



JACQUELINE MICHEL, Ph.D.

Research Planning, Inc.

Geochemist, President

Dr. Michel is a geochemist specializing in terrestrial and marine pollution studies, coastal geomorphology, and environmental risk assessments. Having worked in 33 countries, she has extensive international experience and has worked in many different coastal and terrestrial environments.

Dr. Michel is one of the founders of RPI and has been President since 2000. She often leads multi-disciplinary teams on projects where her problem-solving skills are essential to bringing solutions to complex issues. For example, her work during spill emergencies requires her to rapidly develop consensus and provide decision-makers needed information. Because of her routine scientific support for spills, she has extensive knowledge of and practical experience in pollutant fate, transport, and effect issues. She has been a leader in the development of methods and the conduct of Natural Resource Damage Assessments (NRDA) following spills and groundings. She has taken a lead role in over 30 NRDA cases for Federal and State Trustees since 1985.

Dr. Michel has been recognized for her achievements through appointments to many respected committees and panels, including six National Academies committees:

- Spills of Nonfloating Oil (1999);
- Oil in the Sea (2002);
- Chairman of Spills of Emulsified Fuels: Risks and Response (2001);
- Chairman of Committee on Understanding Oil Spill Dispersants: Efficacy and Effects (2005);
- Fate and Effects of Diluted Bitumen (2015); and
- 2016 Committee on Environmental Science and Assessment for Ocean Energy Management, advising the Bureau of Ocean Energy Management in its efforts to manage development of the nation's offshore energy resources in an environmentally and economically responsible way.

She was on the Oceans Studies Board at the National Academies for 2001-2005 and is a Lifetime Associate of the National Academies. She was on the Science Advisory Panel to the U.S. Commission on Ocean Policy. She is an Adjunct Professor in the School of the Environment, University of South Carolina. She has written over 230 technical reports and publications, including 48 peer-reviewed journal articles.

She co-authored three books on the coastal geology and ecology of different coastal states, targeted to the layperson living on or visiting the coast: South Carolina (2008), Central California (2010), and Georgia (2013). A book on the Southern Alaska coast is in preparation.

EDUCATION

Ph.D., Department of Geology, University of South Carolina (USC), Columbia (1980). Dissertation Title: Behavior of Uranium and Thorium Decay-Series Isotopes in the Hydrologic Cycle

M.S., Department of Geology, USC, Columbia (1976). Thesis Title: Ground Water Pollution and Geochemical Variations in Leachate from Solid Waste Disposal

B.S., Department of Geology, USC, Columbia (1974)

HONORS

Distinguished Alumni Achievement Award, 2002, College of Science and Mathematics, USC
Lifetime Associate of the National Academies

PROFESSIONAL EXPERIENCE

Expertise in four technical areas is outlined separately below:

- 1) Oil and chemical emergency spill response, research, and contingency planning
- 2) Natural resource damage assessment and restoration
- 3) Environmental risk assessment/geology
- 4) Environmental radiochemistry

OIL AND CHEMICAL SPILL RESPONSE, RESEARCH, AND CONTINGENCY PLANNING

Multidisciplinary Assessment of Coastal Ecosystems Impacted by Oil and Chemical Spills, Dr. Michel was part of the original team of RPI scientists who pioneered much of the early research on oil spill impacts on coastal ecosystems. This work, sponsored by the National Oceanic and Atmospheric Administration, has involved multidisciplinary studies of hazardous materials spill impacts and the development of strategies to mitigate these impacts. Scientific support for hazardous materials spills includes rapid assessment of the aquatic toxicology, chemical hazards, field methods, and fate and effects for a wide range of chemicals. Because of her routine scientific support for spills, she has extensive knowledge of and practical experience in pollutant fate, transport, and effect issues.

Spills of note where field responses have been conducted include the following:

T/V <i>Metula</i>	Strait of Magellan, Chile	1976
T/V <i>Amoco Cadiz</i>	Brittany, France	1978
T/B <i>Peck Slip</i>	Puerto Rico	1978
IxTOC well blowout	South Texas	1979
Funiwa 5 blowout	Nigeria	1982
Cape Fear River	Wilmington, N.C.	1983
T/V <i>Puerto Rican</i>	San Francisco, Calif.	1985
T/V <i>Amazon Venture</i>	Savannah, Ga.	1986
M/V <i>Pac Baroness</i>	Santa Barbara, Calif.	1987
Shell Refinery	Martinez, Calif.	1988
T/V <i>Exxon Valdez</i>	Valdez, Alaska	1989
T/V <i>American Trader</i>	Huntington Beach, Calif.	1990
T/B <i>Bella Vista</i>	St. Kitts/Puerto Rico	1991
Gulf War Spill	Saudi Arabia and Kuwait	1991
T/V <i>Katina P</i>	Mozambique	1992
Benzene Trail Derailment	Duluth, Minn.	1992
Greenhill Petroleum Blowout	Timbalier Bay, Louisiana	1992
UNOCAL refinery	Neches River, Texas	1993
Colonial Pipeline Break	Reston, Va.	1993
T/B <i>Bouchard 255</i>	Tampa, Fla.	1993
T/B <i>Morris J. Berman</i>	Puerto Rico	1994
RASA Refinery	Acajutla, El Salvador	1994
Kharyaga-Usinsk Pipeline Spills	Komi Republic, Russia	1995
Powell-Duffryn Chemical Fire	Savannah, Georgia	1995
T/B <i>North Cape</i>	Rhode Island	1996
Colonial Pipeline–Reedy River	Greenville, South Carolina	1996
T/V <i>Julie N</i>	Portland, Maine	1996
Lake Barre Texaco Pipeline Spill	Lake Barre, Texas	1997
Kapitan Egorov Grounding	Guayanilla, Puerto Rico	1998
BP Offshore Platform	Southwest Pass, Louisiana	1998
M/V <i>New Carissa</i>	Coos Bay, Oregon	1999

Chevron Pipeline	Quatre Bayou, Louisiana	1999
Petrobras Pipeline	Guanabara Bay, Brazil	2000
Sun Oil Co. Pipeline	John Heinz NWR, Penn.	2000
PEPCO Pipeline	Patuxent River, Maryland	2000
M/V <i>Westchester</i>	Mississippi River, RM 38	2000
Williams Pipeline Break	Mosquito Bay, Louisiana	2001
Oiled Shoreline Survey	Saudi Arabia	2002
T/B <i>Bouchard-120</i>	Buzzards Bay, Mass.	2003
M/V <i>Fortune Epoch</i>	Savannah, Ga.	2004
M/T <i>Athos 1</i>	Delaware River, Pa, NJ, DE	2004
Hurricane Katrina and Rita spills	Louisiana	2005
T/B <i>DBL-152</i>	Offshore Louisiana	2005
Bayou Perot	Louisiana	2007
M/V <i>Cosco Busan</i>	San Francisco, CA	2007
T/V <i>Hebei Spirit</i>	South Korea	2008
Deepwater Horizon/MC252	Gulf of Mexico	2010
ExxonMobil Pegasus Pipeline spill	Arkansas	2013
Texas City Y barge spill	Texas	2014
Refugio Incident, Santa Barbara	California	2015

Shoreline Assessment and Cleanup. Dr. Michel is an international specialist in shoreline assessment and cleanup. In 1995, she was Senior Advisor to the World Bank responsible for development and oversight of a \$45 million emergency oil spill cleanup in the Komi Region of the Former Soviet Union. The plan was to prevent the release of massive amounts of oil into rivers draining to the Arctic Ocean. In 1997-8, she was again asked to assist the World Bank on cleanup of onshore oil production fields in Azerbaijan. In 2000, she was asked by the Inter-American Development Bank to advise the environmental agencies of Brazil on assessment of a major oil spill in Guanabara Bay.

Lecturer and Instructor on Oil Spill Response. Dr. Michel is the primary lecturer of 3-5 day courses on the behavior, effects, and cleanup considerations at oil spills. Through the use of case histories via slide presentations and training manuals, participants are given experience in oil spill response needs for protection of natural resources. This course has been conducted more than 50 times since 1992.

Scientific Adviser on Pollutant Fate and Effects. In 1991-1992, Dr. Michel was the Chief Scientist on Leg II–Nearshore Biogeochemical Processes for the *Mt. Mitchell* cruise in the Arabian Gulf. This project studied the fate and transport mechanism for contamination of the intertidal and subtidal habitats in Saudi Arabia following the Gulf War spill. She coordinated the studies of 25 scientists from ten countries for a 22-day cruise and a six-week shoreline survey. In 2002-2003, she was the Senior Scientist on the \$6 million Oiled Shoreline Survey to assess the injury and need for remediation of intertidal habitats along the 800 km of shoreline of Saudi Arabia affected by the Gulf War oil spill. She developed the study plan, participated in the fieldwork, and was the senior author of the technical report.

