# OIL SPILL SCIENCE *and* TECHNOLOGY

Edited by
Mervin Fingas

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# Oil Spill Science and Technology

## Prevention, Response, and Cleanup

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# Oil Spill Science and Technology

# Preface

Oil spill studies continue to evolve. While there are few books on the topic, there are regular conferences and symposiums which provide updates. This is the first book on the topic of oil spills for some time. As such, this book focuses on providing material that is more practical and somewhat introductory. While every attempt was made to include the essential material, there may be some gaps. The importance of many sub-topics changes with time and current spill situations.

All material in this book, including introductions have been peer reviewed by at least two persons. The following peer reviewers are acknowledged (in alphabetical order): Carl Brown, Phil Campagna, Francois Charbonneau, Dagmar Schmidt Etkin, Ken Doe, Eric Gundlach, Kurt Hansen, Mike Kirby, Debra French McCay, Hugh Parker, Roger Percy, Karen Purnell, Doug Reimer, Gary Sergy, Debra Simecek-Beatty, Heidi Stout, Jordan Stout, Zhendi Wang, and Chun Yang. A special thanks goes out to the following reviewers who reviewed several papers (again in alphabetical order): Fred Beech, Leigh de Haven, Ben Fieldhouse, Anita George-Ares, Ron Goodman, Peter Lane, Robin Law, Bill Lehr, Jacqui Michel, and William Nichols.

A special thanks goes out to the authors, many of whom put in their own time to complete their chapters. Their names appear throughout the text. Following this forward, I have a brief biography of each of them.

I would also like to thank the many people who provided support and encouragement throughout this project, especially Meibing. I also thank Environment Canada and my former colleagues for their help and support. Environment Canada is acknowledged for permission to use materials and photos from my former employment.

# About the Contributors

**Carl Brown** Dr. Carl E. Brown is the Manager of the Emergencies Science and Technology Section, in the Water Science and Technology Directorate of Environment Canada. Dr. Brown has a doctorate degree in Physical Chemistry from McMaster University and a BSc in Laboratory Science from Ryerson Polytechnical University. Prior to joining Environment Canada, Dr. Brown was a research scientist on a Natural Sciences and Engineering Research Council (NSERC) Industrial Fellowship with Intera Information Technologies (now Intermap). Dr. Brown has post-doctoral experience as a research associate with the Organic Reaction Dynamics and the Laser Chemistry Groups at the Steacie Institute for Molecular Sciences, at the National Research Council of Canada and held a Canadian Government Laboratory Visiting Fellowship in Chemistry, with the Laser Chemistry Group, Division of Chemistry, National Research Council of Canada in Ottawa. His specialities include airborne oil spill sensor development, and the application of laser technologies to environmental problems. He has authored over 180 scientific papers and publications. Dr. Brown is the Chemical Science Cluster Leader for the CRTI (Chemical, Biological, Radiological, Nuclear, and Explosives Research and Technology Initiative) Program lead by Defence Research and Development Canada (DRDC) and Public Safety Canada. Dr. Brown was one of 24 scientists who recently completed the inaugural Scientists as Leaders program.

**Greg Challenger** Greg Challenger is a Principal Marine Scientist for Polaris Applied Sciences, Incorporated in Seattle, Washington, U.S.A. Mr. Challenger is a marine ecologist by training and is involved in scientific support for oil spill and ship grounding response, natural resource injury assessment and development of habitat restoration programs. He has been a lead investigator for nearly 50 large vessel groundings, oil spills, and wreck removal operations in the Western Atlantic, Caribbean Sea, and Indo-Pacific Oceans.

**Dagmar Etkin** Dagmar Schmidt Etkin has 35 years of experience in environmental analysis – 14 years investigating issues in population biology and ecological systems, and 21 years specializing in the analysis of oil spills. For the past 10 years, she has been president of Environmental Research Consulting (ERC), focusing on providing regulatory agencies and industry with sound scientific data and perspectives for responsible environmental decision-making. Dr. Etkin has a BA from University of Rochester, and M.A. and PhD from Harvard University. She is a member of the American Salvage

Association, Maritime Law Association, and the UN Joint Group of Experts on the Scientific Aspects of Marine Protection.

**Merv Fingas** Merv Fingas is a scientist focussing on oil and chemical spills. He was a spill researcher in Environment Canada for over 30 years and is currently working privately in Western Canada. Mr. Fingas has a PhD in Environmental Physics from McGill University, three masters degrees; Chemistry, Business, and Mathematics, all from University of Ottawa. His specialities include: spill dynamics and behaviour, spill treating agent studies, remote sensing and detection, and in-situ burning. He has over 750 papers and publications in the field. Dr. Fingas has been editor of the Journal of Hazardous Materials for 6 years. He has served on two committees on the U.S. National Academy of Sciences on oil spills including the recent 'Oil in the Sea'. He is chairman of several ASTM and inter-governmental committees on spill matters.

