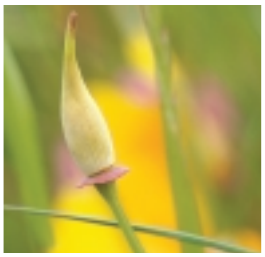
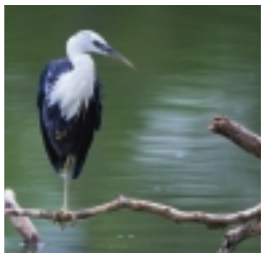
Innovation and Research for a Clean Environment







NATIONAL CENTER FOR ENVIRONMENTAL RESEARCH | 2002 Report

EPA United States Environmenta Protection Agency

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Dear Stakeholders,

High quality science is essential for sound decisions on national and international environmental issues. In 1995, EPA created the Science to Achieve Results (STAR) program and established the National Center for Environmental Research (NCER) to significantly expand EPA's knowledge base.

Now more than eight years later, NCER has built a significant program of extramural research grants and fellowships and a body of research results that have already begun to influence environmental protection in our nation. NCER's program engages the nation's best scientists and engineers in targeted research that complements EPA's own intramural research program and those of our partners in other federal agencies.

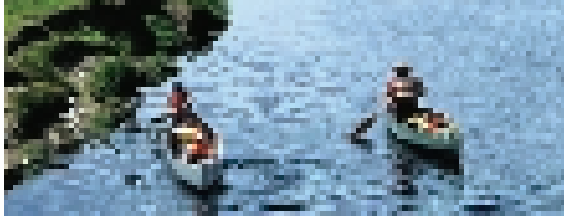
EPA also recognizes the critical need to support graduate students in environmental science and engineering so that they can carry on the work of building a stronger environmental science foundation. As a result, NCER developed and manages the only federal fellowship program exclusively designed for students pursuing advanced degrees in the environmental sciences.

In April 2003, NCER received excellent marks from the National Research Council (NRC) of the National Academy of Sciences for its strong contribution to EPA scientific efforts. In its report, the Council said, "The STAR program has established and maintained a high degree of scientific excellence. It has provided EPA with independent analysis and perspective that has improved the agency's scientific foundation. By attracting young researchers, this program has also expanded the nation's environmental science infrastructure." Our program's good review by the NRC would not have been possible without the dedicated performance of NCER's technical and administrative staff.

With this report—NCER's first comprehensive program description—we begin a wider dialogue with our diverse stakeholders. We are proud of what we have accomplished so far and look forward to a future with many more exciting opportunities to advance our understanding of the world we live in.

Sincerely,

John C. Puzak
Acting Director
National Center for Environmental Research



About the National Center for Environmental Research

Scientific research is one of the most powerful tools we have for understanding and protecting our environment. It provides the foundation for what we know about our planet, how it has changed, and how it could be altered in the future.

The National Center for Environmental Research (NCER) in the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD) supports high-quality research by the nation's leading scientists and engineers to strengthen the basis for decisions about local and national environmental issues. NCER works with academia, state and local governments, other federal agencies, and scientists in EPA to increase human knowledge of how to protect our health and natural resources through its three major programs:

- Science to Achieve Results (STAR) Grants
- Graduate Environmental Research Fellowships
- Small Business Innovative Research (SBIR)

As one of EPA's three national research laboratories and three national research centers, NCER supports leading-edge, scientific research to determine how people and wildlife are exposed to environmental pollutants, understand the harmful effects of pollution, and develop approaches to manage the risks to our health and the environment. STAR, NCER's primary program, funds research grants and graduate fellowships in environmental science and engineering. Through competitive application and independent peer-review processes, STAR funds only the highest quality scientific work. Outstanding STAR researchers have received many awards including the Nobel Prize, National Medal of Science, Guggenheim Fellowship, and New Investigator Award.

Most important, the research under these programs is strategic, with priorities determined in concert with EPA's strategic plan and research plans for specific topics developed by ORD. STAR focuses on many important research areas shown in the box on the left.

