Regional Applied Research Effort Highlights

EPA's Regions and ORD Putting Science to Work

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Foreword

The Regional Applied Research Effort (RARE) is a mechanism used by the Office of Research and Development's (ORD) Regional Science Program to respond to high-priority, near-term research needs of EPA's regional offices. Annually, ORD makes funds available to each EPA region to develop research topics that are submitted to specific ORD laboratories or centers as extramural research proposals. Regional Science Liaisons manage their region's RARE process, and coordinate all necessary interactions between regional technical staff and ORD project managers throughout the life cycle of the projects, ensuring that regional expectations from the research are fully met. The goals of RARE are to: (1) provide the regions with near-term research on high-priority, region-specific needs; (2) improve collaboration between regions and ORD laboratories and centers; (3) build the foundation for future scientific interactions; and (4) develop useful tools for state, local, and tribal governments to address near-term environmental issues.

This report highlights RARE accomplishments, providing one or two examples per Region, to demonstrate how RARE has contributed over the past decade to advancing EPA science. Now more than ever, as environmental decision makers look for scientific and technological solutions to environmental problems, RARE is a key component of ORD's emphasis on providing science for positive environmental outcomes.

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Introduction

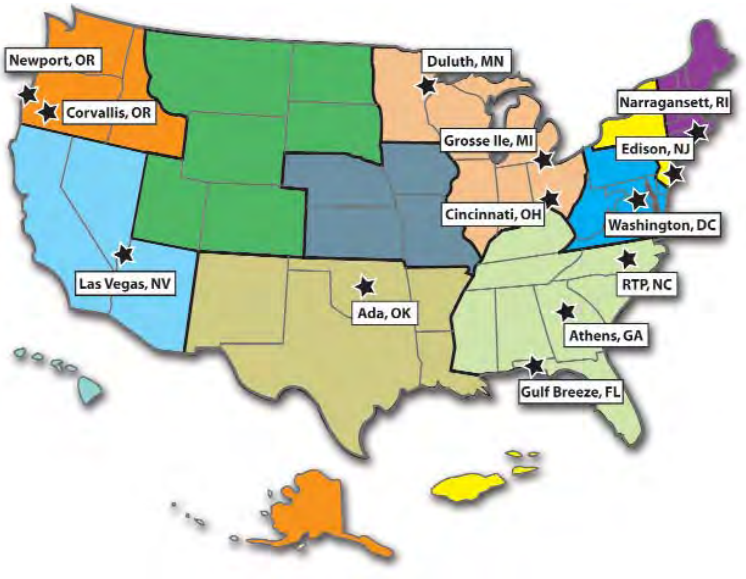
The Regional Applied Research Effort (RARE) Program responds to high-priority, near-term research needs of the U.S. Environmental Protection Agency's (EPA) regional offices. Each year, the Office of Research and Development (ORD) makes funds available for each EPA region to develop research issues that are submitted to specific ORD laboratories or centers as research proposals. Joint participation by ORD researchers and regional staff throughout the planning and performance of these projects enhances communication and coordination between the Agency scientists and the ultimate users of the research in the EPA regional offices. The Regional Science Liaisons (RSLs) facilitate the implementation of the RARE Program in their respective regions and coordinate all necessary interactions between regional technical contacts and the ORD project managers throughout the life cycle of projects selected for RARE funding.

The RARE process is initiated by a memorandum issued by ORD's Assistant Administrator. Regional staff (often collaborating with ORD researchers) develops a project proposal according to the guidelines of their respective region, clearly articulating the issue to be pursued and the anticipated product. An intra-regional competition and selection process is managed by each RSL. Once endorsed by senior regional management, the project proposal is sent to an ORD laboratory or center division director, who verifies that the project falls within the scope of the division and is consistent with the division's objectives. The project is assigned to an ORD lead scientist who, collaborating with expert staff in the regional office, develops a full research proposal and related funding package. The proposal and funding package are submitted to the Office of Science Policy (OSP) for assignment of funds. OSP provides program oversight and fiduciary control, while the laboratory or center is responsible for all aspects of project management.

Research topics pursued under RARE span the full spectrum of the environmental sciences. Many projects have addressed human health concerns, while others have focused specifically on the ecological effects of various pollutants. Because RARE is designed to address near-term regional issues, most projects are conceptually designed to be completed within a 2-year time period.

OSP presently maintains a RARE Tracker database to track and notify all parties in the region, ORD, and OSP at each point in the funding process. The database contains over 15 years of RARE project information, representing approximately 200 projects and $20 million in funds.

This document is a collection of highlights from each region to demonstrate the near-term, high-priority, region-specific nature of RARE research projects that can be linked to measurable environmental outcomes. For additional information, EPA staff can access the following intranet site: http://intranet.epa.gov/ospintra/scienceportal/ under "ORD Regional Science Program." Information also is available on the internet at: http://www.epa.gov/osp under "Regions."



ORD Laboratories, Centers, and Offices

Multiple Environmental Factors for Asthmatic Children

in Public Housing

Background

Asthma is one of the most common chronic illnesses in the United States today, and is particularly prevalent among children from birth to 14 years of age. One of every three Americans with asthma is a child, and the most severe cases are usually found in inner-city children. Asthma is a disease with many influencing factors, including genetics, available medical care, and environmental factors. Evaluations of the environmental factors associated with pediatric asthma are fragmented and assessment has not been undertaken in a comprehensive manner. In urban areas, housing conditions as well as ambient air pollution have been viewed as environmental factors that cause or exacerbate asthma. Because the primary outdoor air pollutants have declined over the same period that asthma has increased, attention has shifted to the role of indoor environmental risk factors.

Science

Region 1 and ORD's National Risk Management Research Laboratory collaborated with researchers from the Tufts University School of Medicine, the Boston University Medical Center, the Committee for Boston Public Housing, and the Harvard School of Public Health to conduct an intensive environmental evaluation of a small number of inner-city public housing apartments in which asthmatic children lived. The goal was to evaluate the relative importance of a wide range of environmental exposures based on a targeted set of measurements, rather than on the diffuse records obtained by studies of larger populations. Interventions were tailored to each apartment after a baseline assessment to test their effectiveness in the public housing setting.