**Bruce Hollebone** Bruce Hollebone is a chemist with 14 years experience in the field of chemical and oil spill research and development. He has a PhD in Chemistry from the University of British Colombia. His research interests include: the fate and behaviour of oil and petroleum products in the environment, including simulation of spill behaviours in the laboratory; the development of new methods for physical and chemical analyses relevant to spills studies; environmental forensics for oil spill suspect-source identification; and environmental emergencies response. He currently works at the Oil Research Laboratory of Environment Canada.

**Mark Kirby** Mark is an internationally recognised senior Ecotoxicologist with over 20 years experience working on studies pertaining to aquatic pollution. He has worked extensively on the toxicological impacts of oil and chemical spills and the assessment of appropriate methods of mitigation and has been involved in impact assessments in the UK from the *Sea Empress* to the *MSC Napoli*. He is a key advisor to the UK government and industry on the effects of oil and chemical spills in the marine environment and of any subsequent treatment actions (e.g. dispersants, sorbents etc.). Mark oversees the toxicological testing and approval of oil spill treatment products for use in UK waters and is the coordinator of a national initiative in the UK, PREMIAM (www.premiam.org), to implement improved post spill monitoring and impact assessment practices. He is first author of over 15 scientific papers and numerous reports in the field and continues to be actively involved in associated environmental research.

**Alain Lamarche** Mr Lamarche is a recognized expert in spill response management systems. He has been involved in the analysis and management of environmental data since 1979. Mr. Lamarche has been responsible for the development and implementation of many computerized environmental decision support systems databases. He is also the original designer of the ShoreClean® and ShoreAssess software, dedicated to the provision of Shoreline Cleanup Assessment Technique (SCAT) data management support, and

Personal Digital Assistant (PDA) based geo-referenced field data acquisition tools. Mr. Lamarche has acted as a SCAT data manager and Geographical Information System (GIS) specialist during a number of oil spills, including: the Kure, New Carissa, Swanson Creek, Lake Wabamun, Westridge Line and Cosco Busan incidents. As principal of EPDS, Mr Lamarche is also responsible for all aspects of environmental software development projects including design, management, and implementation.

**Robin Law** Robin Law is a chemist who joined Cefas (The UK Centre for Environment, Fisheries, and Aquaculture Science) in 1975. During the last 35 years he has been involved in the response and impact assessment activities following a number of major oil and chemical incidents, including the blow-out on the *Ekofisk Bravo* platform, and from the oil tankers *Amoco Cadiz*, *Eleni V*, and *Sea Empress*, and the chemical tankers *Ievoli Sun* and *Ece*. Most recently, he designed and operated an environmental monitoring programme targeting oil and chemicals following the grounding of the container ship *MSC Napoli* on the south coast of the UK in 2007. Currently, he leads an emergency response team that advises UK government following oil and chemical spills at sea.

**Gary Mauseth** Mr. Gary Mauseth has over 35 years of experience in the management and technical aspects of a wide variety of projects in the marine and freshwater environments. He has provided scientific support to vessel interests in over 90 spills, groundings, and natural resource damage assessment cases in the United States and its territories, as well as Canada, Mexico, the Caribbean and Mediterranean Seas, Micronesia, South America, and Europe. He has conducted research on the fate and effects of spilled oil, as well as the environmental effectiveness of response techniques, and has authored numerous publications and presentations on oil spill response, NRDA, and ecological restoration. Mr. Mauseth is a principal and President of Polaris Applied Sciences in Kirkland, Washington, USA. He has a Bachelor of Science in Biology from Whitman College in Walla Walla, Washington and a Master of Marine Biology from University of the Pacific, Pacific Marine Station, Dillon Beach, California.

**Jacqui Michel** Dr. Jacqueline Michel is the President of Research Planning, Inc., and an internationally recognized expert in oil and hazardous materials spill planning and response. Her primary areas of expertise are in oil fates and effects, non-floating oils, shoreline cleanup, alternative response technologies, and natural resource damage assessment. Much of her expertise is derived from her role, since 1978, as part of the Scientific Support Team to the U.S. Coast Guard provided by the National Oceanic and Atmospheric Administration (NOAA). Under this role, she is on 24-hour call and provides technical support for 50-100 spill events per year. She leads shoreline assessment teams and assists in selecting cleanup methods to minimize the environmental impacts of the spill. She has evaluated and used a wide range of alternative response technologies, including surface washing agents, solidifiers, bioremediation agents, in-situ burning (mostly on wetlands and inland habitats), and methods to track and recover non-floating oils.