Each year, STAR scientists publish research results in numerous scientific journals and books and present hundreds of papers at scientific conferences, making STAR research results widely available. To date, STAR researchers have produced more than 4,800 papers that have been published in peer-reviewed, scientific journals. The frequency by which scientists cite journal publications by others in their own work indicates the

The STAR program counts four Nobel Prize winners among its grant recipients.

STAR Research Areas:

- Human Health
- Children's Environmental Health
- Particulate Matter
- Endocrine Disruptors
- Drinking Water
- Water and Watersheds
- Monitoring Water Body Conditions
- Mercury
- Global Change
- Economics and Decision Sciences
- Pollution Prevention
- Small Business Innovation
- Remediation
- Nanotechnology

influence of individual papers or the cumulative work of specific researchers on the scientific community. From 1981 to 1999, 42 STAR grantees—representing almost 19 percent of the 250 people on the "highly cited" list—are currently noted as the most-cited scientists in the fields of environmental science and ecology. See Appendix C and visit <www.isihighlycited.com/>.

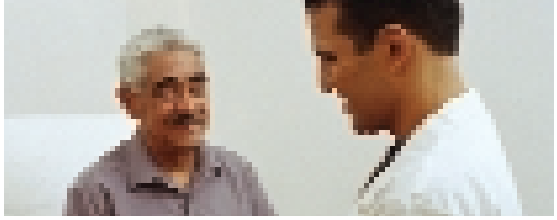
Developing the next generation of environmental scientists and engineers is one of NCER's most important objectives. Each year, NCER helps between 80 and 160 students achieve Master's or Ph.D. degrees in environmental science and engineering through its STAR and Minority Academic Institution (MAI) fellowships. Some of these students have moved on to careers in government while others are now full-time professors and researchers. Still others are working for state environmental agencies or furthering their studies through postdoctoral positions at universities.

Small businesses are the source of much of the technological innovation in the United States. Entrepreneurs are developing needed environmental technologies under EPA's SBIR program, and have created new businesses and jobs from these technologies. Under NCER's SBIR program, small firms compete for annual awards related to EPA's technology needs. In this area of high-risk, cutting-edge inventions where trial and error is often the norm, SBIR- funded projects have led to hundreds of patents and many successfully commercialized technologies.

Two hallmarks of NCER's programs are competition and high-quality science. All STAR and SBIR awards are made using competitive requests for applications and external peer review panels using leading scientists and engineers. In keeping with the growing importance of peer review in scientific work, NCER's peer review process is a model for other programs in EPA. Each year, NCER uses about 1,000 outside scientific experts to peer review its grant, fellowship, and SBIR submissions.

Since the inception of the NCER program, STAR grants and fellowships and SBIR awards to small businesses have been made in every state in the country. With the help of STAR and SBIR scientists and engineers, we learn more each day about how to preserve and protect human health and our precious resources.

Through NCER's model peer-review process, more than 1,000 outside scientific experts peer review STAR and SBIR grant and fellowship submissions annually.



Human Health

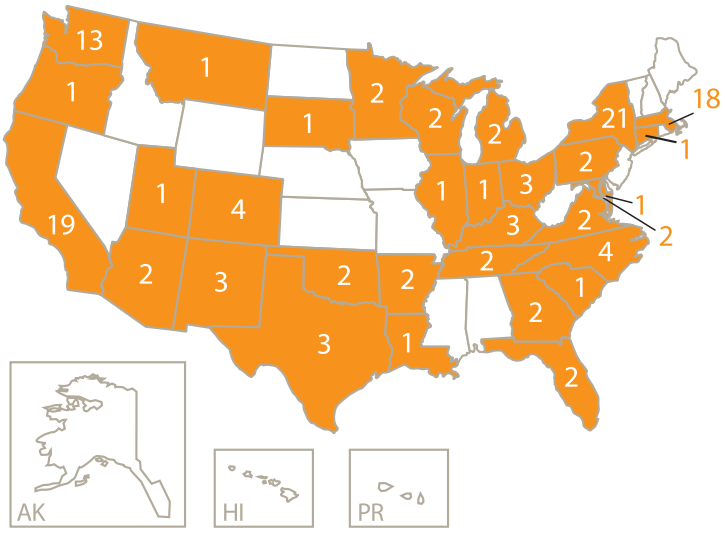
To meet EPA's mission to protect human health, NCER is supporting one of our nation's most diverse, multidisciplinary health programs focused on assessing and preventing exposures to toxicants in the environment.

