initiated May 1, 2008 to follow up on the extensive and office study conducted in 2006 (West and Cho, 2007) on the Valdez Marine Terminal. This first study involved a detailed analysis of the rock slope stability for the site. The Executive Summary for that report and the table of data compiled by PWSRCAC on slope stability are included in Appendix A of this current report.

The initial purpose of the second phase of work was to determine the extent to which Alyeska had considered the recommendations of the 2007 report.

Rock Slope Stability of the VMT

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/rock_slope_stability_vmt.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 0.7Hw/Hslope or equal to pore pressure of 0.6Hw/Hslope with 0.1g of horizontal acceleration will cause the BWT Slope to become unstable. For the PVR Slope, the external loading conditions equal to 0.85Hw/Hslope or equal to pore pressure of 0.8Hw/Hslope with 0.1g of horizontal acceleration or 0.55Hw/Hslope 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 0.35Hw/Hslope, and the external loading conditions equal to pore pressure of 0.15Hw/Hslope 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 0.7Hw/Hslope or the external loading conditions equal to pore pressure of 0.45Hw/Hslope 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 0.65Hw/Hslope or the external loading conditions equal to pore pressure of 0.5Hw/Hslope 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/wp-content/uploads/filebase/programs/terminal_operations/natural_disaster_hazards_valdez.pdf

Alaska Begét Consulting. March 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.

2006 Fire Report, Alyeska Terminal

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/lca_inc_fire_safety_review_vmt.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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/From%20Tankers%20to%20Tissues%20%E2%80%93%20Tracking%20the%20Degradation%20and%20Fate%20of%20Oil%20Discharges%20in%20Port%20Valdez,%20Alaska.pdf

James R. Payne, Payne Environmental Consultants, Inc., William Driskell, Joan Braddock and Justin Bailey, 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/wp-content/uploads/filebase/programs/terminal_operations/vmt_non_tank_corrosion_abatement.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 nontank 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, Alyeska Marine Terminal

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/amt_bwtf_hydrocarbon_biodegradation.pdf

Payne Environmental Consultants. May 2005.

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.

Fire Hazard Assessment for Valdez Crude Tank Internal Floating Roofs

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/capstone_fire_hazard_assessment.pdf

Capstone Engineering Services, Inc. January 2004.

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.

MARINE SERVICES TRANSITION

Recommendations to Verify and Sustain Prevention and Response System Readiness in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/802.431.170907.LRMCnukaReadines.pdf

Little River Marine Consultants & Nuka Research and Planning Group, LLC. September 2017.

Executive Summary

In 2018, Edison Chouest Offshore (ECO) will replace Crowley Marine Services as the provider of tugs, barges, equipment, and personnel for Alyeska Pipeline Service Company's (Alyeska) Ship Escort/Response Vessel System (SERVS). This transition will bring new tugs, barges, and equipment to Prince William Sound. New personnel will also come to Valdez, playing key roles in oil spill prevention and response for the Valdez Marine Terminal and associated tanker traffic.

The arrival of new tugs and custom-built response barges to Prince William Sound provides an excellent opportunity for improved oil spill prevention and response. In order to verify that this improvement is realized, it will be important to verify the capabilities of new crew, vessels, barges, and other equipment. The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) contracted Little River Marine Consultants and Nuka Research and Planning Group, LLC to recommend options for to verify readiness of the new resources during the transition and in the future.

The authors recommend a combination of computer (mathematical) hydrodynamic modeling, full mission bridge simulations, scale-model testing, field demonstrations, and table top exercises (the latter related only to personnel and response decision-making). We recommend a series of activities to verify

the capability of the new tugs and barges to assure their capability to perform oil spill prevention and response:

1. Conduct initial computer hydrodynamic modeling and full mission bridge simulations to identify the tug maneuvers most likely to be effective with the different tug and tanker configurations, and evaluate whether rescue maneuvers would be expected to stop a tanker within the distance available in different parts of the Sound up to worst-case conditions.
2. Conduct field demonstrations in a narrower range of conditions to validate the tug modelling results, beginning in calm conditions and working in up to at least 90th percentile conditions for both wind and waves based on data from Seal Rocks buoy near Hinchinbrook Entrance. (Based on 2013-2016 data, 90th percentile conditions are 22-knot winds and 12-foot seas.)
3. Use a combination of on-water and table top exercises to verify that the response system can deploy and sustain the response tactics according to the timeline and other specifications necessary to meet state response planning requirements.
4. Conduct ongoing exercises to sustain readiness related to both prevention and response for all crews and in all seasons.

The recommendations are based on U.S. Coast Guard and Alaska Department of Environmental Conservation regulations applicable to assessing oil spill prevention and response for tankers in Prince William Sound. Recommendations regarding verifying tug rescue capabilities follow the approach used when the current escort vessels were introduced in 1999-2001.

Development of the Current Prince William Sound Escort System: Regulations, Analysis, and System Enhancements

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/801.431.170608.NukaservsHistory.pdf

Nuka Research and Planning Group, LLC. June 2017.