**William Nichols** William (Nick) Nichols was born in Baltimore, Maryland and now lives in Ellicott City, Maryland. He has a Bachelor's in Economics \Geography from Salisbury State University, Salisbury, Maryland and a Masters of Environmental Science from Johns Hopkins University, Baltimore. He has been an environmental scientist in the U.S. Environmental Protection Agency Office of Emergency Management (OEM) from 1997 and was U.S. National Contingency Plan Product Schedule Manager from 1998 to 2006. He is the national expert on chemical and biological oil spill countermeasures. He is also the OEM Tribal Coordinator from 2004 to the present.

**Ed Owens** Dr. Owens is recognized internationally as an expert on oil spill shoreline cleanup and has worked on spill-related projects in the Arctic, North-South America, Africa, Russia, the Caspian, Australia, throughout South America, and in the Middle East. He has over 40 years experience providing technical and scientific support on oil response operations worldwide including: *T/V Arrow (Canada), Hasbah 6 blowout (Arabian Gulf), T/V Exxon Valdez (USA), Arabian Gulf/Desert Storm (Bahrain, Qatar), Komineft pipeline (Russia), M/V Iron Baron (Australia), T/V Estrella Pampeana (Argentina), Desaguadero River (Bolivia), and M/V Cosco Busan spill (USA).* Dr. Owens has conducted oil spill related missions as a United Nations Expert Consultant for the International Maritime Organization and as a consultant for the World Bank and the European Bank of Reconstruction and Development, and was a member of the U.S. National Academy of Science Oil Spill R&D Committee.

**Karen Purnell** Dr Karen Purnell has been Managing Director of ITOPF since May 2009. She is a graduate of the Royal Society of Chemistry, with a PhD in Chemical Physics. Before joining ITOPF as a technical adviser in 1994, she worked on toxic waste management and environmental remediation in the nuclear industry and as a research chemist at several universities. Whilst at ITOPF, she has attended several major oil spills, including the *sea empress* (UK, 1996), *prestige* (Spain, 2002), and *tasman spirit* (Pakistan, 2003). Prominent amongst Karen's achievements is the expansion of ITOPF's capability to respond to spills of HNS (Hazardous & Noxious Substances). She has also worked closely with key U.S. agencies and the International Group of P&I Clubs on environmental issues. Dr Purnell has established a constructive dialogue with shipowners and is highly respected in the maritime community.

**Qiuhui Quek** Qiuhui Quek holds a Bachelor's degree in Environmental Engineering and has attended a number of responses in Australia, India, Indonesia, Korea, Libya, and Singapore. She has also delivered several workshops for Oil Spill Response members in various countries in the region. Qiuhui recently completed a secondment in Southampton as part of the Duty Manager rotation program. She also presented papers in international conferences such as IOSC, Interspill, and SPE. Qiuhui has since left Oil Spill Response and is working in the HSE Management Unit of A*STAR Research Institutes.

**Gary Shigenaka** Gary Shigenaka is the lead marine biologist with the Emergency Response Division (ERD) of the NOAA, based in Seattle. Gary received both his bachelor of science and masters degrees from the University of Washington in Seattle. As a graduate student, he served as a Knauss Sea Grant Policy Fellow in Washington D.C., and was awarded the Donald L. McKernan prize for outstanding marine affairs thesis. He has provided biological and shoreline assessment support during spills of oil and hazardous chemicals across the country and internationally over the last two decades. Gary was part of the early scientific mobilization for the *Exxon Valdez* oil spill in 1989, and continues to monitor the long-term effects in Prince William Sound. He also oversees other research initiatives for NOAA/ERD designed to improve oil spill impact understanding, and also to develop and improve biological tools for response and assessment. He has published numerous articles on the science and applied aspects of his spill-related research.

**Debra Simecek-Beatty** Debra Simecek-Beatty has been a physical scientist for the NOAA's Emergency Response Division for 25 years. She has a Masters degree in Marine Affairs from the University of Washington. During an emergency response, she is responsible for providing estimates of the movement and behavior of the spill. This includes collecting visual observations, remote sensing information, wind and current data, and computer modeling output to form an analysis. In addition, she is responsible for interfacing with local experts (i.e., meteorologist, academia, researchers) in formulating the trajectory analysis.

**Ruth Yender** Ruth Yender is a marine ecologist with NOAA's Office of Response and Restoration, based in Seattle, Washington. As NOAA's Scientific Support Coordinator for the U.S. Pacific Northwest and Pacific Islands regions, Ruth provides remote and on-scene support to the U.S. Coast Guard during responses to oil and hazardous materials spills. Since joining NOAA in 1992, she has responded to more than 100 oil and chemical spills in the U.S. and internationally. Ruth also participates in spill response planning, conducts training for responders, and writes response technical guides.

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