

Mala Pattanayek

Senior Consultant



Education and Credentials

M.S., Environmental Toxicology, Clemson University, Clemson, South Carolina, 1996

B.S., Microbiology and Biochemistry, University of Mumbai, Mumbai, India, 1993

Continuing Education and Training

Hazardous Waste Operations and Emergency Response 40-hour Certification (1995; refreshers are current)

Professional Affiliations

Member of Groundwater Resources Association of California

Member of Society of Environmental Toxicology and Chemistry (SETAC)

Member of the Association for Environmental Health and Sciences Foundation (AEHS)

Member of the ITRC TPH Team

Professional Profile

Ms. Mala Pattanayek is a consultant in toxicology and risk assessment. She has 20 years of experience in the field of environmental toxicology. She has executed and managed several ecological risk assessment (ERA) and human health risk assessment (HHRA) projects. Ms. Pattanayek has a successful track record of managing multiple-client projects. She has experience working with leading industry clients and public sector environmental and regulatory agencies and has developed excellent working relationships with federal and state regulatory agency staff.

Ms. Pattanayek is part of Integral's product stewardship group, tracking and evaluating product compliance under California's Proposition 65 and Toxic Substances Control Act. Ms. Pattanayek was part of the Interstate Technology & Regulatory Council (ITRC) Total Petroleum Hydrocarbons (TPH) team, leading the state surveys and coauthoring multiple chapters of the guidance document. Ms. Pattanayek is also on the board of the Women in Environment Bay Area chapter, and leads the mentorship committee. She has published several peer-reviewed scientific articles and technical white papers in leading research and industry journals, and has presented at numerous industry conferences and tradeshows.

Relevant Experience

Toxicology and Risk Assessment

Topock Compressor Station Risk Assessment, Topock, California— Technical lead for implementing the risk assessment for RCRA/CERCLA compliance at a site adjacent to a compressor station in California. Developed a work plan and risk-based levels for multiple chemicals, including hexavalent chromium, used in the site characterization/data gaps assessment. Working with Tribes, agencies, and stakeholders to achieve concurrence on the HHRA and ERA process.

Redevelopment Projects, Multiple sites in California— Conducted HHRA for multiple redevelopment projects in California. Contaminated sites included pesticide-impacted agricultural land, several volatile organic compound (VOC)-impacted industrial sites, and hazardous chemical-impacted sites. Evaluated human health risks via direct contact and vapor intrusion into buildings.



Evaluated risk to workers via trench air during construction (using various box models) and risk to receptors via ambient air (using California guidance recommended models). Evaluated and calculated site-specific metals background concentrations (using DTSC guidance).

Pesticide Use Profiles, Tule Lake and Lower Klamath National Wildlife Refuges, California— Participating in multiyear project with federal agencies in developing pesticide use profiles for several active ingredients including toxicological assessments and fate and transport to determine potential effects of pesticide use on wildlife resources.

Corrective Action Plan, Susanville, California—Completed a risk assessment to support a corrective action plan for a former sawmill facility. Developed a conceptual site model, completed a HHRA for a dozen areas of concerns with impacted soil and groundwater, developed remedial action objectives, and recommended risk-based remedial actions.

Steel Mill, Portland, Oregon—Risk assessment lead for an active steel mill site impacted with PCBs and metals. Worked with Oregon Department of Environmental Quality to complete the HHRA and ERA. Developed site-specific risk-based screening levels used in feasibility study and remedial design. Work also included upland site closure via risk assessment and review of CERCLA RI/FS for adjacent river sediments.

Portland Harbor Superfund Site Feasibility Study/Remedial Design Support, Portland, Oregon— Reviewed and provided comments on the feasibility study, proposed plan, and record of decision for multiple clients for a large and complex sediment site impacted with DDT, PCBs, dioxins/furans, and other chemicals. Supporting pre-remedial design work including development of a site-specific sediment work plan to evaluate risk to aquatic receptors using bioassays, toxicity identification evaluation, and passive sampling.

Ecological Risk Assessment for PCBs, Oahu, Hawaii—Providing a range of technical services to a key client in association with a planned Superfund remedy for PCB-impacted sediments in Hawaii where EPA Region 9 and the U.S. Navy were the lead agencies. Activities included review and comment on the RI/FS documents prepared by others. Developed and implemented a work plan to conduct a site-specific ecological risk assessment to support selection of appropriate preliminary remediation goals and refine the remedial footprint.