Abstract

Within two months of the T/V Exxon Valdez oil spill in Prince William Sound (PWS), the State of Alaska mandated that all tankers shipping crude oil through PWS be escorted. Today, Alyeska Pipeline Services Company operates the Ship Escort/Response Vessel System (SERVS), which is governed by both federal and state regulations. This report documents the process through which the current escort system evolved by summarizing relevant technical studies and other activities that lead to the current system. While escort system development was guided by a series of collaborative efforts by the shipping companies, SERVS, Prince William Sound Regional Citizens' Advisory Council (PWSRCAC), the U.S. Coast Guard (USCG), and the Alaska Department of Environmental Conservation (ADEC), the system that was ultimately established was compelled by ADEC's authority under the State of Alaska's statutes and regulations, and complemented by federal statute and regulations.

A Review of the Proposed New Escort and Support Tugs for Tanker Operations in Prince William Sound

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/A%20Review%20of%20the%20Proposed%20New%20Escort%20and%20SupportTugs%20for%20Tanker%20Operations%20in%20%20PWS%20-%20Feb%202017.pdf

Robert Allan LTD. February 2017.

Summary

This review identifies many aspects of both proposed tug designs that indicate (a) a lack of thoroughness in proving suitability for purpose of the tugs, and (b) unfamiliarity with the requirements for safe and sensible operation in the Alaskan climate. The latter issues are perhaps not all critical to the vessel base mission but will certainly render the boats difficult to operate and to maintain well. Many other issues are raised that are simply good design practise issues that could be revised at minimal cost to provide a safer and better operating environment for the crew, and result in less downtime and long term maintenance. The most critical aspects of the design review are summarized below, categorized for each vessel type according to:

- Performance Predictions
- General Design Configuration, and
- Suitability for Operation in Alaskan Environment

Industry and Class Standards for Escort Tugboats

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/tanker_escorts/801.431.170128.LRMCtugStandrds.pdf

Little River Marine Consultants. January 2017.

Background

Alyeska Pipeline Service Company (Alyeska) is changing their marine services provider from Crowley Marine Services to Edison Chouest Offshore in July 2018. The marine services contractor provides escorts and general purpose tugs, oil spill recovery barges, and the associated personnel to operate these vessels and others in the Alyeska system. Little River Marine Consultants was retained by Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) to develop a summary of modeling, simulations, and full-scale testing identified by the industry and classification societies for escort tugs in the U.S. and around the world. As part of this process, Little River Marine Consultants developed the summary contained in this report of recognized standards for escort tugboats as addressed among a number of different organizations, and identified supporting documents as an attachment to this document. This supporting reference summary is just one piece of the overall effort by the PWSRCAC, intended to help develop recommendations to Alyeska, the Prince William Sound Shippers, and regulatory agencies.

OTHER

Coping with Technological Disasters: A User Friendly Guidebook

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/Coping-With-Technological-Disasters-Guidebook-Version-3.pdf

PWSRCAC. January 2019.

The purpose of the Coping with 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. In essence, it is an assessment tool and road map for dealing with these disasters so that communities, businesses, and individuals alike understand what a technological disaster is, how it differs from a natural disaster, and what to expect both during the disaster and in the years following the event. Although natural disasters occur more often, technological disasters, which are human-caused, tend to have a greater, more profound emotional impact on people. And, natural disasters can cause technological disasters such as the oil spills caused by Hurricane Katrina and Hurricane Harvey in 2015 and 2017 respectively. Technological disasters can disrupt an ecosystem for many years and tend to disrupt the psychological well-being of communities for long periods of time.

Coping with Technological Disasters: Appendices

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/oil_spill_response_operations/coping_with_technological_disasters_appendices.pdf

PWSRCAC. December 2004.

Peer Listener Training

Part of the "Coping With Technological Disasters" guidebook project included a training course on peer listener training. This training teaches peer-listening techniques that allow community members to counsel each other. A community member can learn to be an advisor, friend, and referral agent for people who may not want professional services or may not know that help is available.

The peer listener training information is available in the guidebook's Appendix F. The council also produced an award-winning video/DVD training course based on the peer listener training.

Developed during the aftermath of the Exxon Valdez oil spill, this training was used during the aftermath of Hurricane Katrina, and is now being used to help victims of disasters such as the BP/Deepwater Horizon oil spill.

The updated version is available now. If you would like a DVD copy, please contact the council's Anchorage office: 277-7222. Peer Listener Training Manual

The Peer Listener Training Manual was updated by the Mississippi-Alabama Sea Grant Consortium to help with response to BP's 2010 Deepwater Horizon disaster in the Gulf of Mexico. Find the Gulf of Mexico version on the consortium's website: http://masgc.org/assets/uploads/publications/523/11-006_2.pdf

Peer Listener Train the Trainer Training Session, Anchorage Alaska Final Report

http://www.pwsrcac.org/wp-content/uploads/filebase/board_meetings/2017_01_19_board_meeting/3-03--Attachment--Final%20Report%20Peer%20Listener%20Train%20the%20Trainer%20Training%20Session.pdf

University of South Alabama Coastal Resource & Resiliency Center. September 2016.