Selected Publications

OIL/CHEMICAL SPILL EFFECTS AND FATE RESEARCH

- Michel, J., D. Esler, and Z. Nixon. 2016. Studies on *Exxon Valdez* Lingering Oil: Review and Update on Recent Findings. *Exxon Valdez* Oil Spill Trustee Council, Anchorage, AK. 39 pp.
- Zengel S, B.M. Bernik, N. Rutherford, Z. Nixon, and J. Michel. 2015. Heavily oiled salt marsh following the *Deepwater Horizon* oil spill, ecological comparisons of shoreline cleanup treatments and recovery. *PLoS ONE* 10(7): e0132324. doi:10.1371

- Hoff, R. and J. Michel. 2014. Oil Spills in Mangroves: Planning & Response Considerations. Office of Response and Restoration, NOAA, Seattle, WA. 90 pp.
- Michel, J. and N. Rutherford. 2014. Impacts, recovery rates, and treatment options for spilled oil in marshes. *Marine Pollution Bulletin* 82(1-2):19-25.
- Zengel, S., N. Rutherford, B. Bernik, Z. Nixon, and J. Michel. 2014. Salt marsh remediation and the *Deepwater Horizon* oil spill, the role of planting in vegetation and macroinvertebrate recovery. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1985-1999.
- Michel, J. and N. Rutherford. 2013. Oil Spills in Marshes: Planning & Response Considerations. Emergency Response Division, NOAA, Seattle, WA and American Petroleum Institute, Washington, D.C. 129 pp.
- Nixon, Z., J. Michel, M.O. Hayes, G.V. Irvine, and J. Short. 2013. Geomorphic factors related to the persistence of subsurface oil from the *Exxon Valdez* oil spill. In: Kana, T., J. Michel, and G. Voulgaris (eds.), Proceedings, Symposium in Applied Coastal Geomorphology to Honor Miles O. Hayes, *Journal of Coastal Research*, Special Issue No. 69:115-127.
- Michel, J., E.H. Owens, S. Zengel, A. Graham, Z. Nixon, T. Allard, W. Holton, P.D. Reimer, A. Lamarche, M. White, N. Rutherford, C. Childs, G. Mauseth, G. Challenger and E. Taylor. 2013. Extent and degree of shoreline oiling: *Deepwater Horizon* oil spill, Gulf of Mexico, USA. *PLoS ONE* 8(6):e65087.
- Zengel, S. and J. Michel. 2013. *Deepwater Horizon* Oil Spill: Salt Marsh Oiling Conditions, Treatment Testing, and Treatment History in Northern Barataria Bay, Louisiana (Interim Report October 2011). U.S. Dept. of Commerce, NOAA Technical Memorandum NOS OR&R 42. Seattle, WA: Emergency Response Division, NOAA. 74 pp.
- Michel, J., Z. Nixon, M.O. Hayes, G. Irvine, and J. Short. 2011. The distribution of lingering subsurface oil from the *Exxon Valdez* oil spill. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C.
- Boufadel, M. C., B. A. Wrenn, B. E. Moore, K. J. Boda, and J. Michel. 2011. Biodegradation assessment tool for decision on beach response. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C.
- Bejarano, A.C. and J. Michel. 2010. Large-scale risk assessment of polycyclic aromatic hydrocarbons in shoreline sediments from Saudi Arabia: Environmental legacy after twelve years of the Gulf War Oil Spill. *Environmental Pollution* 158:1561-1569.
- Michel, J., Z. Nixon, M.O. Hayes, J. Short, G. Irvine, D. Betenbaugh, C. Boring, and D. Mann. 2010. Distribution of subsurface oil from the *Exxon Valdez* oil spill. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 070801), National Oceanic and Atmospheric Administration, Juneau, AK. 121 pp. + app.
- Michel, J., Z. Nixon, J. Dahlin, D. Betenbaugh, M. White, D. Burton, and S. Turley. 2009. Recovery of interior brackish marshes seven years after the Chalk Point oil spill. *Marine Pollution Bull.* 58:995-1006.
- Michel, J., Z. Nixon, J. Dahlin, D. Betenbaugh, M. White, D. Burton, and S. Turley. 2008. Monitoring of Recovery of Marshes Impacted by the Chalk Point Oil Spill. NOAA Office of Response & Restoration, Silver Spring, MD. 68 pp. + app.
- Henry, C., D. Helton, J. Michel, and C. Woodle. 2008. Bayou Perot and the unusual situation of stranded oil adhered to mud flats. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 551-556.
- Etkin, D.S., D. J. Michel, French-McCay, M. Boufadel, and H. Li. 2008. Integrating state-of-the-art shoreline interaction knowledge into spill modeling. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 915-922.
- Michel, J., Z. Nixon, and L. Cotsapas. 2006. Evaluation of oil remediation technologies for lingering oil from the *Exxon Valdez* oil spill in Prince William Sound, Alaska. *Exxon Valdez* Oil Spill Restoration

- Project Final Report (Restoration Project 050778), National Marine Fisheries Service, NOAA, Juneau, AK, 47 pp. + app.
- Nixon, Z. and J. Michel. 2006. Assessment of hazardous materials and debris from Hurricane Rita in the Sabine National Wildlife Refuge. Report to U.S. Fish and Wildlife Service, Washington, D.C., 29 pp.
- Michel, J., M.O. Hayes, C.D. Getter, and L. Cotsapas. 2005. The Gulf War oil spill twelve years later: Consequences of eco-terrorism. Proc. 2005 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 957-961.
- Getter, C.D., J. Michel, and M. Hayes. 2005. Natural recovery of salt marshes from the 1991 oil spill on the Saudi Arabian Gulf coast. Proc. 2005 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 869-872.
- Michel, J. and D. Helton. 2003. Environmental considerations during wreck removal and scuttling. Intl. Tug & Salvage, November/December 2003, pp. 16-18.
- Lord, C. and J. Michel. 2003. Conceptual models for assessing the risk of seafood tainting during oil spills. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730, Washington, D.C. pp. 1311-1316.
- Walker, D., J.C. Coleman, K. Michel, and J. Michel. 2003. Oil in the Sea: Changes in the nature of sources and inputs since 1985. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730, Washington, D.C. pp. 669-673.
- Yender, R., J. Michel, and C. Lord. 2002. Managing Seafood Safety after an Oil Spill. Seattle: Hazardous Materials Response Division, Office of Response and Restoration, National Oceanic and Atmospheric Administration. 72 pp.
- Michel, J., C.B. Henry, Jr., and S. Thumm. 2002. Shoreline assessment and environmental impacts from the *M/T Westchester* oil spill in the Mississippi River. Spill Science & Technology Bull. 7:155-161.
- Hayes, M.O. and J. Michel. 2001. A primer for response to oil spills on gravel beaches. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 1275-1279.
- Michel, J. and M.O. Hayes. 1999. Weathering patterns of oil residues eight years after the *Exxon Valdez* oil spill. Marine Pollution Bull. 38:855-863.
- Hayes, M.O. and J. Michel. 1999. Factors determining the long-term persistence of *Exxon Valdez* oil in gravel beaches. Marine Pollution Bull. 38:92-101.
- Sauer T.C., J. Michel, M.O. Hayes, and D.V. Aurand. 1998. Hydrocarbon characterization and weathering of oiled intertidal sediments along the Saudi Arabian coast two years after the Gulf War oil spill. Environment International.
- Michel, J., S.M. Lehmann, and C.B. Henry, Jr. 1998. Oiling and cleanup issues in wetlands, *M/T Julie N* spill, Portland, Maine. Proc. 21st Arctic and Marine Oilspill Program Tech. Seminar, Environment Canada, pp. 841-856.
- Michel, J. and C.B. Henry, Jr. 1997. Oil uptake and depuration in oysters after use of dispersants in shallow water in El Salvador. Spill Science & Technology Bull. 4:57-70.
- Hayes, M.O. and J. Michel. 1998. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment: 1997 geomorphological monitoring survey. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 109 pp. + app.
- Zengel, S.A. and J. Michel. 1996. Vegetation cutting as a clean-up method for salt and brackish marshes impacted by oil spills: a review and case history of the effects on plant recovery. Marine Pollution Bull. 32:876-885.
- Michel, J. and M.O. Hayes. 1996. Geomorphological shoreline monitoring survey of the *Exxon Valdez* spill site, Prince William Sound, Alaska, July 1994. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, Wash., Technical Memo. NOS ORCA 82, 119 pp.+ app.
- Michel, J. and M.O. Hayes. 1996. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment: volume II: 1994