Tank Farm Facility, Cut Bank, Montana— Technical lead for the risk assessment for a Tank Hill CERCLA Facility. Evaluated risk to human health and ecological receptors from exposure to impacted soil, groundwater, surface water, and sediment from refinery-related activities. Evaluated multiple current and future scenarios following Montana guidance.

Risk Assessment and Evaluation of Liability, Fox Point Park, Wilmington, Delaware—Leading the ecological risk assessment being conducted in the area of the Delaware River adjacent to Fox Point State Park. The state park was created historically using industrial fill material and later was used for the storage and stockpiling of sewage sludge.



Water Reuse and Development of Benchmarks—Developed a conceptual site model for reuse of produced water generated during exploration and production activities. Developed risk-based benchmarks for a groundwater recharge and agricultural scenario protective of farmers and consumers of produce.

Hazardous Waste Facility Ecological Risk Assessment, Casmalia, California—Conducted an ERA as part of a remedial investigation for a former hazardous waste management facility. Led the effort in developing a work plan, responding to agency comments, preparing the scope and budget for the ERA, managing tasks, and preparing and submitting Tier 1 and Tier 2 ERA reports to EPA and California regulators. Species of concern at the site included California red-legged frogs, California tiger salamander, and other threatened and endangered species in both upland and aquatic areas. The Tier 1 ERA included assessment of various exposures using concentrations of site abiotic media, literature toxicity values, and exposure parameters to estimate risk to ecological receptors at the site and identify risk drivers for a Tier 2 ERA. Played a key role in developing a sampling and analysis plan for conducting a Tier 2 ERA, including collecting tissue data to develop site-specific bioaccumulation factors/regressions; also developed tissue toxicity reference values (TRVs) for use as weight-of-evidence to identify site-specific risk drivers to address in the feasibility study. Developed risk-based concentrations protective of ecological receptors and used the results of the risk assessment to delineate the remedial footprint as part of the feasibility study.

Former Industrial Facility in the San Francisco Bay Area, California—Leading the risk assessment to support the feasibility study for a 10-acre parcel containing two freshwater lagoons adjacent to San Francisco Bay. Constituents of concern include metals and thiocarbamate and organochlorine pesticides. Assessment includes a treatability study to evaluate the effectiveness of carbon amendment to reduce leachability and bioavailability of constituents. Lead agency is the California Department of Toxic Substances Control. Several natural resource trustee agencies are also involved in the project due to the proximity to sensitive habitats that support special-status species.

Sediment Assessment, Risk Assessment, Remedial Design, and Implementation of Waterfront/Subtidal Area, Eureka, California—Prepared a memorandum on delineation of the sediment area of concern as part of the sediment remedial action plan for the waterfront portion of a lease site located in Eureka, California. The objective of the report was to define the lateral and vertical extent of impacted sediment based on a multiple lines of evidence approach, using data from previous investigations as well as the current sediment sampling investigation. The investigation concluded that the area of concern was sufficiently defined vertically and that concentrations below the impacted volume would not require long-term monitoring.

Sediment Characterization, San Diego Bay, California—Used California’s sediment quality objectives to identify impacted sediments in San Diego Bay in areas identified by the San Diego Regional Water Quality Control Board as having impaired water quality; major contaminants included volatiles, metals, petroleum hydrocarbons, and PCBs.

Risk Assessment of Tidal Creek, Richmond, California—Prepared the work plan for the human health and ecological risk assessment to evaluate risk from contaminants in tidal creek sediments



and surface water that receives refinery and other urban discharge/runoff. Prepared work plan for collecting bioaccessibility data to refine the list of chemicals of concern. Calculated risk-based concentrations protective of human health and ecological receptors including special-status species.

Former Rocket Propellant Facility Risk Assessment, San Jose, California—Developed and implemented approach to ERA and HHRA for compliance at a former solid propellant rocket motors facility in San Jose, California. Key issues included assessing effect of perchlorate and VOCs on humans and ecological receptors. Led the efforts to successfully engage the San Francisco Regional Water Quality Control Board in developing risk-based cleanup goals protective of ecological and human health receptors to support a site-wide remedial action plan. Completed a post-remediation risk assessment, which received agency concurrence for site closure with no comments in 6 months, and a risk management plan for the site, which also received agency concurrence with no comments in less than 6 months.