NCER's basic and applied research includes efforts to study Polychlorinated Biphenyl (PCB) exposure in the Great Lakes; the effects of air toxics exposure in Krakow, Poland, and Tongliang, China, as well as the inner cities of Baltimore and New York City; fetal and childhood pesticide exposures in the agricultural belts of Arizona and Washington State; and integrated pest management in East Detroit and East Harlem.

Exposure to minuscule environmental toxicants happens every day, almost everywhere, to virtually everyone. However, it is the potency, frequency and timing of harmful exposures that can pose a threat to human health. STAR is supporting three case studies of pesticide exposure in the agricultural belts of California and Washington to develop better methods to assess aggregate exposure to environmental chemicals and the cumulative risk of this exposure. Eventually, the results and shared experiences gleaned from these studies should enable EPA to make more accurate estimates of the risks from pesticide use to migrant workers or other farming communities. Furthermore, these studies could advance our capabilities to calculate cumulative risks in any population of concern.

STAR's new scientific inquiries on complex chemical mixtures and molecular toxicology will shed light on the pathways and effects of environmental threats to human health. Through this set of programs, STAR is aiming to promote our understanding of how harmful agents could affect a particular organ, organ system or onset of symptoms, or contribute to the development of disease. These studies will help us use new computational, statistical and predictive strategies to assess the impacts of chemical mixtures on human health. Other research will give us an opportunity to explore and extrapolate the effects of chemicals across and within species, across time and from high to low doses. This work will close critical gaps for assessing the risks of vulnerable populations to toxic exposures.

NCER has a total of 125 active grants in Human Health research.



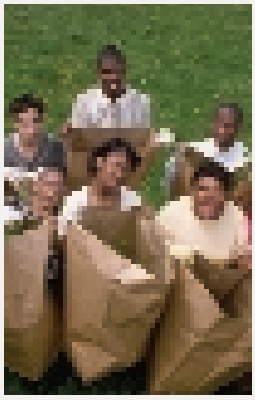
Methods of Measuring Pesticide Exposure and Susceptibility

Accurately linking exposure to pesticides with potential health effects in people is a challenge for public health officials. Add to that scientific findings that point to different susceptibility for different age groups and the challenges are even greater. To help officials measure exposures and estimate doses, researchers at the Battelle Institute are developing a biological model that incorporates age-dependent information, such as differences in metabolism and enzyme activity across different age levels. To help with sampling, the researchers have established that saliva samples, which are more easily acquired than blood or urine samples, can be used to measure dose and response in rats exposed to certain pesticides. After verification using human saliva, these parameters will be added to the biological model.

In another study, researchers at Colorado State University are evaluating whether a widely-used pesticide group (the triazines) binds to human red blood cells and hair in a way that can be used to determine how much of the pesticide a person was exposed to. The researchers will also develop a biological model that will take into account the physiological differences between children and adults.

Mechanisms of Age-Dependent Ozone-Induced Airway Dysfunction

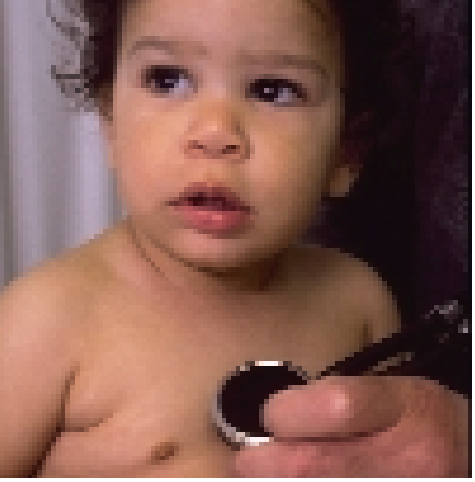
More than half of the U.S. population lives in areas that do not meet EPA's air quality standard for ozone. High exposure to ozone is known to cause inflammation of the airway and airway hyperresponsiveness. While children may be more exposed to ozone because they spend more time outdoors and are generally more active than adults, some biological factors may make children more susceptible to its effects. Researchers at the Harvard School of Public Health have been investigating whether children are more susceptible to the effects that can result from exposure to ozone and evaluating the biological reasons behind why these differences occur, while trying to understand the sequence of events that cause these effects. Based on their studies with juvenile and adult mice, researchers have determined that differences in response to ozone do exist between the age groups and that age plays a significant role in the response to ozone.