- geomorphological monitoring survey, July 1994. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 120 pp. + app.
- Zengel, S.A. and J. Michel. 1995. Cutting oiled marshes: a review of the effects on vegetation recovery, with illustrated examples from riverine, salt, and brackish-water environments. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, HAZMAT Report 95-6, 41 pp.
- Michel, J. and J.A. Galt. 1995. Conditions under which floating slicks can sink in marine settings. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 573-576.
- Hayes, M.O., J. Michel, T.M. Montello, D.V. Aurand, T.C. Sauer, A. Al-Mansi, and A.H. Al-Momen. 1995. Distribution and weathering of oil from the Iraq-Kuwait conflict oil spill within intertidal habitats-two years later. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 443-451.
- Wolfe, D. A., M. J. Hameedi, J. A. Galt, G. Watabayashi, J. Short, C. O'Clair, S. Rice, J. Michel, J. R. Payne, J. Braddock, S. Hanna, and D. Sale. 1994. The fate of the oil spilled from the T/V EXXON VALDEZ. *Environmental Science and Technology* 28(13):560A-568A.
- Michel, J. and C.B. Henry. 1994. Oil uptake and depuration in oysters after use of dispersant in shallow water during the RASA Refinery, El Salvador oil spill. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, HAZMAT Report 95-5, 38 pp.
- Hayes, M.O., J. Michel, T.M. Montello, and T.C. Sauer. 1994. ROPME Sea oil spill nearshore geochemical processes study, distribution and weathering of oil in intertidal sediments for year 2 (1993). Prepared for the Marine Spill Response Corporation, Washington, D.C., Technical Report Series 94-009, 140 pp.
- Hayes, M.O., J. Michel, and T.M. Montello. 1994. ROPME Sea oil spill nearshore geochemical processes study, volume 1, distribution and weathering of oil in intertidal and subtidal sediments for year 1 (1992). Prepared for the Marine Spill Response Corp., Washington, D.C., Technical Report Series 93-002.1, 230 pp.
- Jensen, J., S. Narumalani, M.O. Hayes, and J. Michel. 1994. ROPME Sea oil spill nearshore geochemical processes study, volume 3, remote sensing derived habitat classification and error evaluation year 1 (1992). Prepared for the Marine Spill Response Corporation, Wash., D.C., Technical Report Series 93-002.3, 43 pp.
- Michel, J., M.O. Hayes, R.S. Keenan, J.R. Jensen, and S. Narumalani. 1993. Oil in nearshore subtidal sediments of Saudi Arabia from the Gulf War spill. Proc. 1993 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 383-388.
- Michel, J., M.O. Hayes, R.S. Keenan, T.C. Sauer, J.R. Jensen, and S. Narumalani. 1993. Contamination of nearshore subtidal sediments of Saudi Arabia from the Gulf War oil spill: *Marine Pollution Bulletin* 27:109-116.
- Hayes, M.O., J. Michel, T.M. Montello, D.V. Aurand, A.M. Al-Mansi, A.H. Al-Momen, T.C. Sauer, and G.W. Thayer. 1993. Distribution and weathering of shoreline oil one year after the Gulf War oil spill. *Marine Pollution Bulletin* 27:135-142.
- Sauer, T.C., J.S. Brown, P.D. Boehm, D.V. Aurand, J. Michel, and M.O. Hayes. 1993. Hydrocarbon source identification and weathering characterization of intertidal and subtidal sediments along the Saudi Arabian coast after the Gulf War oil spill: *Marine Pollution Bulletin* 27:117-134.
- Hayes, M.O., J. Michel, and six others. 1993. Distribution of oil from the Gulf War oil spill within intertidal habitats—one year later. Proc. 1993 Intl. Oil Spill Conference, American Petroleum Inst., Washington, D.C., pp. 373-381.
- Michel, J. and M.O. Hayes. 1993. Persistence and weathering of *Exxon Valdez* oil in the intertidal zone—3.5 years later. Proc. 1993 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 279-286.

- Montello, T.M., M.O. Hayes, J. Michel, Ahmed M. Al-Mansi, Abdul Halim Al-Momen, D.V. Aurand, and G.W. Thayer. 1993. Persistence of Gulf War oil versus intertidal morphology and sediments—one year later. Proc. 1993 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 894-895.
- Michel, J. and M.O. Hayes. 1993. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment: volume I: summary of results—geomorphological shoreline monitoring survey of the *Exxon Valdez* spill site, Prince William Sound, Alaska, September 1989-August 1992. Prepared for Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 94 pp. + app.
- Michel, J. and M.O. Hayes. 1993. Summary of results—geomorphological shoreline monitoring survey of the *Exxon Valdez* spill site, Prince William Sound, Alaska, September 1989-August 1992. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 113 pp. + app.
- Scholz, D. and J. Michel. 1992. The *Mega Borg* oil spill: fate and effect studies. Prepared for the Damage Assessment Regulations Team, NOAA Damage Assessment Center, Rockville, MD, 145 pp. + app.
- Michel, J. and A. Al-Thukair. 1992. End of cruise report—nearshore biogeochemical processes leg II *Mt. Mitchell* cruise of the Gulf War oil spill. Prepared for the NOAA Gulf Program Office, Washington, D.C.
- Michel, J. and M.O. Hayes. 1991. Geomorphological controls on the persistence of shoreline contamination from the *Exxon Valdez* oil spill. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 307 pp. + appendix.
- Michel, J. and J.A. Dahlin. 1991. Rate of recovery of intertidal vegetation and sediments associated with various oil spill response activities during the Shell oil spill. Rept. to the State of California, Department of Justice; Research Planning, Inc., Columbia, SC, RPI/SR/91/7/15-11, 77 pp. + app.
- Michel, J. 1991. Oiled marshes and tidal flats in the Arabian Gulf, What is going to happen? Inter-government Oceanographic Commission IMS Newsletter, September 1991, Paris, France, p. 9.
- Michel, J., M.O. Hayes, W.J. Sexton, J.C. Gibeaut, and C. Henry. 1991. Trends in natural removal of the *Exxon Valdez* oil spill in Prince William Sound from September 1989 to May 1990. Proc. 1991 Intl. Oil Spill Conference, American Petroleum Institute, Wash., D.C., pp. 181-187.
- Michel, J. 1991. Prince William Sound, Alaska: the cleanup continues. *Geotimes*, March 1991, pp. 16-17.
- Hayes, M.O., J. Michel, and D.C. Noe. 1991. Factors controlling initial deposition and long-term fate of spilled oil on gravel beaches. Proc. 1991 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 453-460.
- Hayes, M.O., J. Michel, and B. Fichaut. 1990. Oiled gravel beaches: a special problem. Proc. Conf. on Oil Spills: Management and Legislative Implications, 15-18 May 1990, Newport, RI, pp. 444-457.
- Michel, J., C. Henry, W.J. Sexton, and M.O. Hayes. 1990. The *Exxon Valdez* winter monitoring program results. Proc. Conf. on Oil Spills: Management and Legislative Implications, 15-18 May 1990, Newport, RI, pp. 396-407.
- Michel, J. 1990. The EXXON VALDEZ oil spill: status of the shoreline. *Geotimes*, May 1990, pp. 20-22.
- Biedenbender, P.L. and J. Michel. 1989. Response strategies in a high tidal range estuarine system: The Savannah River oil spill. Proc. 1989 Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 95-100.
- Nwankwo, J.N., J. Michel, and M. Murday. 1987. Environmental baseline studies for oil pollution control in Nigeria. Proc. 1987 Oil Spill Conf., American Petroleum Institute, Washington, D.C. pp. 517-519.
- Owens, V.H., W.J. Sexton, and J. Michel. 1987. A comparison of soil-gas sampling methods used at two harbor sites. Proc. 1987 Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 605-610.
- Baca, B.J., J. Michel, T.W. Kana, and N.G. Maynard. 1983. Cape Fear River oil spill (North Carolina): determining oil quantity from marsh surface area. Proc. 1983 Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 419-422.

- Michel, J., D.D. Domeracki, and W.J. Sexton. 1982. Site evaluation methodology and results, American Creosote Plant site, Louisiana. Proc. Hazardous Materials Spills Conf., 19-22 April 1982, Milwaukee, WI, pp. 50-55.
- Getter, C.D., G.I. Scott, and J. Michel. 1981, The effects of oil spills on mangrove forests: a comparison of five oil spill sites in the Gulf of Mexico and Caribbean Sea. Proc. 1981 Oil Spill Conf., American Petroleum Institute, Washington, D.C., pp. 535-540.
- D'Ozouville, L., M.O. Hayes, E. Gundlach, W.J. Sexton, and J. Michel. 1979. Occurrence of oil in offshore bottom sediments at the AMOCO CADIZ spill site. Proc. 1979 Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 187-192.

ENVIRONMENTAL SENSITIVITY INDEX MAPPING/UNUSUALLY SENSITIVE AREA MAPPING

- Santos, C.F. J. Michel, M. Neves, J. Janeiro, F. Andrade, and M. Orbach. 2013. Marine spatial planning and oil spill risk analysis: Finding common grounds. *Marine Pollution Bulletin* 74:73-81.
- Phillips-Born, K., C. Locke, J. Michel, and D. Braud. 2005. Feasibility of using remote-sensing techniques for shoreline delineation and coastal habitat classification for environmental sensitivity index (ESI) mapping. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-047. 45 pp. + app.
- Born, K., C. Locke, C., J. Michel, J., and B. DeWitt. 2004. Using IKONOS Imagery for Mapping Coastal Habitats for Oil Spill Applications. *ASPRS 2004 Annual Conference, May 23-28, 2004*. Denver, CO.
- Owens, E.H. and J. Michel. 2003. Planning for shoreline response to spills in Arctic environments. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 591-596.
- Plank, C., W.T. Holton, M. White, J. Michel, C. Sherman, I. Csato, and C. Sames. 2003. Nation-wide assessment and mapping of drinking water "Unusually Sensitive Areas" (USAs). Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. p. 685.
- Petersen, J., J. Michel, S. Zengel, M. White, C. Lord, and C. Plank. 2002. Environmental Sensitivity Index Guidelines Version 3.0. NOAA Technical Memo NOS OR&R 11. NOAA, Seattle, WA, 89 pp. + app.
- Zengel, A., M.O. Hayes, J. Michel, M. White, B. Benggio, F. Lopez, Steve Touw, and E. Mosher. 2001. Integrated planning from the mountains to the sea: Environmental Sensitivity Index mapping in the Caribbean. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 1113-1117.
- Jensen, J.R., J.N. Halls, and J. Michel. 1998. A systems approach to Environmental Sensitivity Index (ESI) mapping for oil spill contingency planning and response. *Photogrammetric Engineering & Remote Sensing* 64:1003-1014.
- Hayes, M.O., J. Michel, and T.M. Montello. 1997. The Reach Sensitivity Index (RSI) for mapping rivers and streams. Proc. 1997 Intl. Oil Spill Conference, API Publ. 4651, American Petroleum Institute, Washington, D.C., pp. 343-350.
- Halls, J., J. Michel, S. Zengel, J. Dahlin, and, J. Petersen. 1997. Environmental sensitivity index guidelines, Version 2.0. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, Wash., NOAA Tech. Memo. NOS ORCA 115, 79 pp. + app.
- Hayes, M.O., J. Michel, J.A. Dahlin, and K. Barton. 1995. Identifying and mapping sensitive resources for inland area planning. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 365-371.
- Pavia, R., J. Michel, J. Petersen, and S. Birk-Risheim. 1995. An integrated program for sensitive environment mapping. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 73-76.