Small Arms Ranges, Fort Ord, California—Conducted an ERA evaluating site-related chemicals at 41 sites for effects to aquatic receptors, mammals, birds, and plants as part of the base-wide RI/FS. Developed TRVs for a variety of chemicals, including heavy metals and explosive compounds. Evaluated the results of bioassays on aquatic organisms and plants. Assessed potential impacts to special-status species, characterized sites, conducted fate and transport analyses, and modeled exposure and effects. The record of decision was signed for all sites except for the Beach Ranges. A Tier 3 ERA was performed for this site that included site-specific studies of plant and mammal uptake, plant health and condition surveys, and butterfly, lizard, and insect population assessments. Various cleanup scenarios were evaluated in the Tier 3 assessment, and remediation of only 10 percent of the 800-acre site was negotiated with the EPA and California regulators.

Leather Tannery Human Health Risk Assessment, Santa Cruz, California—Conducted an HHRA for former tannery based on specific site development plans. Evaluated potential exposures to chemicals in soil and groundwater for future residents and office and construction workers. Chemicals of concern included chromium VI and arsenic as well as VOCs and TPH. Provided target cleanup levels for soil and participated in public outreach programs, including presentations at city planning and city council meetings.

Presidio of San Francisco, San Francisco, California—Prepared a memorandum to provide recommendations for cleanup levels for TPH in soil/sediment and groundwater/surface water at the Presidio of San Francisco for the protection of aquatic receptors. These recommendations were applicable for soil/sediment and groundwater/surface water in the ecological protection zone areas. In these areas, soil is assumed to be in contact with or be converted to sediment currently or in the future and groundwater is assumed to discharge directly to surface water bodies. This memorandum included results of a literature review based on previous studies conducted at the Presidio of San Francisco and in the San Francisco Bay Area, and other sources of TPH toxicity data and cleanup levels.

Hunting Lodge Ecological Risk Assessment, Star Lake, Texas—Prepared and submitted a Tier 2 screening-level ERA as part of the affected property assessment report for a hunting lodge and



surrounding area located in Jefferson County, Texas. The ERA was conducted according to Texas Commission on Environmental Quality (TCEQ) guidance. The site was used as a recreational facility and hunting camp. Key issues included assessing the effect of lead from spent shot and PAHs from clay pigeon fragments on aquatic and terrestrial sensitive and non-sensitive ecological receptors. Played a lead role in preparing the ERA report, responding to agency comments, preparing the scope and budget for the ERA, and managing tasks.

Refinery Risk Assessment, Port Arthur, Texas—Prepared and submitted a Tier 2 screening-level ERA for the Intertidal Area at the Port Arthur Facility, Port Arthur, Texas, which was conducted according to the TCEQ guidance. Key issues included assessing the effect of refinery-related chemicals, such as metals, PAHs, and VOCs, on sensitive and nonsensitive aquatic and terrestrial ecological receptors. Developed soil, sediment, and surface water protective concentration levels. Played a lead role in preparing the ERA report, responding to agency comments, preparing the scope and budget for the ERA, managing tasks, and working with Texas regulators on obtaining approval of the ERA and addressing risks at the site via an ecological services analysis.

Gas Terminal Ecological Risk Assessment, Eureka, California—Conducted an ERA for a gas terminal based on the effect of lead, VOCs, and PAHs on aquatic and wildlife receptors. Played lead role in developing a work plan and a sampling and analysis plan; prepared the scope and budget for the ERA, managed tasks, lead a site visit and sample collection. Worked with California regulators to get approval of the ERA conclusions.

Risk Assessment at Former Refinery, Lawrenceville Refinery, Illinois—Conducted an ERA as part of an RI/FS for a former refinery Superfund site located in Lawrenceville, Illinois. Key issues included assessing the effect of refinery-related chemicals, such as metals, PAHs, and VOCs, on sensitive and non-sensitive ecological receptors. Conducted a site-specific prey tissue data evaluation, developed risk-based screening levels (RBSLs), and site-specific bioaccumulation factors. Played a lead role in preparing the ERA report, responding to agency comments, preparing the scope and budget for the ERA, managing tasks, and working with Illinois regulators on getting approval of the ERA.