For example, researchers determined that in mice, the rate of respiration decreases with age and also decreases as the concentration of ozone increases. In young mice, however, the rate of respiration is greater, causing them to inhale a greater dose of ozone per gram of body weight than adult mice. Despite the fact that the young mice had the greater dose of ozone, the adult mice showed more airway inflammation and hyperresponsiveness. While researchers are still investigating this finding, they hypothesize that these differences may be due to differences in expression of certain proteins and protein receptors that are responsible for airway inflammation and hyperresponsiveness.

Lifestyles and Cultural Practices of Tribal Populations and Risks from Toxic Substances in the Environment

In 2002, STAR and the Centers for Disease Control and Prevention released the nation's first research solicitation geared exclusively toward investigating the threats of toxicants to indigenous people who depend daily on their immediate natural environment for sustenance and traditional ways of life. This novel program provides funding for tribes and university-tribal partnerships to assess pollutant exposures and to promote practices that reduce these exposures in tribal communities, without sacrificing cultural values. Through this research, NCER is underscoring the concept that understanding and controlling environmental threats on tribal lands can enhance, rather than threaten, culture and tradition.



Children's Environmental Health

Through its exploration of the mysterious micro-environments of kids, NCER's ground-breaking research in children's health is one of the nation's finest investments in the future.

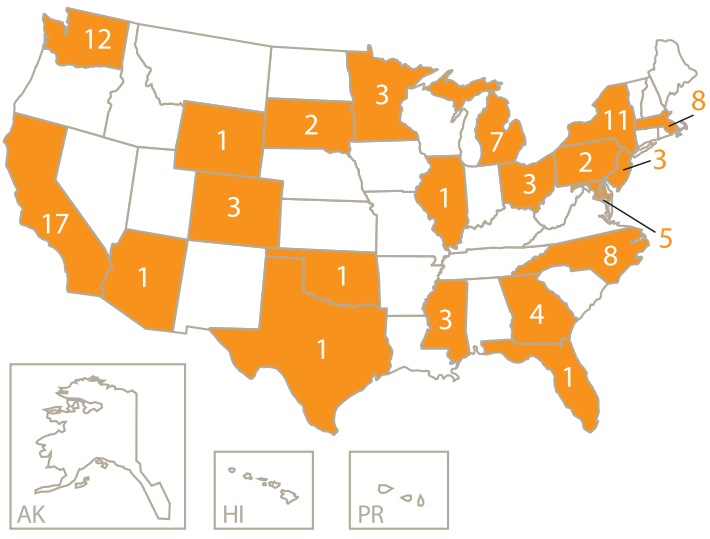
As humans mature from fetus to adulthood, the physical, chemical and biological processes that make up our growth and metabolism also mature and develop. These years of change in a developing infant and child affect the way chemicals are absorbed and how much of a chemical reaches target organs of the body. Children also exhibit certain behaviors—such as crawling on the floor, playing outdoors and putting things in their mouths—that make them more vulnerable to exposure to toxic environmental chemicals.

NCER's strategy for research in children's environmental health is broad, multidisciplinary and forward-thinking to address diverse environmental contaminants, diseases, developmental stages, cultural influences and the social and economic realities of children of nearly every walk of life. Since 1998, EPA in partnership with the National Institute of Environmental Health Sciences (NIEHS) has funded eight university-based research centers exclusively focused on children's health that are central to this program. These centers study the causes and mechanisms of children's disorders with an environmental link, such as asthma, other respiratory distress illness and developmental delays due to pesticide exposures. In 2001, EPA and NIEHS added four new centers to the program to investigate the role of toxic exposures in the development of autism, hyperactivity and neurological development and behavior.