Measurements showed that nitrogen dioxide measurements in the apartments were higher than outdoor concentrations and generally were above the National Ambient Air Quality Standard of 50 parts per billion. The higher levels were thought to be due to the use of gas stoves. Particulate matter (PM) levels also were above the outdoor measurements and were attributed to tobacco smoking. Several volatile organic chemicals (e.g., benzene and chloroform) were found at levels that indicated a high exposure risk. Analysis of the dust samples indicate that cockroach, mouse, and pet antigen levels were variable and frequently high in settled dust, while dust mite allergen levels were below the level of concern. Intervention results showed that although none of the filtration units reduced the mean PM concentration, ongoing industrial cleaning did reduce antigen levels.

Outcome

The study demonstrated that asthma intervention must involve a multi-factorial approach, a paradigm now being applied in a larger Boston study in which Region 1 is working with the tenant groups, the Boston Housing Authority, industry groups, city government, and philanthropic foundations. This approach and new studies are highlighted on the web site of the Healthy Public Housing Initiative at: http://www.hsph.harvard.edu/hphi/. Region 1 has formed an Asthma Regional Coordinating Council with members from other federal agencies (U.S. Department of Housing and Urban Development, U.S. Department of Health and Human Services) to address this issue.

Proof-of-Concept Demonstration

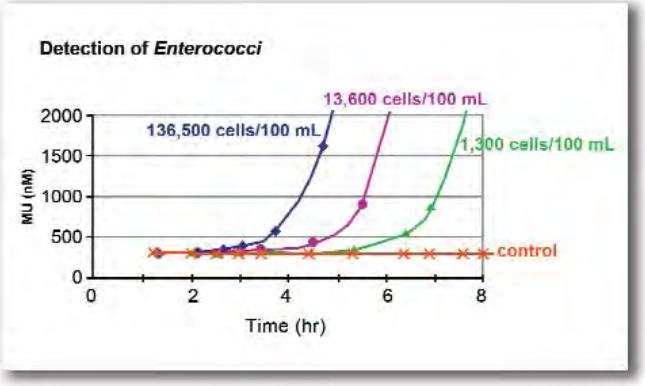
for Near Real-Time In Situ Detection of Fecal Contamination in Fresh and Marine Waters

Background

Fecal contamination of freshwater and marine beaches is a major public health concern. Current methods for measuring fecal contamination require 24 to 48 hours to get test results. Consequently, when deciding whether to open or close a beach, an environmental manager must use data that is at least 24 hours old. This time lag interferes with making time-relevant decisions. Based on the results of the test taken a day prior, the beach would likely be open. By the time the results of the tests are known 24 hours later (and the beach could be closed), the results are back below the threshold, suggesting it is again safe to swim. This project is part of multiple-pronged efforts of many researchers to address this problem through the development of a more rapid test method.

Science

ORD's National Health and Environmental Effects Research Laboratory Atlantic Ecology Division and Region 1 collaborated with researchers from the University of Rhode Island (URI) and the State of Rhode Island Department of Health to produce a proof-of-concept demonstration on a near real-time in situ fecal contamination method.



Proof-of-Concept
Demonstrated feasibility of combining existing enzyme-based technologies with an ultra-sensitive optical detection system.

The first stage of research was to determine if laboratory-based optical detectors could detect the enzymatic activity-associated bacteria more quickly than the minimum of 24 hours needed with the existing method. For the next phase, a bench-top prototype was built that automatically handled the sample manipulation, reagent and temperature control, and data processing. Ultimately, the goal is to reduce the time needed to detect bacteria through improved temperature control and other means and for the detector to be modified so that it can be either moored onsite or transported in a briefcase from site to site.

Outcome

This technology has been demonstrated at national workshops and shows short-term promise that warrants continued efforts.

The "Proof-of-Concept" figure demonstrates that bacteria could be detected in as little as 3 hours, depending on bacteria density, and the bench-top prototype of the second phase resulted in the detection of bacteria in approximately 9 hours.

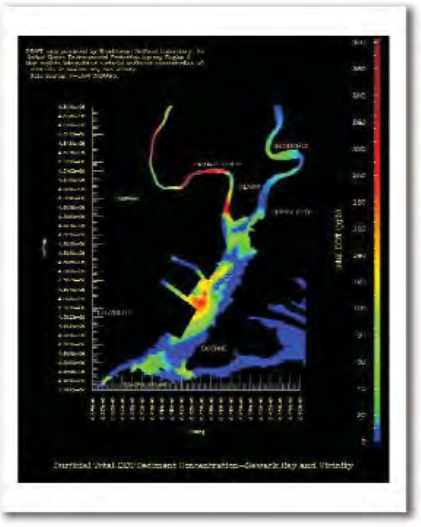
The RARE project also served as seed money for the URI researchers to acquire additional funding from the National Oceanic and Atmospheric Administration, the Southern California Coastal Water Resources Project, and the Cooperative Institute for Coastal and Estuarine Environmental Technology to continue work on the new technology.

Sediment Visualization and Data Modeling

of Scattered Sediment Contaminant Data in New York/New Jersey Harbor Estuaries

Background

Over the last decade, several high-resolution sediment collection efforts have been conducted in the New York/New Jersey Harbor estuary. These are data sets that have been generated from spatial monitoring programs such as the EPA's Regional Environmental Monitoring and Assessment Program (REMAP) and the National Oceanic and Atmospheric Administration's Status and Trends Program, as well as sediment data collected as part of the Lower Passaic River Restoration Study Superfund efforts. Large contaminated sediment data sets are difficult to resolve to a scale that can integrate different chemical attributes into a regional map that can assist in meaningful contaminant assessments and source tracking for basin-wide management decisions. A regional map may also help in remedial design for potential clean-ups. Historical sediment core sampling data in the New York/New Jersey Harbor are poorly conditioned for data modeling because the sampling locations are sparse and irregularly distributed.