Risk-Based Screening Levels for Livestock, American Petroleum Institute, Washington, DC—Developed soil and drinking water RBSLs for protection of a variety of livestock from exposure to petroleum hydrocarbons, including crude oil, BTEX, and PAHs. The TRVs and RBSLs developed for this framework were comparable to human health RBSLs and other published livestock guidelines. The approach can be adapted for assessing other chemicals (i.e., metals, PCBs, pesticides).

Oil Pits Risk Case Study, Oriente Region, Ecuador—Conducted a case study to evaluate potential risks to livestock from petroleum hydrocarbon exposures at oilfield sites in the Oriente Region of Ecuador. In this case study, data from more than 300 surface soil and 100 surface water samples from 7 oilfields in northeastern Ecuador were collected during field inspections conducted from 2004 through 2006. Potential hydrocarbons of concern included crude oil or TPH, BTEX, and PAHs.



Produced Waters Ecological Risk Assessment, Escravos Delta State, Nigeria—Conducted an ERA for the Nigeria Escravos Produced Water Project located in the Delta State, Nigeria, Africa. Used a screening-level ERA approach to determine potential risks to aquatic life by comparing exposure levels of constituents in produced water from the site to saltwater screening values or benchmarks protective of aquatic life. Developed benchmarks based on available literature applicable to the aquatic life at the site.

Global Upstream Produced Water Environmental Standard, San Ramon, California—Prepared detailed risk assessment guidance to support a global upstream produced water environmental standard. The operational excellence expectations for environmental stewardship require that processes are in place to identify, assess, mitigate, and manage significant potential risks and potential impacts to human health and the environment associated with operations, emissions, releases, and wastes.

Ecological Exclusion Criteria Document, San Ramon, California—Prepared an ecological exclusion criteria document, which outlined an approach for justifying that an ERA would not be required, defined as a “Tier 0” decision point. This document was developed for the Petroleum Environmental Research Forum and included a checklist that could be used by site managers to determine whether an ERA would be required and provided technical justification for such a decision. The document focused on exploration and production sites.

Site Investigations

California Environmental Quality Act (CEQA) and Permitting for Remediation at a Former Wastewater Plant, Larkspur, California—Developed a CEQA document (mitigated negative declaration) for a former wastewater plant with PCB contamination. The lead cleanup agency is EPA Region 9 but the Ross Valley Sanitary District was the lead for CEQA. The assessment included an evaluation of air quality impacts using CalEEMod and greenhouse gas impacts as well as tribal consultations under AB52.

CEQA and Permitting for a Sewer Rehabilitation Project, Ross, California—Developed a CEQA document (mitigated negative declaration) for compliance. The assessment included an evaluation of air quality impacts using RoadMod and greenhouse gas impacts as well as tribal consultations under AB52.

Engineering Evaluation and Cost Analysis, San Francisco, California—Supported the potentially responsible party group in coordinating with EPA Region IX’s effort to develop an engineering evaluation and cost analysis (EE/CA) for a contaminated slough in San Francisco. Assisted EPA’s consultant in developing work plans and reports to support the EE/CA and assisted in the development of cleanup goals and permitting strategies. Also involved with source evaluations and historical data evaluations, as well as the development of remedial alternatives.

Sediment Investigation, Oakland, California—Conducted an ERA to evaluate risks to ecological receptors from contaminants in offshore marine sediments and a small freshwater marsh habitat located within an army base in Oakland, California. Prepared a work plan for sediment sampling



and analysis, including a tiered chemical and biological testing program designed to focus the investigation on the areas and chemicals of most concern, thus reducing cost. Conducted bioassay and bioaccumulation tests for samples collected at 12 stormwater outfalls to evaluate potential impacts to terrestrial and aquatic receptors. Risks from ubiquitous anthropogenic contamination were factored out. Successfully negotiated approval of these plans, as well as the risk assessment results, with the federal and state regulators.