- Michel, J., M.O. Hayes, J.A. Dahlin, and K. Barton. 1994. Sensitivity mapping of inland areas: technical support to the Inland Area Planning Committee working group, USEPA Region 5. Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, HAZMAT Report 95-4, 54 pp.
- Narumalani, S., J.R. Jensen, M.O. Hayes, J. Michel, T.M. Montello, and J. Robinson. 1993. Gulf War legacy using remote sensing to assess habitat in the Saudi Arabian Gulf before the Gulf War oil spill. *GeoInfo Systems*, pp. 33-41.
- Michel, J. and J. Dahlin. 1992. Guidelines for developing digital environmental sensitivity index atlases and databases. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 43 pp. + app.
- Jensen, J.R., with seven others. 1992. Utilization of remote sensing and GIS technologies for oil spill planning and response: case studies in Florida, UAE, and Saudi Arabia. Proc. First Thematic Conf. on Remote Sensing for Marine and Coastal Environments, ERIM, Ann Arbor, MI.
- Jensen, J.R., E.W. Ramsey, J.M. Holmes, J. Michel, B. Savitsky, and B.A. Davis. 1990. Environmental sensitivity index (ESI) mapping for oil spills using remote sensing and geographic information system technology. *International J. of Geographic Information Systems* 4:181-201.
- Michel, J., M.O. Hayes, and P.J. Brown. 1978. Application of an oil spill vulnerability index to lower Cook Inlet, Alaska. *Environ. Geology* 2(2):107-117.

SPILL TECHNOLOGIES - *IN-SITU* BURNING

- Merten, A.A., C. Henry, and J. Michel. 2008. Decision-making process to use in-situ burning to restore an oiled intermediate marsh following hurricanes Katrina and Rita. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 545-550.
- Michel, J., Z. Nixon, and H. Hinkeldey. 2003. Use of *in situ* burning as an oil spill response tool: Follow-up of four case studies. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 123-128.
- Henry, C., S. Thumm, J. Brolin, P. Cuty, and J. Michel. 2003. Application of *in-situ* burning during the Mosquito Bay oil spill: Observations and trade-off discussions. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 307-310.
- Williams, G.W., R. Gondek, A.A. Allen, and J. Michel. 2003. Use of *in situ* burning at a diesel spill in wetlands and salt flats, northern Utah, USA: Remediation operations and 1.5 years of post-burn monitoring. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730. Washington, D.C. pp. 109-113.
- Michel, J., Z. Nixon, and H. Hinkeldey. 2002. Recovery of Four Oiled Wetlands Subjected to *In Situ* Burning. American Petroleum Institute, Washington, D.C., 71 pp.
- Dahlin, J.A., S. Zengel, C. Headley, and J. Michel. 1999. Compilation and Review of Data on the Environmental Effects of *In Situ* Burning of Inland and Upland Oil Spills. Report No. 4684, American Petroleum Institute, Washington, D.C.
- Zengel, S.A., J.A. Dahlin, C. Headley, J. Michel, and D.E. Fritz. 1999. Environmental effects of *in situ* burning in inland and upland environments. Proc. 1999 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1283-1286.

SPILL TECHNOLOGIES - SHORELINE ASSESSMENT AND CLEANUP

- Michel, J., Z. Nixon, W. Holton, M. White, S. Zengel, F. Csulak, N. Rutherford, and C. Childs. 2014. Three years of Shoreline Cleanup Assessment Technique (SCAT) for the *Deepwater Horizon* Oil Spill, Gulf of Mexico, USA. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1251-1266.

- Tarpley, J., J. Michel, S. Zengel, N. Rutherford, C. Childs, and F. Csulak. 2014. Best practices for Shoreline Cleanup and Assessment Technique (SCAT) from recent incidents. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1281-1297.
- Whelan, A., G. Andrews, J. Clark, J. Michel, and B. Benggio. 2014. Developing cleanup endpoints for inland oil spills. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1267-1280.
- Michel, J. C. Boring, J. Tarpley, G. Shigenaka, and F. Csulak. 2011. SCAT: Improving the process, training, tools, data management, and products. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., 2011-40.
- Santner, R., M. Cocklan-Vendl, B. Stong J. Michel, E.H. Owens, and E. Taylor. 2011. The Deepwater Horizon MC252-Macondo Shoreline Cleanup Assessment Technique (SCAT) Program. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., 9 pp.
- Owens, E.H., R. Santner, M. Cocklan-Vendl, J. Michel, P.D. Reimer, and B. Stong. 2011. Shoreline treatment during the Deepwater Horizon-Macondo response. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., 9 pp.
- Locke, C., M. White, J. Michel, C. Henry, and J. Sellars. 2008. Use of vertical digital photography at the Bayou Perot, LA spill for oil mapping and volume estimation. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 127-130.
- Dunagan, H.H., J. Michel, and B. Benggio. 2008. Estimating oil volume for the 2006 Savannah River mystery spill. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 541-544.
- Michel, J., C.B. Henry, Jr., and S. Thumm. 2003. *M/T Westchester* oil spill: Shoreline assessment and cleanup along the lower Mississippi River. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730, Washington, D.C. pp. 1109-1114.
- Michel, J., R. Yender, G.A. Sergy, E.H. Owens, R.D. Martin, and J.A. Tarpley. 2001. Improving the shoreline assessment process with new SCAT forms. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 1515-1522.
- Owens, E.H., R.D. Martin, J. Michel, G.A. Sergy, J.A. Tarpley, and R. Yender. 2000. SCAT 2000 - A new generation of forms for the description and documentation of oiled shorelines. Proc. 23th Arctic and Marine Oilspill Program Technical Seminar, Environment Canada.
- Michel, J. and B. Benggio. 1999. Guidelines for Selecting Appropriate Cleanup Endpoints. Proc. 1999 Intl. Oil Spill Conference, API Publ. No. 4686, American Petroleum Institute, Washington, D.C.
- Michel, J., B. Benggio, and I. Byron. 1998. Shoreline Assessment Manual, Second Edition. Report. No. HAZMAT 98-3, NOAA, Seattle, WA.
- Michel, J., S. Lehmann, and C.B. Henry, Jr., 1998. Oiling and cleanup issues in wetlands, *M/T Julie N* spill, Portland, Maine. Prepared for the Hazardous Materials Response and Assessment Division, NOAA, Seattle, Wash., Technical Memorandum, 34 pp.
- Barton, K., J. Michel, E.H. Owens, D.E. Fritz, and A.E. Steen. 1995. Options for minimizing environmental impacts of freshwater spill response. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 987-989.
- Owens, E.O. and J. Michel. 1995. Options for minimizing environmental impacts of freshwater spill response, February. Response Guide Jointly Published by NOAA and the American Petroleum Institute, Washington, D.C., 130 pp.
- Owens, E.H., R.A. Davis, J. Michel, and K. Stritzke. 1995. Beach cleaning and the role of technical support in the 1993 Tampa Bay spill. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 627-634.
- Owens, E.H., G.A. Sergy, and J. Michel. 1995. Case studies of standardized techniques to document shoreline oiling conditions. Proc. 1995 Intl. Oil Spill Conference, API Publ. No. 4620, American Petroleum Institute, Washington, D.C., pp. 904-905.

Michel, J., K. Barton, and A. Steen. 1994. Inland oil spills—options for minimizing environmental impacts of freshwater spill response. American Petroleum Institute, Wash., D.C. and the Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 126 pp. + app.

SPILL TECHNOLOGIES - ALTERNATIVE RESPONSE STRATEGIES/NON-FLOATING OILS

McClinton, T., G. Schweitzer, and J. Michel. 2016. Application of Sonar for Oil Spill Response: Acoustic Detection, Evaluation and Monitoring of Sunken Oil Spills. *Sea Technology* June:10-14.

Michel, J., M. Ploen, J. Elliott, and W. Key. 2016. Sunken Oil Detection and Recovery, API Technical Report 1154-1 and Operations Guide 1154-2. American Petroleum Institute, Washington, DC.