Surficial Sediment Concentration of Total DDT in Newark Bay

Science

Research was conducted by ORD's National Health and Environmental Effects Research Laboratory in partnership with the Department of Energy–Brookhaven National Laboratory. The scattered data modeling technique used for this project has been successfully applied in high-resolution geophysical fluid dynamics. The computational properties of this method, such as geometrical flexibility, high convergence rate, and suitability for parallel computing, make it a good choice for data modeling as well.

Surficial and 3-dimensional plots of sediment contaminant data were developed. The 3-dimensional images could be freely rotated to any desired angle to allow further examination of contaminant impacted areas or "hot spots."

Outcome

The maps developed under this RARE project were successful in determining sediment trends, "hot spots," and data gaps. These maps have been extensively used during the ongoing Remedial Investigation/Feasibility Study for the Passaic River Superfund Project, and for determining the magnitude and spatial extent of sediment contamination in the New York/New Jersey Harbor Estuary Program.

Citation

Hong Ma, Keith W. Jones, Eric A. Stern. "Scientific Visualization and Data Modeling of Scattered Sediment Contaminant Data in New York/New Jersey Estuaries," vis, p. 467, Ninth IEEE Visualization 1998 (Vis '98), 1998.

Web Site

http://www.bnl.gov/wrdadcon/Publications/image/status_jpg.htm

Development of Scientific Basis for Promulgation of Standards:

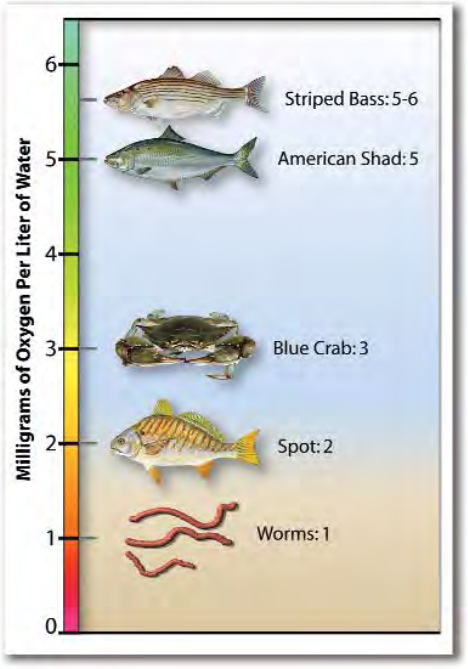
Bay-wide Dissolved Oxygen, Light Penetration, Nutrient, and Suspended Sediment Water Quality Standards for Chesapeake Bay

Background

The Chesapeake Bay Program emphasizes a multimedia approach to protecting the Chesapeake Bay, focusing on point and nonpoint sources of pollution. The program targets implementation at the state, subwatershed, and local jurisdiction levels. Observations through the bay-wide monitoring program of the short- and long-term recovery of the bay ecosystem must be matched with more quantifiable definitions of the water quality conditions that define a restored estuary.

Science

This project is built upon ongoing efforts to revise the 1992 submerged aquatic vegetation habitat requirements and dissolved oxygen restoration goal research being funded under the Chesapeake Bay Program, and the draft EPA Estuarine/Marine Dissolved Oxygen Aquatic Life Criteria for the Virginia Province. This RARE project was the scientific basis for water quality criteria for dissolved oxygen, light penetration, nutrient, and suspended sediment aquatic life criteria applicable to Chesapeake Bay and other mid-Atlantic estuaries and coastal systems.



Oxygen Needs of Key Species

Research was conducted to determine dissolved oxygen thresholds for sensitive species in the Bay ecosystem in areas where warmer water dissolved oxygen fluctuations were a special concern. Scientists in ORD's National Health and Environmental Effects Research Laboratory, in cooperation with Region 3's Chesapeake Bay Program, generated data that were critical to understanding the exposure effects on a range of organisms under conditions of cyclic dissolved oxygen concentrations. ORD scientists developed an experimental system that modeled a tidal cycle by exposing test organisms to dissolved oxygen levels that fluctuate to simulate a typical tidal cycle.

Outcome

These data were used by the Chesapeake Bay Dissolved Oxygen Criteria Task Group to recommend and promulgate dissolved oxygen criteria. These criteria were developed to protect against short-term exposures that could impact aquatic organisms, particularly during larval and juvenile life stages. The recommended dissolved oxygen concentrations include instantaneous minimums and multiple day mean criteria.

This research also contributed to developing ecoregion-based estuarine water quality criteria for nutrients (nitrogen and phosphorus) for the states to adopt estuarine water quality standards for nutrients by 2003. This work in the Chesapeake Bay will serve as a prototype for the balance of the other estuaries in the Mid-Atlantic.

Delaware Estuary PCB Model

Background

The Delaware River Basin Commission recently completed the first phase of a program to develop and implement Total Maximum Daily Loads (TMDLs) for toxic pollutants for the Delaware Estuary. This complex body of water extends from Trenton, New Jersey, to the head of Delaware Bay at Liston Point. Water quality problems in the estuary related to toxic pollutants have been documented, and fish consumption advisories issued by the States of Delaware, New Jersey, and Pennsylvania are still in effect. Polychlorinated biphenyls (PCBs) are the primary toxic pollutant of concern because this class of compounds forms the basis for many of the advisories currently in place in the estuary. The RARE project contributed to a larger effort to establish TMDLs for total PCBs for the Delaware Estuary by September 2003, as required by court orders or agreements between EPA and the states bordering the estuary.

Delaware Estuary

Science

The goal of this RARE project was to help address toxic pollutants that strongly adsorb to particulates (i.e., sediments and soils) and have a significant contribution from both point sources and nonpoint sources. PCBs are an example of this type of pollutant and have been identified using low-level, congener-specific analytical methods in several tributaries, including the Schuylkill River, and in effluents from six large municipal wastewater treatment plants.