Extended Site Investigation, Sausalito, California—Developed both a work plan and a sampling and analysis/quality assurance plan for the collection of sediment samples from Horseshoe Bay as part of an extended site inspection in support of the base realignment, closure of the U.S. Army East Fort Baker Facility, and transfer of the property to the National Park Service. Managed sampling efforts and conducted aquatic bioassays and chemical analyses of sediments. The study was designed to determine if historical East Fort Baker operational practices had caused any adverse impact to the adjacent Horseshoe Bay sediments of sufficient magnitude to warrant dredging. Assessed the data to describe the presence and extent of sediment contamination and associated risks to aquatic biota and wildlife, and presented an extended site investigation report. Risks were shown to be minimal and no action was concluded based on the risk evaluation.

Whole Effluent Toxicity Database, Gulf Coast—Managed the whole effluent toxicity database for a petroleum firm. For the firm, the protection of receiving waters from the effects of produced water and effluent discharges from refinery wastewater treatment plants and other facilities was an important compliance issue. Reviewed reports on toxicity tests from several laboratories, compiled data, and evaluated results for NPDES compliance.

Publications

DeLeo, P., C. Huynh, M. Pattanayek, K. Clark Schmid, and N. Pechacek. 2020. Assessment of ecological hazards and environmental fate of disinfectant quaternary ammonium compounds. *Ecotox. Environ. Safe*. doi.org/10.1016/j.ecoenv.2020.111116

ITRC. 2018. Total petroleum hydrocarbons (TPH) risk evaluation at petroleum-contaminated sites. Interstate Technology and Regulatory Council. November 13.

Hagström, E.L., C. Lyles, M. Pattanayek, B. DeShields, and M.P. Berkman. 2016. Produced water—Emerging challenges, risks, and opportunities. *Environmental Claims Journal* 28(2):122–139.

Pattanayek, M., and B.R. DeShields. 2004. Risk-based screening levels for the protection of livestock exposed to petroleum hydrocarbons. Regulatory Analysis and Scientific Affairs. American Petroleum Institute (API) Publication No. 4733. July 2004.

Pennings, S.C., V.D. Wall, D.J. Moore, M. Pattanayek, T.L. Buck, and J.J. Alberts. 2002. Assessing salt marsh health: a test of the utility of five potential indicators. *Wetlands* 22(2):405–414.



Wall, V.D., J.J. Alberts, D.J. Moore, S.Y. Newell, M. Pattanayek, and S.C. Pennings. 2001. The effect of mercury and PCBs on organisms from lower trophic levels of a Georgia salt marsh. *Arch. Environ. Contam. Toxicol.* 40:10–17.

Alberts, J.J., M. Takács, and M. Pattanayek. 2000. Natural organic matter from a Norwegian lake: possible structural changes resulting from lake acidification. In: *Humic Substances: Versatile Components of Plants, Soil, and Water*. E.A. Ghabbour and G. Davies (eds). Royal Chemical Society, Cambridge, England.

Alberts, J.J., M. Takács, and M. Pattanayek. 2001. Influence of IHSS standard and reference materials on copper and mercury toxicity to *Vibrio fischeri*. *Acta hydrochimica et hydrobiologica*. 28(7):428–435.

Invited Presentations/Panels/Peer Reviews

Panel discussion titled “TPH—What is the Right Cleanup Level?” Speaker. Battelle Bioremediation and Sustainable Environmental Technologies Symposium. May 2015.

Short course titled “Ecological Risk Assessment.” Society of Risk Analysis annual meeting. December 2012.

Panel titled “Diversity, Inclusion, and the Bottom Line: Pledge to Profitability.” San Francisco Bar Association. September 2012.

Short course titled “Ecological Risk Assessment.” NorCal Society of Toxicology and Chemistry annual meeting. May 2012.

Presentations/Posters

DeLeo, P., M. Pattanayek, Y. Atalay, C. Huynh, and N. Pechacek. 2020. Assessment of ecological hazards and environmental fate of disinfectant quaternary ammonium surfactants. SETAC SciCon, SETAC Europe 30th Annual Meeting (Online). May 3–7.

Pattanayek, M., T. Booze, M. Kwiecinski, R. Thun, N. Santella, D. Ries, and K. Johnson. 2018. Current state of cleanup levels and approaches for petroleum-contaminated sites. Poster presentation at the 38th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Sacramento, CA. November 4–7.

Pattanayek, M., R. Thun, and R. Scofield. 2018. Current state of cleanup levels and approaches for petroleum-contaminated sites. Poster presented at the Eleventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA. April 8–12.