In addition, STAR has strengthened its program in children's environmental health through research that develops biomarkers to assess exposure and toxicity in children. A biomarker is an indicator, found in a biological medium such as blood or urine, showing that an exposure or effect has occurred. Biomarkers can also indicate if a person is more susceptible to adverse effects of contaminants.

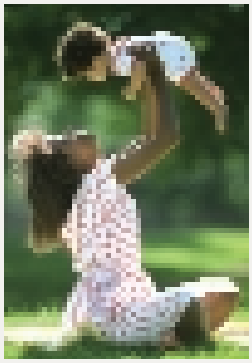
Most recently, STAR researchers have focused on the biological basis for age-related differences in susceptibility. This topic includes understanding differences in the development of target organs; how chemicals are absorbed metabolized and detoxified; and how organ damage is repaired. Additionally, several researchers are working on models that will help policy-makers use data from laboratory animal studies in a way that is more relevant to children.

NCER has a total of 97 active grants in Children's Environmental Health research.



Environmental Exposures and Low Birth Weights

Researchers at the Columbia Center for Children's Environmental Health, jointly funded by STAR and the National Institute for Environmental Health Science (NIEHS), have found that air contaminants in Upper Manhattan and the South Bronx boroughs of New York City are linked to lower birth weights and smaller skulls in African-American infants, according to an ongoing five-year study of over 500 newborns. This group of children has an unusually high rate of respiratory symptoms that require regular treatment. Children in the study exposed to environmental tobacco smoke while in the womb were particularly susceptible to developmental delays by age two. These and other findings from the study have been widely disseminated to the community, policy-makers, and clinicians.



Community Approach to Reduce Home Pesticide Exposure

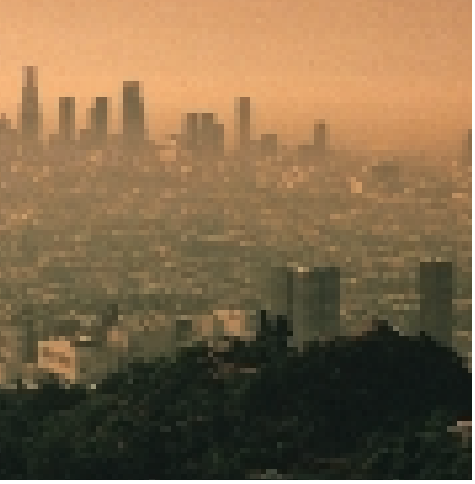
"Growing Up Healthy in East Harlem," a community-university partnership funded by STAR and NIEHS, has successfully implemented an Integrated Pest Management (IPM) intervention to reduce early childhood exposures to pesticides and cockroach allergens in the home. With the advice and active participation of the East Harlem Community, researchers at Mount Sinai School of Medicine adopted culturally appropriate techniques of IPM at the household level. This approach to pest control relies principally on non-chemical approaches and community education. The researchers have maintained a significant decrease in cockroach infestations while, in half the homes, the cockroach count fell to zero. The reduction (or elimination) of pesticide use and cockroach infestation could greatly reduce the potential for early childhood developmental delays and respiratory distress (e.g. asthma) from cockroach allergens.

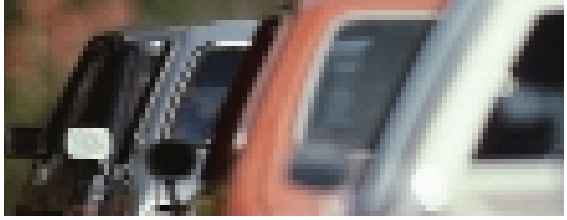
Assessing Children's Risks from PM and Ozone Exposures

Community Action Against Asthma is an ambitious exposure assessment and intervention study, jointly funded by STAR and NIEHS, in Detroit, Michigan. The research partners from University of Michigan and inner-city Detroit organizations have discovered that children with moderate to severe asthma are at increasing risk of illness as ambient particulate matter (PM) and ozone levels increase. Furthermore, they found that outdoor levels of PM are often above national standards particularly in neighborhoods with heavy diesel truck traffic. Also, the presence of cigarette smokers in a household substantially increases indoor particulate levels.