Summary

By any metric, the Peer Listener Train the Trainer Training Session was a success. Facilities at the BP Center were excellent, and PWSRCAC staff members were helpful and accommodating. The training presentations were found to be interesting and relevant, and were generally well-received. Based upon formal evaluations and informal comments, an overwhelming majority of trainees learned a lot during the session and were highly pleased and appreciative of the opportunity to participate. As they share their newly acquired skills and knowledge with their fellow community members and bring the Peer Listening concept to bear on community needs and problems, these Peer Listener graduates have the potential to make significant contributions to the well-being of their respective communities.

Iceberg Future Iceberg Discharge from Columbia Glacier, Alaska

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/columbiaglacier/Future%20Iceberg%20Discharge%20from%20Columbia%20Glacier,%20Alaska%20-%20Reports%201%20to%205%20and%20Final%20Report.pdf

W. T. Pfeffer Geophysical Consultants. 2012-Final Report June 2015.

Final Abstract

Columbia Glacier, in the northeastern corner of Prince William Sound and ca. 12 miles distant from the path of tankers leaving the southern terminus of the Alaska Pipeline, has been in a state of rapid tidewater retreat since the early 1980s. Icebergs discharged by the glacier during the retreat have largely been contained within the moraine shoal at the position of the terminus prior to the glacier's retreat, but the fraction of icebergs crossing the moraine and entering Prince William Sound proper still pose a potential hazard to ship traffic in the Sound.

This study assesses the current and future status of iceberg discharge from Columbia Glacier. There is a long history of glaciological research at Columbia Glacier that we can draw on, much of it conducted by

the US Geological Survey in the 1970s and 1980s. In addition to these resources, starting in 2012 and continuing at present, we have worked on the glacier and in the fjord collecting and compiling new datasets, including time---lapse photography, weather data, tectonic uplift, ice motion (diurnal to annual time scales), bathymetry, ocean water properties, and ice surface topography. The details of these investigations are described in our five earlier reports to PWSRCAC, but the overall conclusions of the project are stated here, and we make our final assessment of Columbia Glacier's future retreat, the characteristics of iceberg discharge, and our judgment of the primary hazards posed by the glacier in the future. We estimate that the tidewater retreat phase of Columbia Glacier may continue for as long as another 20 years, but that icebergs discharged from the retreating terminus in future will be reduced both in size and number. The increasing distance that icebergs must traverse between the retreating terminus and the moraine shoal at Heather Island (where the vast majority of icebergs are trapped and prevented from escaping into the Sound proper), as well as increasing water temperature, will also contribute to further degradation of icebergs before they reach the shoal. Risk to tanker traffic from icebergs will thus likely be reduced, but not absent, in the next two decades. In addition to risk to tankers, however, a new class of risk may be developing to other boat traffic in the inner Columbia Fjord, as this area becomes more accessible with declining iceberg density.

Iceberg Detection Performance Simulations to Support the Installation of New S6 Processor with the Reef Island Radar

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/maritime_operations/ice_detection/Iceberg%20Detection%20Performance%20simulations%20to%20Support%20the%20Installation%20of%20New%20S6%20Processor%20with%20the%20Reef%20Island%20Radar.pdf

C-CORE. July 2014.

Introduction

In 2002, under contract from the Prince William Sound Regional Citizens' Advisory Council (PWS-RCAC), C-CORE assisted with the installation of an ice detection radar on Reef Island in PWS (Figure 1). The primary function of the ice detection radar is to provide a means to locate icebergs as they calve from Columbia Glacier and drift across the Sound towards the shipping lanes. This provides a means for deciding whether it is safe for tankers and other vessels to transect the Sound through the region of highest iceberg density; this region is generally located in front of the Columbia Glacier and in the general vicinity of Point Freemantle and Glacier Island. The installation of the ice radar on Reef Island was a joint initiative, led by RCAC, and involved C-CORE, the US Coast Guard (USCG) and Ship Escort/Response Vessel System (SERVS).

The PWS ice detection radar, in its original form, consisted of a USCG surplus Vessel Traffic System (VTS) surveillance radar and a SeaScan processor from Sigma Engineering Limited. The SeaScan processor is past end of life and is presently non-operational (as of March 2014). This report provides some guidance and rationale behind the installation of a modern S6 Ice Navigator from Rutter Inc.

The Effectiveness of Citizen Involvement

http://www.pwsrcac.org/wp-content/uploads/filebase/resources/citizen_oversight_and_history_of_the_council/effectiveness_of_citizen_involvement.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 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.

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

http://www.pwsrcac.org/wp-content/uploads/filebase/programs/terminal_operations/The%20Profitability%20and%20Economic%20Viability%20of%20Alaska%20North%20Slope%20and%20Associated%20Pipeline%20Operations,%202005.pdf

Richard A. Fineberg/Research Associates. 2005.

Despite high oil prices, some observers believe that continued aggressive petroleum development on Alaska North Slope is not assured, Based on government documents, company report, 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 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/wp-content/uploads/filebase/programs/maritime_operations/Prince%20William%20Sound%20Risk%20Assessment%20Overview,%202005.pdf

Dr. Martha Grabowski. 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.