The research supported the water quality modeling efforts, initiated under the Delaware Estuary Toxics Management Program, by developing a hydrodynamic sediment and water quality model for PCBs that can be used to apportion the TMDLs. A critical component of the water quality model for PCBs was the interaction of PCBs with suspended and bottom sediments. Such sediments are both a sink and source of PCBs in the estuary.

Outcome

The Delaware River Basin Commission, in cooperation with EPA Region 3, ORD's National Exposure Research Laboratory and the states bordering the estuary, developed a strategy to address the PCB contamination in the estuary that included monitoring of potential sources and living resources, and developing models to attribute risk and provide a basis for mitigation.

This RARE project contributed to the model that was used for determining PCB loadings into the Delaware Estuary and for developing risk management alternatives. This model is a key component of the ongoing Delaware Estuary PCB Strategy and directly supports the goal of reducing, and hopefully eliminating, the PCB contamination of the Delaware Estuary.

Heavy-Duty Diesel Vehicle Activity Factors Analysis

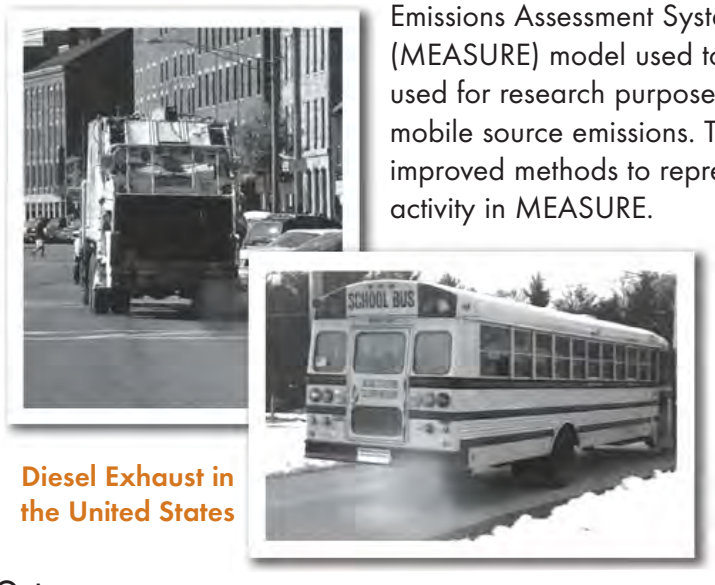
Background

Emissions from cars and small trucks, known as light-duty vehicles, have been controlled for many years, with emission controls first required on cars in the 1968 model year. Developed and refined over a period of more than 30 years, these controls have resulted in today's light-duty vehicles being more than 90 percent cleaner than vehicles were in 1969.

As emissions from light-duty vehicles have decreased, the relative importance of emissions from heavy-duty diesel vehicles (HDDV) has increased significantly. HDDV engines have not been as rigorously controlled as light-duty gasoline engines, with the first emission standards and transient testing requirements for oxides of nitrogen (NOx) and particulate matter (PM) being implemented in 1988. HDDVs in that year were allowed to emit approximately 50 times more NOx than a similar vehicle produced in 2007 will be allowed to emit. HDDVs typically produce large amounts of NOx and PM and are kept in service for much longer periods of time than light-duty vehicles.

Science

Region 4, ORD's National Risk Management Research Laboratory, and the Georgia Institute of Technology collaborated on a RARE project to develop an HDDV module that could be incorporated into the Mobile Emissions Assessment System for the Urban and Regional Evaluation (MEASURE) model used to estimate mobile source emissions. MEASURE is used for research purposes to evaluate improved methods for estimating mobile source emissions. This RARE project supported the development of improved methods to represent spatial and temporal distribution of HDDV activity in MEASURE.



Diesel Exhaust in the United States

The information and model developed from this project provide a mechanism to evaluate potential control strategies that could lead to reduced HDDV emissions. These strategies are based on variables that were included in the emissions module and include restrictions on idling time, time-of day operation restrictions, and improvements in traffic flow.

Outcome

Region 4 has used the results from this project to provide input for national-scale models, provide state-of-the-art information to interested organizations, and evaluate possible control strategies. Because the emissions module that was developed as part of this project provides a high level of detail regarding HDDVs, it has been offered to EPA's Office of Transportation and Air Quality to be evaluated for inclusion into its MOBILE model.

The information developed through this project is being shared with public and private groups whose actions could result in reduced diesel emissions. Region 4 is able to reach a large number of relevant groups through its Southeastern Diesel Collaborative Network. The goal of the network collaboration is to improve air quality by encouraging the use of clean, renewable energy and by reducing diesel emissions from existing engines and equipment from the agriculture, heavy construction, and on-road sectors.

Tracking MTBE Diving Plumes

Background

Methyl tertiary butyl ether (MTBE) from various sources, but mainly from leaking underground storage tanks (LUST), has contaminated the groundwater in many areas. In some cases, drinking water has been impacted forcing communities to adopt expensive alternatives. One of the physical properties of MTBE is that it is very soluble in water. It has been demonstrated that MTBE can "dive" below monitoring well networks that are designed to detect other petroleum chemicals near the surface, leading some sites to miss the contamination.

Science

This project was designed to provide specific tools or models to help state and federal environmental regulators overseeing LUST corrective action projects. The tools were designed to help predict the site-specific conditions that may indicate plume diving. The study represented a cooperative effort among ORD's National Risk Management Research Laboratory, Region 5, the Illinois Environmental Protection Agency, the Wisconsin Department of Natural Resources, and the Michigan Department of Environmental Quality.

Site work was conducted to assess MTBE plumes at three locations (Spring Green, Wisconsin; Milford, Michigan; and East Alton, Illinois) using an ORD-owned direct push rig to collect groundwater samples from discreet depths along transects perpendicular and downgradient to the contamination plume. Various samples also were collected from community water supply wells.