Pattanayek, M., and B. DeShields. 2017. Value in refining risk assessments for remedial design. Poster presented at the 38th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Minneapolis, MN. November 12–16.



Pattanayek, M., and B. DeShields. 2017. Risk assessment and its role in the remedial design process. Poster presentation at the 10th International Conference on Remediation of Contaminated Sediments, New Orleans, LA.

DeShields, B., M. Pattanayek, P. Spadaro, and N. van Aelstyn. 2015. The perfect is the enemy of the good: A rational approach to PCB cleanup goals and source control for San Francisco Bay. Platform presentation at the Eighth International Conference on Remediation of Contaminated Sediments, New Orleans, LA.

Pattanayek, M., and S.J. McMillen. 2008. Risk assessment for livestock: A case study from Ecuador. Poster presentation at the SPE Meeting in Nice, France.

Orr, T., M. Pattanayek, B.R. DeShields, and C. Baker. 2007. Reducing uncertainty in ecological risk assessments using site-specific measures of bioavailability. Poster presentation at the 28th Annual Meeting of the Society of Environmental Toxicology and Chemistry in North America, Milwaukee, WI.

Pattanayek, M., G.M. Dimundo, B.R. Deshields, and N. Navarro. 2005. Uptake of antimony, copper, and lead into plants at small arms firing ranges in central California. Poster presentation at the 26th Annual Meeting of the Society of Environmental Toxicology and Chemistry in North America, Baltimore, MD.

Pattanayek, M., G.M. Dimundo, B.R. Deshields, and N. Navarro. 2005. Evaluation of remedial scenarios for metal exposures at small arms firing ranges in central California. Platform presentation at the 26th Annual Meeting of the Society of Environmental Toxicology and Chemistry in North America, Baltimore, MD.

Pattanayek, M., and B.R. DeShields. 2003. Characterizing risks to livestock from petroleum hydrocarbon exposure. Presentation at and publication in proceedings of the 10th Annual International Petroleum Environmental Conference, Houston, TX.

Pattanayek, M. and B.R. DeShields. 2003. Characterizing risks to livestock from petroleum hydrocarbon exposure. Poster presentation at the SETAC 24th Annual Meeting in North America, Austin, TX.

DeShields, B.R., J.J. Gravenmier, M. Pattanayek, and C.F. Kemos. 2001. A Framework for Developing Sediment Screening Levels. 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry, Baltimore, MD.

Pattanayek, M., B.R. DeShields, J.J. Gravenmier, C.F. Kemos, and N. Navarro. 2001. Wildlife screening level benchmarks for evaluating bioaccumulation potential. 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry, Baltimore, MD.

DeShields, B.R., M. Pattanayek, P. McClaren, and J. Stilwell. 2000. Using sediment trend analysis (STA) to evaluate the distribution of DDT-contaminated sediments in the Monterey Submarine



Canyon. 21st Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN.

Pattanayek, M., W.R. Gala, G.A. Rausina, M.J. Ammann, E.A. Harvey, and P. Krause. 2000. Predicting aquatic toxicity of crude oils. 21st Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN.

Alberts, J.J., M. Takács, and M. Pattanayek. 1999. Effect of lake acidification on natural organic matter from a Norwegian lake. Humic Substances Seminar IV, Northeastern University, Boston, MA.

Pattanayek, M., J.J. Alberts, and M. Takács. 1998. Effects of natural organic matter and estuarine salinities on toxicities of copper and mercury. 19th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Charlotte, NC.

Alberts, J.J., M. Takács, and M. Pattanayek. 1998. IHSS stream standards and natural organic matter effects of copper and mercury toxicity. International Humic Substances Society (IHSS), Adelaide, Australia.

Pattanayek, M., and G. Cobb. 1996. Enhanced bioremediation of anthracene-contaminated soil by bioaugmentation and application of non-ionic surfactant-fuelbuster. 17th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Pattanayek, M., and G. Cobb. 1996. Application of surfactant on soil and effluent remediation. Carolina Society of Environmental Toxicology and Chemistry, Charlotte, NC.

Pattanayek, M., and G. Cobb. 1995. Environmental application of surfactant-fuelbuster on fire suppression and soil remediation. 16th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, Canada.