Boufadel, M.C., B.A. Wrenn, B.E. Moore, K.J. Boda, and J. Michel. 2011. A biodegradation assessment tool for decision on beach response. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. 19 pp.

Michel, J. 2008. Spills of nonfloating oil: Evaluation of response technologies. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 261-267.

Michel, J., B. Benggio, and P. Keane. 2008. Pre-authorization for the use of solidifiers: Results and lessons learned. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 345-348.

Michel, J. 2007. Submerged Oil – State of the Practice and Research Needs. Prepared for Coastal Response Research Center, University of New Hampshire, Durham, NH, 29 pp + app.

Michel, J. 2006. Assessment and Recovery of Submerged Oil: Current State Analysis. Prepared for the U.S. Coast Guard R&D Center, Groton, CT, 34 pp.

Michel, J., D. Scholz, S.R. Warren Jr., and A.H Walker. 2005. A Decision-makers Guide to *In-situ* Burning. American Petroleum Institute, Washington, D.C., Publ. No. 4735, 40 pp.

Scholz, D., S.R. Warren Jr., A.H Walker, and J. Michel. 2004. Risk Communication for *In-situ* Burning: The Fate of Burned Oil. American Petroleum Institute, Washington, D.C., Publ. No. 4740, 60 pp.

Michel, J., A.H. Walker, D. Scholz, and J. Boyd. 2001. Surface-washing agents: product evaluations, case histories, and guidelines for use in marine and freshwater habitats. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 805-813.

Scholz, D, J. Boyd, A.H. Walker, and J. Michel. 2001. Using the selection guide for spill countermeasure technologies in response decision making and planning. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 797-803.

Michel, J. and 5 others. 2001. Spills of non-floating oils: Findings, conclusions, and recommendations to improve preparedness and response. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 1301-1305.

Clayton, J.R., J. Michel, and six others. 1997. The decision process to support shoreline cleaning agents in the field. Proc. 1997 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 960-961

Clayton, J.R., J. Michel, and six others. 1996. Methodology for estimating cleaning effectiveness and dispersion of oil with shoreline cleaning agents in the field. Proc. 19th Arctic and Marine Oilspill Program Technical Seminar, Environment Canada, pp. 423-452.

Clayton, J.R., J. Michel, and six others. 1996. Methodologies for estimating toxicity of shoreline cleaning agents in the field. Proc. 19th Arctic and Marine Oilspill Program Technical Seminar, Environment Canada, pp. 543-586.

Whipple, F. CDR, S. Christopherson, and J. Michel. 1995. Mechanical Protection Guidelines. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 841-842.

Burns, G.H., C.A. Benson, S. Kelly, T. Eason, B. Benggio, J. Michel, and M. Ploen. 1995. Recovery of submerged oil at San Juan, Puerto Rico 1994. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Inst., Washington, D.C., pp. 551-557.

- Owens, E.H., G.A. Sergy, and J. Michel. 1995. Case studies of standardized techniques to document shoreline oiling conditions. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 904-905.
- Michel, J., D. Scholz, C.B. Henry, and B.L. Benggio. 1995. Group V fuel oils: source behavior, and response issues. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 559-564.
- Michel, J. and B.L. Benggio. 1995. Testing and use of shoreline cleaning agents during the *Morris J. Berman* spill. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 197-202.
- Walker, A.H., J. Kucklick, J. Michel, D. Scholz, and T. Reilly. 1995. Chemical treating agents: response niches and research and development needs. Proc. 1995 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 211-217.
- Walker, A.H., J. Michel, G. Canevari, J. Kucklick, D. Scholz, C.A. Benson, E. Overton, and B. Shane. 1994. Chemical oil spill treating agents: herding agents, emulsion treating agents, solidifiers, elasticity modifiers, shoreline cleaning agents, shoreline pre-treatment agents, and oxidation agents. Marine Spill Response Corp, Washington, D.C., Tech. Report 93-015, 328 pp.
- Scholz, D.K., J. Michel, C.B. Henry, and B. Benggio. 1994. Assessment of risks associated with the shipment and transfer of Group V fuel oils. Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 30 pp.
- Michel, J., S. Christopherson, and F. Whipple. 1994. Mechanical protection guidelines. Hazardous Materials Response and Assessment Div., NOAA, Seattle, WA, 87 pp.
- Michel, J., C.B. Henry, and B. Benggio. 1993. Evaluation of options for removal of submerged oil offshore Treasure Island, Tampa Bay oil spill. Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 10 pp.
- Michel, J., C.B. Henry, and J.M. Barnhill. 1993. Use of Elastol during the Unocal spill on the Neches River, 24 April 1993. Regional Response Team VI, 10 pp.
- Payne, J.R., et al., 1991. Dispersant trials using the *Pac Baroness*, a spill of opportunity. Proc. 1991 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 427-433.

PLANNING AND TRAINING

- Zengel, S. M.O. Hayes, J. Michel, B. Benggio, and L. Francedese. 2001. Sensitive areas planning for inland south Florida. Web and GIS tools. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 789-796.
- Michel, J., M.O. Hayes, R. Hoff, G. Shigenaka, and D. Scholz. 1992. An introduction to coastal habitats and biological resources for oil spill response. Hazardous Materials Response and Assessment Division, NOAA, Seattle, WA, 250 pp.
- Savitsky, B. and J. Michel. 1986. Qualitative risk assessment for hazardous material spills in ports. Proc. Hazardous Material Spill Conf. American Petroleum Institute, Washington, D.C.

ENVIRONMENTAL RISK ASSESSMENTS/GEOLOGY

Development Projects on the OCS: Dr. Michel has assisted the Bureau of Ocean Energy Management (BOEM) on numerous projects related to environmentally sound management of resources in the Outer Continental Shelf, including:

- 1) Principal Investigator and Senior Author of the 2007 Literature Synthesis study on potential environmental impacts associated with alternative energy uses of the OCS. She also authored the Workshop Summary for the workshop held by MMS in June 2007. She has continued to support

alternative energy development as member of the Regulatory Task Force managed by the South Carolina Energy Office.

- 2) Senior Author of the 2013 report: Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand. She authored the sections for foraging seabirds, sea turtles, and marine mammals.
- 3) Principal Investigator and Senior Editor of the 2011 Literature Synthesis of the South Atlantic Planning Area of the southeastern U.S. which covers the topics of Physical Oceanography, Geological Oceanography, Chemical Oceanography, Plankton Communities, Benthic Communities, Fish and Fish Habitat, Birds, Marine Mammals, Sea Turtles, Areas of Special Concern, Socioeconomic Resources, and Research and Development Technologies. This 900+ page synthesis report addresses current conditions and potential environmental impacts associated with oil and gas exploration and production, sand and gravel extraction, and alternative energy development of the outer continental shelf of the southeast U.S. shelf and slope.
- 4) Principal Investigator and Senior Author of the 2007 report on a critical review of the studies techniques being used by the BOEM Marine Minerals Program. In this report, recommendations were made to generate baseline data, evaluate the effectiveness of mitigation measures, and detect cumulative impacts.
- 5) Design and manage regional sand management working groups for Louisiana and Florida. This work involved coordination of agencies, private industry, academia, and stakeholders in the complex issues of dredging offshore sand deposits for habitat restoration. She also developed Monitoring Protocols for Environmental Sound Management/ Development of Federal Offshore Sand Borrow Areas on the East and Gulf Coasts;
- 6) Archaeological damage from offshore dredging: recommendations for pre-operational surveys and mitigation during dredging to avoid adverse impacts; and
- 7) Recommendations for environmentally friendly dredging techniques.

Programmatic Environmental Impact Statements (PEIS)/Biological Assessments:

Dr. Michel assisted the NOAA Restoration Center in preparation of the PEIS for the *Deepwater Horizon* Damage Assessment and Restoration Plan. In 2013, she co-authored the Biological Assessment required under Section 7 of the Endangered Species Act for the Regional Response Team 9 California Dispersant Use Plan. She also co-authored the PEIS for the U.S. Coast Guard rulemaking that requires the inclusion of in-situ burning and dispersant capability in vessel and facility oil spill response plans in 2004.

She prepared Environmental Assessments for: two development projects associated with the Jazan Economic City on the Red Sea in Saudi Arabia in 2015; removal of nine wrecked tuna longliner vessels on a reef in Pago Pago, American Samoa in 1999; a spill in the Obed Wild and Scenic River, Tennessee in 2003; and the offloading of *USS Mississinewa*, a World War II tanker that started leaking oil into Ulithi Lagoon, Federated States of Micronesia in 2002. In 2009-2010 she used data on contamination sources to conduct contaminant and site-specific hazard assessments and develop a vulnerability index of coastal and marine resources to oil spills and releases of hazardous substance resulting from changes in sea level rise.

Environmental Risk/Pollution Assessments: She worked on the assessment of marine oil spill risk and environmental vulnerability for the State of Alaska (2013); risk assessment for Potentially Polluting Shipwrecks in U.S. Waters (2013); risks and effects of chemical spills from offshore wind turbines (2013); an Environmental Vulnerability Index to support coastal management and planning in the Emirate of Abu Dhabi (2011); and the Coastal Pollution Assessment for Jeddah, Saudi Arabia (2008).