An assessment of the data indicates that well pumping plays an important role in plume behavior at all three sites. It appears that there is a downward push on the plume by rainwater recharge only at Spring Green, which was not detected at the other two locations. Evidence shows that although the plume tends to follow the bottom of an upper confining layer, biodegradation is occurring along the top of the plume at all three locations. Another interesting development is the presence of tert butyl alcohol (an MTBE degradation by-product) only at East Alton, which appears to be due to a greater anaerobic effect. There also are greater concentrations of ferrous iron at East Alton compared to the other two locations.

Outcome

As a direct result of the RARE project, a technical paper entitled "Site Characterization to Determine the Influence of Stratigraphy on a Diving Plume of MTBE in a Municipal Well Field" was prepared and published in 2005 in the journal Groundwater Monitoring and Remediation.

The results of this research were provided to various audiences of state and federal regulators, environmental consultants, and responsible parties. The developed models for predicting the movement of MTBE from leaking gasoline tanks into the groundwater were demonstrated to state and regional staff dealing with leaking underground storage tanks, resulting in modified site characterization investigation guidance documents.

The data showing the movement of MTBE deeper into the groundwater assisted program and enforcement staff in convincing responsible parties of the impact from local leaking tanks. Demonstrations at state offices have assisted enforcement officers in developing proper monitoring plans with responsible parties to avoid missing groundwater contaminated by MTBE.

Dioxin Soil Sampling Project

Background

The Columbus Municipal Waste-to-Energy (WTE) incinerator facility in Columbus, Ohio, released an estimated 1,000 grams of dioxin toxic equivalents (TEQ) per year until it was shut down in December 1994. This release by the Columbus WTE is significant considering the 1994 estimate of 9,300 grams of dioxin TEQ per year from all sources emitting dioxins into the air in the United States.

In response to a petition by state and local agencies to the EPA and the Agency for Toxic Substances and Disease Registry (ATSDR), a multi-agency workgroup was formed in 1995 to address the possible human health impact of the incinerator's emissions. The workgroup recommended a study to assess residual dioxin/furan soil contamination in the vicinity of the WTE incinerator.

Science

This RARE project supported the study recommended by the workgroup. The study represented a cooperative effort among ORD's National Center for Environmental Assessment; ORD's National Exposure Research Laboratory, EPA Region 5, ATSDR, the Ohio Environmental Protection Agency, the Ohio Department of Health, and other state and local agencies.

During the first phase of soil sampling at the Columbus WTE, four samples were taken on the site of the incinerator, 20 samples within about 3 km of the incinerator, and three samples at a background, upwind site 45 km away. Phase II soil sampling was undertaken in August 1996. Samples were taken at sites ranging from 2 km to 8 km from the incinerator. The purpose of Phase II was to ascertain whether a background concentration for Columbus could be determined. In all, Phase II included four soil samples taken in the city of Columbus and three background samples taken 45 km away.

With the exception of the off-site cluster near the Columbus WTE, the operation of the WTE incinerator does not appear to have resulted in elevated soil concentrations of dioxin in the Columbus urban area above typical urban concentrations. Therefore, the local population is not expected to receive significant exposure from the soil.

Outcome

This study was extremely useful to the region, state, and local agencies in answering the question of residual health risk from dioxin soil deposition and in addressing the high level of public concern. Results of the first phase of the project were presented in a report, Columbus WTE Municipal Incinerator Dioxin Soil Sampling Project, released by EPA Region 5 in May 1996. The study findings also were discussed with community members at a public meeting. In addition to addressing public concerns, the soil data gathered at the Columbus site helped to further the technical understanding of dioxin fate and transport.

A complete analysis of the Columbus soil data is published in: Lorber, M., Pinsky, P., Gehring, P., Braverman, C., Winters, D., and Sovocool, W. (1998), "Relationships Between Dioxins in Soil, Air, Ash, and Emissions from a Municipal Solid Waste Incinerator Emitting Large Amounts of Dioxins," *Chemosphere*, 37(9-12):2173-2197.

Remote Sensing of Airborne Pollutants in Baton Rouge

Background

The Baton Rouge area currently is classified as being in severe non-compliance with the National Ambient Air Standard for ozone. The Louisiana Department of Environmental Quality (LDEQ) has worked to identify the root causes of ozone exceedance. Several of the exceedances within the previous 2 years had come on days that ozone was not expected to be a problem.

Science

ORD's National Exposure Research Laboratory used this RARE project to assess the feasibility of using a hand-held infrared hyper-spectral remote sensor, operated during flyovers or on the ground, to identify pollutants from various sources that normally may not be monitored. Through the use of the HAWK® surveying instrumentation from a helicopter flying low over the pipelines, barges, and railcars, and by tying that information into LDEQ's existing GIS databases, it was possible to identify the leakers immediately and request to have them repaired. This information also is invaluable in determining if the existing regulations are sufficient to protect the environment and the public from unauthorized releases of hazardous chemicals.

Significant numbers of previously unreported—and evidently large—leaks were observed on many of the hydrocarbon transportation barges in the area. These barges were observed during transportation on the Mississippi River as well as when tied to shore facilities. Leaks were observed both with helicopter flyovers at various distances as well as observations taken from on-shore (ground-based) infrared imaging. Some plumes extended well beyond the boundaries of the barges and at times were observed to be directly impacting barge personnel.

Plume from Barge Using Infrared Technology (plume appears as "black smoke")

Various storage tank configurations were observed leaking. Examples of various colors of tanks showed that detection using infrared imaging can be accomplished with both black or dark-roofed tanks as well as light-colored tanks. These plumes normally are invisible to the naked eye.

Outcome

The information from this RARE project was compiled in a report by LSI Corporation titled Leak Detection using LSI Infrared Gas Imaging—Cajun Cloud. The report included both still shots and video images from the work done. The accompanying photograph shows the black-and-white infrared imaging with the black plume from a leak.