Pesticide Exposure and Pregnant Women in the Salinas Valley

The STAR Center for Health Assessment of Mothers and Children of Salinas (CHAMACOS) at the University of California-Berkeley has completed a five-year study of multiple pesticide exposures experienced by more than 600 pregnant women in the nation's most productive agricultural region. Using these data and EPA's Exposure Assessment Guidelines, CHAMACOS scientists have confirmed that a significant portion of these women and their children are exposed to commonly used pesticides at levels that exceed EPA standards. The researchers are now testing the effectiveness of an intensive "Healthy Homes" intervention project in the community to raise awareness and prevent exposures to developing children.





Particulate Matter

Particulate matter (PM) is one of our country's most persistent, ambient air quality problems. Breathing PM at harmful levels can cause respiratory problems, hospitalization for heart or lung disease, and even premature death.

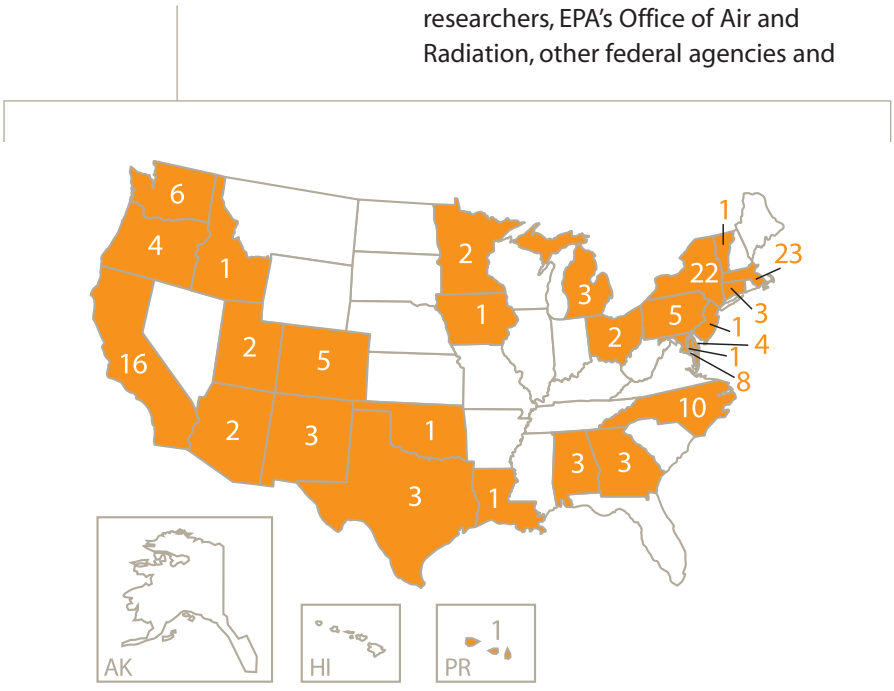
Under the Clean Air Act, EPA is required to list widespread air pollutants that could endanger public health. EPA must also establish National Ambient Air Quality Standards (NAAQS) for those pollutants, including PM. In 1998, Congress requested that EPA accelerate its investigation of the role of PM in health effects associated with air pollution and find ways to reduce the risk via scientifically defensible regulatory actions. In the ensuing five years, intensified research brought forth a surge of new information regarding PM and its potential impacts on human health. This emergence of new information was the result of a comprehensive, national research endeavor involving the coordinated efforts of EPA's own scientists, STAR researchers, EPA's Office of Air and Radiation, other federal agencies and partners such as the Health Effects Institute (HEI).

In an effort to determine the health effects of PM, STAR established congressionally mandated PM Centers that conduct cutting-edge research and communicate new findings and research priorities with partners and other federal agencies.