Dr. Michel was the Project Manager for the Baseline Studies for Oil Pollution Control in Nigeria (1982-1985), a multidisciplinary study of the chemistry and biology of the Niger Delta for the Nigerian National

Petroleum Corporation. Extensive field surveys were conducted over a three-year period to characterize the ecological components, water quality, physical processes, and legal/socioeconomic issues for development of criteria and standards against oil pollution in the Niger Delta ecosystems.

Coastal Habitat Mapping: Dr. Michel was one of the original creators of the concept of Environmental Sensitivity Index (ESI) mapping. In 1990, she spearheaded the use of Geographic Information Systems (GIS) technology for data management and map production, including the development of standards for the production of coastal resource maps and databases. This work includes the Gulf-Wide Information System (G-WIS) projects for the Minerals Management Service. She conducted field mapping and authored the following atlases:

- Northern Puget Sound, Wash.
- Central Puget Sound, Wash.-
- Florida (1980 original and 1993 update)
- Bristol Bay, Alaska
- Lake Michigan, WI, IL, IN, MI
- Lake Superior
- Lake Huron
- Cook Inlet and Kenai Peninsula, Alaska
- South Alaska Peninsula
- Central/Northern California
- Southeastern Alaska
- Lake Ontario
- Prince William Sound, AK

Mapping of Unusually Sensitive Areas, Office of Pipeline Safety. As Project Manager for the contract for mapping of Unusually Sensitive Areas (USAs), Dr. Michel developed the technical definition of drinking water USAs based on aquifer characteristics and development of a complex GIS model to create USAs from available datasets. Over a two-year cooperative development process, RPI worked closely with industry representatives to refine and finalize the technical processes for creating USAs.

Selected Publications

- Symons, L., J. Michel, J. Delgado, D. Reich, D. French McCay, D.S. Etkin, and D. Helton. 2014. The Remediation of Underwater Legacy Environmental Threats (RULET) Risk Assessment for Potentially Polluting Shipwrecks in U.S. Waters. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 783-793.
- French McCay, D., D. Reich, J. Michel, D. Schmidt Etkin, L. Symons, D. Helton, and J. Wagner. 2014. For Response Planning: Predicted Environmental Contamination Resulting from Oil Leakage from Sunken Vessels. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C.
- Reich, D.A. D. French McCay, J. Fontenault, J. Rowe, D.S. Etkin, J. Michel, Z. Nixon, C. Boring, M. McBrien, and B. Hay. 2013. Assessment of Marine Oil Spill Risk and Environmental Vulnerability for the State of Alaska. Restoration Center Northwest, NOAA, Seattle, WA. 134 pp.
- Bejarano, A.C., J. Michel, J. Rowe, Z. Li, D. French McCay, L. McStay and D.S. Etkin. 2013. Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-213. 261 pp.
- Michel, J., A.C. Bejarano, C.H. Peterson, and C. Voss 2013. Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2013-0119. 258 pp.
- Michel, J. (ed.). 2013. South Atlantic Information Resources: Data Search and Literature Synthesis. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-01157. 942 pp.

- Hayes, M.O., J. Michel, and D.V. Betenbaugh. 2010. The intermittently exposed, coarse-grained gravel beaches of Prince William Sound, Alaska: Comparison with open-ocean gravel beaches. *J. Coastal Research* 26(1):4-30.
- Barnea, N., J. Michel, B. Bray, Z. Nixon, G. Imahori, and C. Moegling. 2009. Marine Debris Response Planning in the North-Central Gulf of Mexico. June 2009. NOAA Technical Memorandum. 43 pp.
- Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J.M., McGillis, A. and Hain, J. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Herndon, VA. MMS OCS Report 2007-038, 254 pp.
- Michel, J. and Burkhard, E. 2007. Workshop to Identify Alternative Energy Environmental Information Needs: Workshop Summary. U.S. Department of the Interior, Minerals Management Service, Herndon, VA. MMS OCS Report 2007-057, 55 pp. + app.
- Michel, J., Nairn, R., Peterson, C.H., Ross, S.W., Weisberg, R. and Randall, R. 2007. Critical Technical Review and Evaluation of Site-Specific Studies Techniques for the MMS Marine Minerals Program. Management Service, Herndon, VA. MMS OCS Report 2007-047. 47 pp. + app.
- Etkin, D.S., D. French-McCay, and J. Michel. 2007. Review of the State-of-the-Art on Modeling Interactions between Spilled Oil and Shorelines for the Development of Algorithms for Oil Spill Risk Analysis Modeling. Management Service, Herndon, VA. MMS OCS Study 2007-063. 157 pp.
- Michel, J., D. Etkin, T. Gilbert, J. Waldron, C.T. Blocksidge, and R. Urban. 2005. Potentially Polluting Wrecks in Marine Waters: An Issue Paper Presented at the 2005 Intl. Oil Spill Conference. American Petroleum Institute, Washington, D.C., 76 pp.
- Michel, J. and B. Drucker. 2005. Regional management strategies for Federal offshore borrow areas: The Louisiana Sand Management Working Group. Proc. Coastal Zone '05, Coastal Services Center, NOAA, Charleston, SC.
- Nairn, R., T. Kenny, F. Marvan, J. Michel, R. Newell, and N. Bray. 2004. Review of Existing and Emerging Environmentally Friendly Offshore Dredging Technologies. U.S. Department of the Interior, Minerals Management Service, Marine Minerals Division, Herndon, VA. OCS Report MMS 2004-076, 150 pp.
- Michel, J. 2004. Regional management strategies for Federal offshore borrow areas, U.S. East and Gulf of Mexico coasts. *J. Coastal Research* 20:149-154.
- Nairn, R. J.A. Johnson, D. Hardin, and J. Michel. 2004. A biological and physical monitoring program to evaluate long-term impacts from sand dredging operations in the United States outer continental shelf. *J. Coastal Research* 20:126-137.
- Research Planning, Inc., Tidewater Atlantic Research, Inc., and Baird & Associates Ltd., 2004. Archaeological Damage from Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts. U.S. Department of the Interior, Minerals Management Service, Sand and Gravel Unit, Leasing Division, Herndon, VA. OCS Report MMS 2004-005, 75 pp. + app.
- Michel, J. and C. Lord. 2002. *Mississinewa* Offloading, Ulithi Lagoon, Yap State, Federated States of Micronesia: Environmental Assessment. Naval Sea Systems Command, Washington, D.C., 47 pp + app.
- Michel, J., R. Nairn, and J. Johnson. 2001. Development and Design of Biological and Physical Monitoring Protocols to Evaluate the Long-term Impacts of Offshore Dredging Operations on the Marine Environment. U.S. Department of the Interior, Minerals Management Service, Marine Minerals Division, Herndon, VA. OCS Report MMS 2001-089, 116 pp.
- Michel, J. 2001. Examination of Regional Management Strategies for Federal Offshore Borrow Areas Along the United States East and Gulf of Mexico Coasts. U.S. Department of the Interior, Minerals Management Service, Marine Minerals Division, Herndon, VA. OCS Report MMS 2001-090, 23 pp. + app.

- Hayes, M.O. and J. Michel. 1989. Modern clastic depositional systems of south-central Alaska, field trip guidebook T101, 28th Intl. Geological Congress, 29- June - 7 July 1989. American Geophysical Union, Washington, D.C., 42 pp.
- Kana, T.W., J. Michel, M.O. Hayes, and J.R. Jensen. 1984. The physical impact of sea-level rise in the area of Charleston, South Carolina. M.C. Barth and J. Titus (eds.), Greenhouse Effect and Sea Level Rise: A Challenge for This Generation: Van Nostrand Reinhold Co., New York, NY, pp. 105-151.
- Kana, T.W., J. Michel, M.O. Hayes, and J.R. Jensen. 1983. Shoreline changes due to various sea-level rise scenarios. Proc. Coastal Zone Management '83, ASCE, NY, pp. 2768-2776.
- Hayes, M.O. and J. Michel. 1982. Shoreline sedimentation with a forearc embayment, lower Cook Inlet, Alaska. Jour. Sed. Petrol. 52:251-263.