The findings and video images were used in discussions with the various barge and tank owners, who were surprised that not only were these leaks a significant pollutant source, but also a significant loss of their product. In the short time since these findings, considerable progress has been made in correcting these leaks.

Water Quality Vulnerability in the Ozarks:

An Assessment of the Upper White River Watershed

Background

The White River provides hydroelectric power, water resources, and physical beauty for the residents of, and visitors to, the Ozark Mountains. Residential and other areas of human activity are interspersed within the riparian forests and other natural areas of the White River Watershed.

This RARE project was designed to address stakeholder's expressed concerns about water quality, and to optimize application of ecological restoration efforts throughout the Upper White River Watershed, expressly to induce behavioral changes that result in positive environmental outcomes. Key issues addressed by this research are the cumulative impacts of land cover alteration on surface water quality, in support of the Region 7 watershed planning activities and associated planning groups.

White River Watershed in Branson, Missouri

Science

ORD's National Exposure Research Labratory and Region 7 have collaborated to map and interpret landscape-scale (i.e., broad-scale) ecological metrics among watersheds of the Upper White River in southwestern Missouri and northwestern Arkansas, and have produced the first geospatial models of water quality vulnerability for the Ozarks. These models have been developed by using partial least squares (PLS) analyses, existing field water quality monitoring data, satellite and other remote sensing data, *a priori* information about landscape conditions, and the water quality of streams and rivers in the associated watershed(s) of the Upper White River Watershed.

Outcome

The outputs of this project will assist in White River ecological restoration efforts and may help to focus such efforts in areas that are most likely to result in environmental and societal benefits. A key item addressed by this research is the cumulative impact of land cover alteration on surface water quality, which supports the watershed planning activities of the EPA and other associated planning groups.

The results of this project provide watershed managers with the first broad-scale predictions of surface water quality that effectively utilize information about land cover type, land cover configuration, environmental change, and human activities for the entire Upper White River Watershed. Environmental practitioners in Missouri, Arkansas, and Region 7 are piloting the use of the results of this RARE project to prioritize specific locations within the Upper White River basin for ecological restoration and for the implementation/assessment of best management practices.

Additional information about this RARE project and other ecological vulnerability analyses in the White River Watershed is available on the Internet at: http://www.epa.gov/nerlesd1/land-sci/mississippi.htm.

Missouri-Type Charcoal Kiln

Background

A "Missouri-type" charcoal kiln is a brick, cement, or metal structure (approximately 40 feet wide, 60 feet long, and 16 feet high) used to produce charcoal by burning wood in a limited supply of air. When the State of Missouri developed emission limits for air pollution sources in the 1970s, charcoal kilns were explicitly exempted. However, preliminary monitoring by EPA's Region 7, utilizing both particulate samplers and aerial photography, indicated significant potential impact to sensitive receptors in close proximity to these types of charcoal kilns. Region 7 requested ORD's help to characterize the chemical and physical properties of the emission plumes from these facilities.

Science

Because performance and operation data of full-scale kilns are scarce in the scientific literature, ORD's National Risk Management Research Laboratory agreed to develop a small-scale simulator that would allow Region 7 to better understand the emissions from full-scale operations. ORD undertook a two-phase RARE study to characterize the particle size distribution and the chemical composition of any pollutants released by the process. In phase one of the project, the simulator was constructed and used to measure various volatile and semi-volatile organic compounds and dust particles released to the atmosphere. In phase two, an afterburner was attached to the simulator and evaluated for its ability to destroy any pollutants before passing them to the outside. This information helped assess the extent of pollution contributed by Missouri-type charcoal kilns.

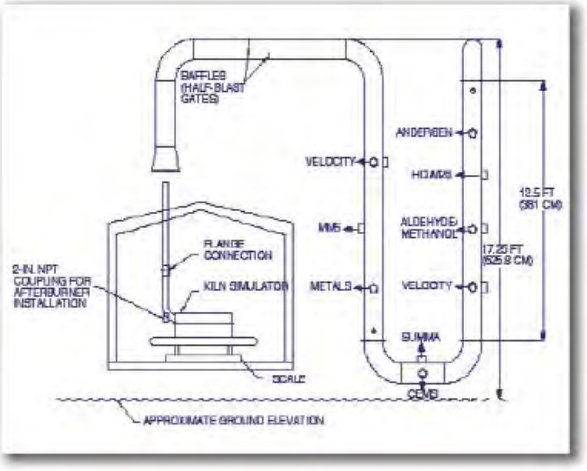


Diagram of a Missouri-Type Charcoal Kiln Simulator Used in This Experiment

Outcome

The State of Missouri and Region 7 used the results of this RARE research project to require that air pollution emissions from these charcoal kilns be reduced to Best Achievable Control Technology-like levels or be further tested by the operators to show the absence of harmful emissions. The charcoal kiln operators are complying with the requirements to control and reduce these emissions.

This RARE project is fully described in two reports. Phase one of the project is described in *Emissions of Air Toxics from a Simulated Charcoal Kiln,* EPA 600/R-99/054, June 1999. The second phase of the project is reported in *Emissions of Air Toxics from a Simulated Charcoal Kiln Equipped with an Afterburner,* EPA 600/ R-01/011, February 2001.