NATURAL RESOURCE DAMAGE ASSESSMENT AND RESTORATION

Dr. Michel has been a leader in the development of methods and the conduct of natural resource damage assessments (NRDA) following spills and groundings. She has taken a lead role in numerous damage assessments Federal and State Trustees. Since 1991, she has been the project manager for RPI's work under contract to the Damage Assessment Center of NOAA on many different aspects of natural resource damage assessments. She worked on the NRDA for the following incidents and waste sites:

1. *T/V Amazon Venture*, Savannah River, Georgia/South Carolina (1985)
2. Shell Martinez tank farm, Martinez, California (1988)
3. *T/V Exxon Valdez*, Prince William Sound, Alaska (1989)
4. *T/V American Trader*, Huntington Beach, California (1991)
5. Arthur Kill spills in New York/New Jersey (1991)
6. Mobil Mining and Minerals Company spill of phosphoric acid into the Houston Ship Channel, Texas (1992)
7. *M/V Mega Borg* spill off the Texas coast (1992)
8. Colonial Pipeline oil spill into Sugarland Run and the Potomac River, Virginia (1993)
9. Unocal Spill, California (1994)
10. *T/B North Cape* barge home heating oil spill in Rhode Island (1995)
11. Colonial Pipeline spill of No. 2 fuel oil into the Reedy River, South Carolina (1996)
12. *T/V Julie N* tanker spill of IFO 180 in Portland, Maine (1996)
13. Lake Barre, Louisiana pipeline crude oil spill by Texaco (1997)
14. Chevron pipeline crude oil spill, Gulf of Mexico (1998)
15. *M/V New Carissa* bunker and diesel spill, Coos Bay, Oregon (1999)
16. Tuna Longliners Vessel Removal Action, American Samoa (1999)
17. Petrobras Pipeline, Guanabara Bay, Brazil (2000)
18. PEPCO pipeline spill, Patuxent River, Maryland (2000)
19. Tug Gilbert grounding, Gulf Islands National Seashore (2001)
20. *M/T Westchester*, Mississippi River (2001)
21. Pryor Oil Well Fire and Spill, Obed Wild and Scenic River, Tennessee (2002)
22. *Bouchard Barge-120*, Buzzards Bay, Massachusetts and Rhode Island (2003)
23. *M/T Athos I*, Delaware River, PA, NJ, DE (2004)
24. Citgo Refinery, Lake Charles, Louisiana (2006)
25. *Cosco Busan*, San Francisco, California (2007)
26. Burton Island Ash Landfill, Delaware (2008)
27. *Selendang Ayu*, Unalaska Island, Alaska (2008)

28. *Deepwater Horizon*, Gulf of Mexico (2010)
29. Motiva, Arthur Kill, New York (2012)
30. ExxonMobil Pegasus Pipeline, Arkansas (2013)
31. Zavanna Oil Field Spill, Williston, North Dakota (2014)
32. Texas City Y, Texas (2014)

From 2009-2014, Dr. Michel was the Senior Science Advisor for RPI's 3.5-year project to speed the ecological recovery the coastal habitats affected by the Gulf War oil spill. Through technical management of 23 individual projects (totaling over \$400 million) to restore tidal channel functions, decrease ponding, and reduce physical barriers including thick algal mats, over 1,800 hectares of marshes, tidal flats, and beaches are now recovering faster

Selected Publicly Available Reports

- Michel, J., S.R. Fegley, J.A. Dahlin, and C. Wood. Oil spill response-related injuries on sand beaches: When shoreline treatment extends impacts beyond the oil. Submitted to: Marine Ecology Progress Series.
- Bejarano, A.C. and J. Michel. Oil spill and their impacts on sand beaches: A literature review. Submitted to Environmental Pollution.
- Nixon, Z., S. Zengel, M. Baker, M. Steinhoff, G. Fricano, S. Rouhani, and J. Michel. 2016. Shoreline oiling from the *Deepwater Horizon* oil spill. *Marine Pollution Bulletin* 107:170-178.
- Zengel, S., C.L. Montague, S.C. Pennings, S.P. Powers, M. Steinhoff, G. Fricano, C. Schlemme, M. Zhang, J. Oehrig, Z. Nixon, S. Rouhani, and J. Michel. 2016. Impacts of the *Deepwater Horizon* oil spill on salt marsh periwinkles (*Littoraria irrorata*). *Environmental Science & Technology* 50:643-652.
- Nixon, Z. and J. Michel. 2015. Predictive modeling of subsurface shoreline oil encounter probability from the *Exxon Valdez* oil spill in Prince William Sound, Alaska. *Environmental Science & Technology* 49:4354-4361.
- Michel, J. and Z. Nixon. 2015. Coastal wetland vegetation: Response-related injuries during the *Deepwater Horizon* oil spill. NOAA Assessment and Restoration Division, Seattle, WA. 19 pp.
- Bejarano, A., J. Michel, and S.E. Allan. 2014. Guidelines for Collecting High Priority Ephemeral Data for Oil Spills in the Arctic in Support of Natural Resource Damage Assessments. Prepared for the Office of Response and Restoration, National Oceanic and Atmospheric Administration, Seattle, WA. 271 pp. Available at: <http://response.restoration.noaa.gov/environmental-restoration/environmental-assessment-tools/noaa-sampling-guidelines-arctic-oil-spills.html>
- Minter, T.G., J.A. Hale, C.D. Cormack, L. Cotsapas, and J. Michel. 2014. Tidal flat and sand beach remediation: Choosing remediation techniques to speed ecological recovery of habitats still impacted 20 years after the Gulf War oil spill. Proc. 2014 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 1719-1733.
- Bejarano, A., J. Michel, and L. Williams. 2012. Net Environmental Benefit Analysis (NEBA) relative risk ranking conceptual design, Kalamazoo River System, Enbridge Line 6B Release. August 8, 2012; document and appendixes; AR-0963.
- Hale, J. C.D. Cormack, L. Cotsapas, T.M. Montello, O. Langman, J.J. Gabriel, and J. Michel. 2011. Relationships between key indicators of environmental condition and degrees of oiling in sediments in salt marsh habitats: A balance between contamination and ecological recovery by natural processes. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., 14 pp.
- Dunagan, H., J. Michel, and J. Burr. 2011. Assessment and restoration scaling of stream services impaired by the Obed River 2002 oil spill. Proc. 2011 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., 11 pp.

- Michel, J. and A.C. Bejarano. 2010. The *Deepwater Horizon* Oil Spill: Shoreline Cleanup Assessment Technique as a key data source in Habitat Equivalency Analysis. SETAC. New Orleans, LA, USA.
- Michel, J., Z. Nixon, J. Dahlin, D. Betenbaugh, M. White, D. Burton, and S. Turley. 2009. Recovery of interior brackish marshes seven years after the Chalk Point oil spill. *Marine Pollution Bull.* 58:995-1006.
- Michel, J., C. Boring, and C. Locke. 2008. Rapid assessment protocols for small vessel groundings. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 381-386.
- Nixon, Z., J. Michel, J. Hoff, D. Forsell, S. Krest, K. Clark, T. Nicols, J. Dunn, and K. Kalasz. 2008. Estimating bird injury from the M/T *Athos 1* incident. Proc. 2008 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 995-1001.
- Greer, R., P. McGowan, J. Michel, and N. Meade. 2005. Injury to muskrats (*Ondatra zibethicus*) from the Chalk Point Oil Spill, Patuxent River, Maryland. Proc. 2005 Intl. Oil Spill Conference, American Petroleum Institute Publ. Washington, D.C. pp. 787-791.
- Michel, J., H. Hinkeldey, N. Meade, and P. McGowan. 2003. Injury to birds and diamondback terrapins resulting from the Chalk Point oil spill, Maryland. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730 A, Washington, D.C. pp. 797-803.
- Michel, J. S. Zengel, H. Hinkeldey, and D. Helton. 2003. Ephemeral data collection during the emergency phase of a spill: Protocols on design and methods. Proc. 2003 Intl. Oil Spill Conference, American Petroleum Institute Publ. No. 14730 A, Washington, D.C. pp. 1139-1145.
- RPI. 2003. Preassessment Phase Report for the Howard/White Unit No. 1 Oil Spill NRDA, Obed Wild and Scenic River, Morgan County, Tennessee. Prepared for National Park Service, 47 pp. + apps.
- Michel, J., S. Zengel, C. Lord, and Z. Nixon. 2002. Surveys of Abandoned Vessels: U.S. Caribbean Region. NOAA Office of Response and Restoration, Silver Spring, MD, 52 pp. + app.
- Michel, J., K. Smith, M. Keiler, A. Rizzo, R. Ayella, and G. Harmon. 2002. Injury to wetlands resulting from the Chalk Point oil spill. Report to the Trustee Council for the Chalk Point Oil Spill. NOAA Damage Assessment Center, Silver Spring, MD, 31 pp + app.
- Michel, J. 2001. Mangrove habitat injury assessment and scaling protocols. Report to NOAA Damage Assessment Center, Silver Spring, MD, 27 pp + 41 pp. annotated bibliography.
- Hinkeldey, H, J. Michel, T. Tomasi, R. Greer, W. Kicklighter, R. Wood and N. Meade. 2001. Estimate of the total injury to diamondback terrapins from the Chalk Point oil spill. Report to the Trustee Council for the Chalk Point Oil Spill. NOAA Damage Assessment Center, Silver Spring, MD, 12 pp.
- Michel, J., P. McGowan, and R. Greer. 2001. Estimate of total acute mortality to birds and production foregone resulting from the Chalk Point oil spill, Swanson Creek, Maryland, April 7, 2000. Report to the Trustee Council for the Chalk Point Oil Spill. NOAA Damage Assessment Center, Silver Spring, MD, 15 pp.
- Michel, J. 2001. Preassessment Data Report for the M/T *WESTCHESTER* oil spill, Mississippi River Mile 38, Louisiana. Report to the Trustees, NOAA Damage Assessment Center, Silver Spring, MD, 19 pp. + app.
- Michel, J., S. Zengel, L. Cotsapas, J. Dahlin, and J. Hoff. 2001. Scaling of injury to reef flat habitats resulting from removal actions of grounded vessels in Pago Pago, American Samoa. Proc. 2001 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C., pp. 671-678.
- Michel, J. 2000. Interim Preassessment Report, M/V *New Carissa* Oil Spill. NOAA Damage Assessment Center, Silver Spring, MD.
- RPI. 1999. Restoration Plan and Environmental Assessment, Tuna Longliners Cleanup, Pago Pago, American Samoa. NOAA Damage Assessment Center, Silver Spring, MD.
- Michel, J., S. Zengel, D. Helton, J.R. Payne. 1999. Protocols for sample design and implementation: field methods, sample handling, and chemical analysis for natural resource damage assessments of oil spills. Proc. 1999 Intl. Oil Spill Conference, American Petroleum Institute, Washington, D.C.

- Michel, J. and S. Zengel. 1998. Monitoring of oysters and sediments in Acajutla, El Salvador. *Marine Pollution Bull.* 36(4):256-266.
- Michel, J. 1997. Extent of oiling of wetlands, *Julie N* oil spill, Portland, Maine. Prepared for the *Julie N* Trustee Council, Maine Department of Environmental Protection, Portland, ME, 12 pp. + app.
- Michel, J. 1997. Natural Resources Damage Assessment Handbook for Thailand. Prepared for the Pollution Control Department, Ministry of Science Technology and Environment, Bangkok, Thailand, 86 pp.
- Michel, J., F. Csulak, D. French, and M. Sperduto. 1997. Natural resource impacts from the *North Cape* oil spill. Proc. 1997 Intl. Oil Spill Conference, API Publ. No. 4651, American Petroleum Institute, Washington, D.C., pp. 841-850.
- Helton, D., J. Michel, and T.J. Reilly. 1997. Incorporating oil behavior in the design of natural resource damage assessment studies: three case histories. Proc. 20th Arctic and Marine Oilspill Program Tech. Seminar, Environment Canada.
- Michel, J. 1996. *North Cape* oil spill natural resource damage assessment, preassessment data report. Prepared for Damage Assessment Center, NOAA; Ninigret National Wildlife Refuge, U.S. Fish and Wildlife Service; and Rhode Island Department of Environmental Management, 85 pp. + app.
- Reinharz, E. and J. Michel. 1996. Preassessment Phase Guidance Document For Natural Resources Damage Assessment Under The Oil Pollution Act Of 1990. Prepared for the Damage Assessment and Restoration Program, National Oceanic and Atmospheric Administration, 1305 East-West Highway, SSMC #4, Silver Spring, Maryland. 47 pp. + app.
- Huguenin, M.T., D.H. Haury, J.C. Weiss, D. Helton, C. Manen, E. Reinharz, and J. Michel. 1995. Injury Assessment Guidance Document for Natural Resources and Services under the Oil Pollution Act of 1990. Prepared for the Damage Assessment and Restoration Program, NOAA, Silver Spring, MD.
- Michel, J., R.E. Unsworth, D.K. Scholz, and E. Snell. 1994. Oil spill damage inventory and assessment: preliminary protocols and methodologies. Prepared for the Florida Marine Research Institute, St. Petersburg, FL, 204 pp. + app.
- Scholz, D. and J. Michel. 1992. The *Mega Borg* oil spill: chronology and summary of spill response activities (chap. 1); and fate of the lost oil (chap. 2). Prepared for the Damage Assessment Center, NOAA, Rockville, MD, 88 pp. + app.
- Michel, J. and D. Scholz. 1992. Natural resources damage assessment emergency procedures manual. Prepared for the Damage Assessment Center, NOAA, Rockville, MD, 93 pp. + app. (version 2.0 published October 1995).
- Michel, J. 1991. Simplified Type B assessments: a cost-effective and rational approach to natural resource damage assessments for spills. Invited Paper, Am. Fisheries Society, San Antonio, TX.
- Michel, J. 1989. Natural resource damage assessment of the *Amazon Venture* oil spill. Proc. 1989 Oil Spill Conference, API Publ. No. 4479, American Petroleum Institute, Washington, D.C., pp. 303-306.

ENVIRONMENTAL RADIOCHEMISTRY

Since 1976, research has been conducted on the distribution and geochemistry of natural radionuclides in soils, groundwater, and surface water. The results have been applied to problems on the occurrence of radionuclides in public drinking water sources, drinking water standards, and understanding the geological factors that affect their distribution, with emphasis on radium and radon isotopes. Models have been developed to predict the levels of uranium, radium, and radon in groundwater nationwide, and these levels have been mapped at the county scale.

Dr. Michel has participated on numerous review panels for EPA's Office of Drinking Water dealing with radionuclides and was a consultant to the Radiation Advisory Committee of the Science Advisory Board. She has provided expert review and testimony on radiological contamination and risk associated with the

phosphate industry. She has also conducted various studies on radiological contamination at the Savannah River Site, Aiken, South Carolina. Selected publications resulting from her research are cited below.

Chapters in Books

- Michel, J. 1991. Relationship of Radium and Radon with Geological Formations: in C.R. Cothorn and P. Rebers (eds.), *Radioactivity in Drinking Water*, Plenum Press, New York.
- Michel, J. 1987. Chapter 4, Sources: in C.R. Cothorn and J.E. Smith, Jr. (eds.), *Environmental Radon*, *Environmental Science Research Volume 35*, Plenum Press, NY, pp. 81-130.
- Crawford-Brown, D.J. and J. Michel. 1987. Chapter 3, Measurement: in C.R. Cothorn and J.E. Smith, Jr. (eds.), *Environmental Radon*, *Environmental Science Research Volume 35*, Plenum Press, New York, pp. 59-80.
- Michel, J. and M. Jordana. 1987. Nationwide distribution of Ra-228, Ra-226, Rn-222, and Uranium in ground water. In: B. Graves (ed.), *Radon, Radium, and other Radioactivity in Ground Water*, Lewis Publishers, Chelsea, Mich., pp. 227-240.
- Michel, J., P.T. King, and W.S. Moore. 1982. Technique for Ra-228 and Ra-226, with results from South Carolina. In: E.C. Perry and C.W. Montgomery (eds.), *Isotopic Studies of Hydrologic Processes*, North. Ill. Univ. Press, pp. 83-90.

Selected Publications and Abstracts

- Michel, J. 1988. Natural radioactivity in ground water near the Savannah River Plant. Rept. to E.I. du Pont de Nemours & Co., Savannah River Plant, Aiken S.C., 45 p. + appendices.
- Michel, J. 1988. Distribution of radon in groundwater in California: Rept. for California Public Health Foundation, Berkeley, Calif., by RPI, 46 pp.
- Michel, J. 1988. Relationship between radon levels and geological formations: (abs.) Proc. American Chemical Society, Los Angeles, Calif., Sept. 1988.
- Michel, J. 1988. Geological aspects of radon: Invited Paper-Symposium on Radon, 9th Annual Meeting American College of Toxicology, Baltimore, Md.
- Michel, J. and C.R. Cothorn. 1986. Predicting the occurrence of radium-228 in groundwater. *Health Physics*, 51:715-723.
- Cothorn, C., W.L. Lappenbusch, and J. Michel, 1986, Drinking water contribution to natural background radiation. *Health Physics*, 50:33-47.
- Hess, C.T., J. Michel, T.R. Horton, H.M. Pritchard, and W.A. Coniglio. 1985. The occurrence of radioactivity in public water supplies in the United States. *Health Physics*, 48:553-586.
- Cothorn, C.R., P. Lassovszky, W.L. Lappenbusch, and J. Michel. 1984. Review of advances in analytical measurement techniques and treatment methodology for radioactivity in drinking water (abs.). American Chemical Society Annual Meeting, Philadelphia, PA.
- Michel, J. 1984. Redistribution of uranium and thorium series isotopes during isovolumetric weathering of granite. *Geochim. Cosmochim. Acta*, 48:1249-1255.
- Michel, J. and C. Pollman. 1983. Phase II, Ra-228 model, North-central region of the U.S. EPA, Office of Drinking Water, Wash., D.C., 55 pp.
- Michel, J. and C. Pollman. 1982. A model for the occurrence of Ra-228 in ground water: EPA, Office of Drinking Water, Wash., D.C., 50 pp.
- King, P.T., J. Michel, and W.S. Moore. 1982. Groundwater geochemistry of Ra-228, Ra-226, and Rn-222. *Geochim. Cosmochim. Acta*, 46:1173-1182.
- Michel, J., W.S. Moore, and K. Cole. 1982. Uraniferous gorceixite in the South Carolina coastal plain. *Chemical Geology*, 35:227-245.
- Michel, J., W.S. Moore, and P.T. King. 1981. Gamma x-ray spectrometry for determination of ^{228}Ra and ^{226}Ra in natural waters. *Analytical Chem.*, 53:1885-1889.

-
- Moore, W.S., K. Bruland, and J. Michel. 1981. Fluxes of U and Th series isotopes in the Santa Barbara basin. *Earth Plan. Sci. Ltrs.*, 53:391-399.
- Michel, J. and W.S. Moore. 1980. Ra-228 and Ra-226 in fall line aquifers: *Health Physics*, 38:663-671.
- Michel, J., L.R. Gardner, and W.S. Moore. 1978. Mobilization of U, Th, and Ra during saprolization. *EOS*, 59(12):1224.