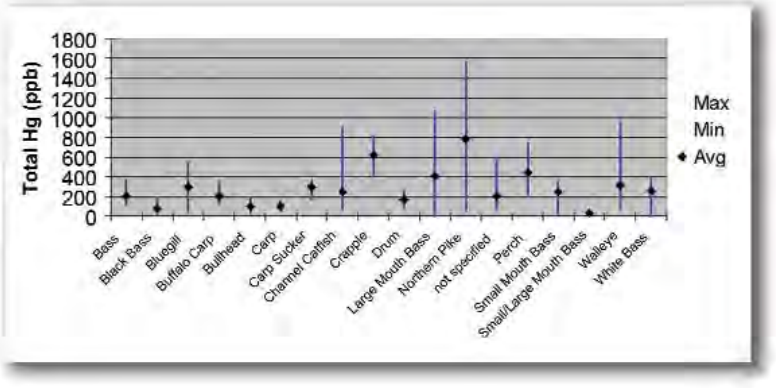
Mercury Source Identification and Risk Management

Background

In a collaborative 3-year study with the Cheyenne River Sioux Tribe Department of Environmental Protection (CRST DEP) and EPA's Emergency Response Team and Region 8, elevated levels of mercury were detected in fish tissues from the Cheyenne River and Lake Oahe in northwestern South Dakota. From these findings, the CRST DEP in 2000 released a fish advisory recommending less consumption of fish, especially for pregnant and elderly individuals. As an alternative to fish consumption from the Cheyenne River and Lake Oahe, the CRST DEP recommended its members consume fish from livestock ponds located on tribal lands. Elevated mercury levels, however, also were detected in these fish. A RARE project was initiated to determine the source of mercury in fish tissues from livestock ponds on tribal lands and provide risk management recommendations to reduce mercury exposure of tribal members.

Science

Scientists in ORD's National Exposure Research Laboratory in Athens, Georgia, along with Region 8 and the CRST DEP, collected field data for input into a model to simulate mercury fate and the dynamics of bioaccumulation within these livestock ponds. The primary focus was to determine if the source of mercury was related to atmospheric deposition or naturally occurring sources of geologic formation. Given the many factors that influence the fate and transport of mercury, these livestock ponds were an opportunity to better understand mechanisms of mercury bioaccumulation when there are no apparent point sources.



Mercury in Fish Species on CRST Lands

Livestock ponds present unique challenges to static mercury models due to:

- High pH, high conductivity, hyper-eutrophy, and high surface area-to-volume ratio.
- High degree of water fluctuation on an annual basis.
- Little to no flushing or outflow of surface water.
- Shallow and well-mixed with no summer stratification.
- Losses of elemental mercury via evaporation tending to be high.
- Particulate and dissolved organic matter being critical inputs into the model.

Fish tissue results show that larger fish like the Northern Pike have higher amounts of methyl mercury that are greater than the national average.

Outcome

Risk management recommendations to the CRST DEP include reviewing existing fish advisories, limiting intake of larger fish species like the Northern Pike, and giving consideration to the analysis of blood and hair to monitor past mercury exposures. Additional benefits from these research results include the use of these farm ponds as model ecosystems for EPA's mercury benefits analysis in the Clean Air Mercury Rule and the use of this information in risk management decisions for a nearby Superfund site remedial investigation.

Prion Fate in Wastewater Systems

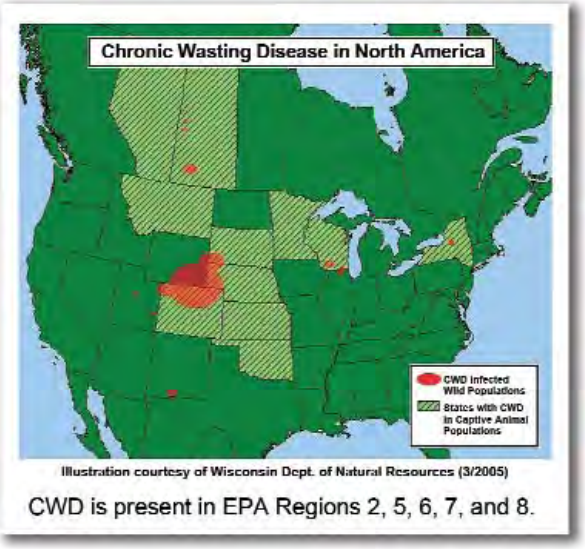
Background

Prions are thought to be the causative agent of transmissible spongiform encephalopathies (TSEs) in animals, including chronic wasting disease (CWD) in deer and elk, scrapie in sheep and goats, and mad cow disease in cattle (bovine spongiform encephalopathy, BSE). Transmission appears to be by an abnormally folded form of a host-encoded protein.

CWD in North American deer and Rocky Mountain elk has been detected within EPA Region 8 in Colorado, Wyoming, Utah, Montana, and South Dakota. Additionally, CWD has been identified in Region 2 (New York); Region 5 (Wisconsin, Illinois, and Minnesota); Region 6 (New Mexico, Oklahoma); and Region 7 (Nebraska, Kansas). Because CWD poses a threat to the hunting and ranching of these species (and related industries), most states with affected herds have responded aggressively to monitor, control, and if possible, eliminate the disease. EPA supports these efforts and is employing the same aggressive approach to the management of potentially CWD-contaminated waste including research in an attempt to understand the fate of prions in the environment and in engineered systems to develop options for managing waste streams generated from infected animals and associated waste materials.

Science

Supported by RARE funding, scientists at ORD's National Risk Management Research Laboratory in Cincinnati, Ohio, and researchers at the University of Wisconsin-Madison (UW) worked in collaboration with EPA Region 8 to identify risks involved with handling and disposing of CWD-contaminated waste and increasing understanding of the fate of prions in the environment. This project involved evaluating the potential for CWD-bearing wastes to enter the environment via wastewater treatment systems, primarily POTWs and/or septic tank systems. The study also is providing preliminary data on whether CWD prions are removed or altered during treatment; and if not, whether they leave the systems in the effluent or waste sludge or both; and whether they are aerosolized by the biological treatment aeration process.



Chronic Wasting Disease in North America

These studies are being performed using the solids from a municipal wastewater treatment plant and are conducted in laboratory microcosms. An extraction method has been developed that is able to extract prion protein experimentally spiked into various solids. It is anticipated that this research will enable the quantitative tracking of prion protein through simulated treatment processes.

Outcome

Initial results indicate that if prions were to enter wastewater streams, most would partition to the solid phase. Preliminary findings also suggest that a small fraction of prions would remain in the liquid phase. These results have assisted Region 8 in the development of best management practices for disposal options for potentially CWD-infected animal material.

Characterization of $PM_{2.5}$ and Air Toxics Emissions

Background

The fine particulate matter ($PM_{2.5}$) emissions from aircraft operations at large airports in non-attainment areas are of major environmental concern. It has been estimated that aircraft emissions account for approximately 97 percent of the total overall emissions of chemicals listed as toxic air pollutants at Los Angeles International Airport (LAX). In addition, no chemical source profile currently exists for aircraft engines, which is a critical need for use in receptor modeling used in the State Implementation Plan (SIP) development process. Finally, the International Civil Aviation Organization is currently taking steps toward the regulation of PM emissions from commercial aircraft engines to replace the older smoke standard.

Science

In this RARE study, ORD's National Risk Management Research Laboratory measured the PM and gas-phase toxic emissions from a commercial aircraft engine in collaboration with NASA, the U.S. Air Force, and both the engine and airframe manufacturer. Three different fuels (base Jet A1 fuel, high sulfur fuel, and high aromatic fuel) were tested under varying engine operating conditions. During a second test sponsored by the California Air Resources Board, two additional engine types were evaluated for in-service aircraft operated by a commercial air carrier. Planning is underway for a third round of experiments, which will be conducted at NASA's Glenn Research Center. This program will involve up to seven different engine types, including a regional jet and a business aircraft. Future testing also is planned as part of activities being conducted under the Federal Aviation Administration's "National Particulate Matter Roadmap for Aviation."

Outcome

These profiles are intended to improve the ability of regulatory agencies to distinguish and properly apportion the sources of fine PM and air toxic compounds in ambient air in localities of concern. Additionally, the profiles are expected to improve the apportioning of such pollutants to the emissions sources associated with airports, for example, jet aircraft exhaust, diesel-powered service vehicles, aircraft fueling operations, airport highway traffic, and airport food service operations.

Results of this RARE study will be used to develop a modeling approach to estimate concentrations of air toxics attributable to airport operations, which, in turn, will be used to develop strategies for reducing air toxics at the airport and its neighboring communities.

APEX1 Sampling Probes

Region 10 Research Highlight

Wetland Management and Lentic Amphibian Communities

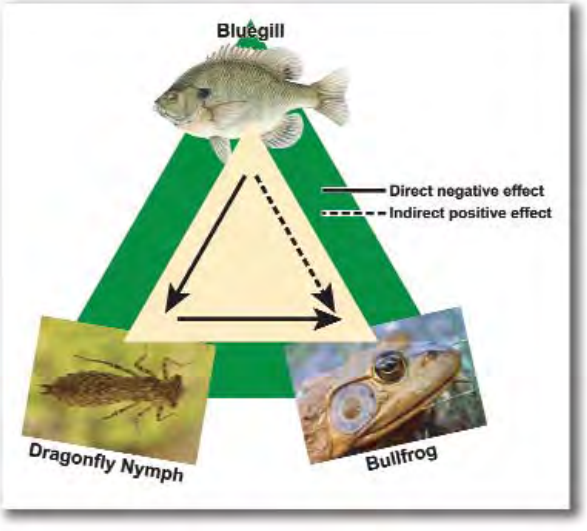
Background

In the past two decades, scientists around the world have increasingly noted losses of amphibian populations. Although declines have been noted in wilderness populations, it is particularly chronic in multiple use landscapes where resource managers face complex conservation problems and must make decisions that affect amphibians. The purpose of this RARE project was to develop recommendations for use by resource managers to mitigate the loss of seasonal wetlands and conserving native wetland amphibians.

Science

This study evaluated the relationships between amphibian communities and hydrology, exotic predators, and landscape context in the Willamette Valley, Oregon. Regional patterns in amphibian communities of managed and naturally occurring wetlands were examined. In addition, the influences of site-level and landscape-level wetland characteristics on lentic community composition in the lowlands of western Oregon were studied. The study was co-sponsored by ORD's National Health and Environmental Effects Research Laboratory and the U.S. Geological Survey (USGS).

Research indicated that the occurrence for four of five native amphibians in this study had negative associations with the presence of non-native fish. Non-native fish appeared to be more detrimental to native amphibians than bullfrogs, and they also appeared to facilitate bullfrog invasion. Furthermore, mitigation wetlands containing a disproportionate amount of more permanent, deeper water habitats seemed to favor invasion of non-native fish and bullfrogs.



Relationship Between Non-Native Fish, Bullfrogs, and Dragonfly Nymphs
Solid arrows represent direct negative effects; dashed arrow is an indirect positive effect.

Outcome

Wetland mitigation recommendations resulting from this work were incorporated into the Willamette Valley hydro-geomorphic wetland functional assessment. Wetland managers should know that creating wetlands with seasonal or permanent connections to streams or permanent wetlands may result in fish invasion, thereby rendering the wetland unsuitable for most native amphibians.

Results of this assessment were used to design appropriate mitigation necessary to compensate for functional loss at impacted sites. In addition, the recommendations were used by the Oregon Division of State Lands and the U.S. Army Corps of Engineers as part of their mitigation design guidance.

Summary

The Regional Applied Research Effort (RARE) is an important mechanism to put science to work in EPA's regions and produce noteworthy environmental outcomes. As environmental decision makers look for scientific and technological solutions to environmental problems, this document serves as confirmation of the partnership between ORD and the regions to provide a well-built and treasured approach for producing results.

The RARE Program has supported a significant number of projects that reach across the environmental sciences, from human health impacts to the ecological effects of various pollutants. The RARE Program is a robust tool that can be used to address any type of scientific issue or problem that a region identifies as a high-priority research need, and for which ORD has the necessary expertise and capability to address.

RARE is one approach EPA takes to promote collaboration between the regions and ORD. For additional details about RARE and other initiatives under the "ORD Regional Science Program," EPA staff can access our intranet web site at: http://intranet.epa.gov/opintra/scienceportal/ under "ORD Regional Science Program." Information also is available on the internet at: www.epa.gov/osp under "Regions."

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