The first five years of EPA's expanded research program validated and replicated studies showing that ambient PM can adversely affect human health. While PM exists with other gaseous pollutants in the atmosphere, research now shows PM is associated with these adverse effects independent of the potential effects of other pollutants. It is also clear that certain individuals appear to be at greater risk. Although the elderly with pre-existing heart and/or lung disease appear to be most at risk, other groups such as the very young, asthmatics and perhaps those with some genetic predisposition also may be susceptible to the effects of PM. Even more striking are the findings that suggest that extended exposure to PM can lead to chronic disease and/or shortened life span.

Future PM research will include the effects of long-term exposure to PM; biological mechanisms that explain why some people are more susceptible to PM's effects; and the links between PM's effects, composition and size, and emission sources. NCER is also supporting research on the sources and atmospheric transformation of fine PM to help design and implement cost effective measures to improve air quality.

NCER has a total of 137 active grants in Particulate Matter research.

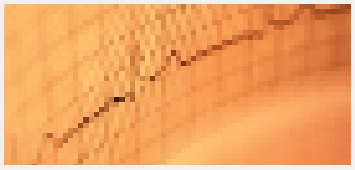


Diabetics, Heart Disease, and PM

Research shows that some groups of people are more susceptible to the health effects of exposure to PM than others, and this fact must be taken into account when EPA determines the appropriate levels for the NAAQS. Researchers at the Harvard PM Center studied the association between PM exposure and hospital admissions for heart and lung disease in people with and without diabetes. Using Medicare data for Cook County, Illinois, the investigators found that diabetics, as compared to nondiabetics, had twice the risk of being admitted to the hospital for heart disease when PM levels increased. As a result, people with diabetes may be considered to be potentially susceptible to the effects of PM.

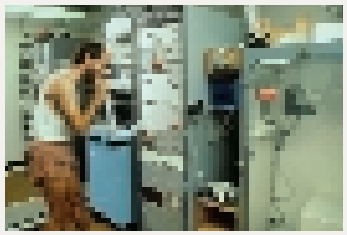
PM Exposure and Heart Attacks

Researchers at the Harvard PM Center have analyzed the risk of triggering heart attacks from exposure to high concentrations of ambient particles. Their analysis compared interview data collected on 772 patients with heart attacks in the greater Boston area to hourly concentrations of PM, carbon black, and gaseous air pollutants. The study suggests that elevated concentrations of fine particles in the air may temporarily elevate the risk of heart attacks within a few hours and within one day after exposure.



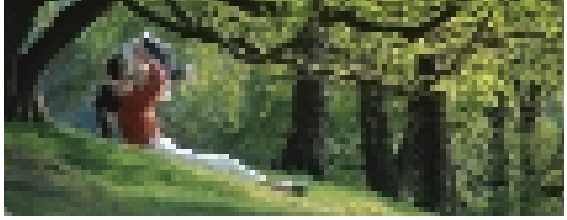
PM Exposure and Inflammation

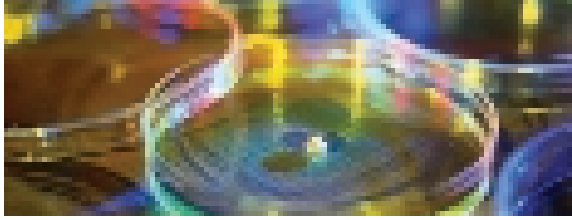
Previous toxicological studies have shown that particles can cause airway inflammation at high doses, but there was little evidence of inflammation at ambient concentrations. Researchers at three PM centers designed studies to look at potential links between PM exposure and two types of inflammation: airway inflammation and markers of systemic inflammation in the blood. Through a series of laboratory animal and human clinical experiments, the PM centers have shown that breathing PM at concentrations only slightly above peak ambient levels causes airway inflammation. The PM centers in Southern California and Rochester, New York, have collaborated in human clinical studies, using the same protocols, measures and overall approach. Preliminary findings from these studies provide evidence for markers of systemic inflammation in the blood. At the Harvard PM Center, studies in laboratory animals exposed to concentrated air pollutants and particle components also showed increases in pulmonary and systemic inflammation. Together, these studies showing significant pulmonary and systemic inflammation due to PM provide one possible explanation for how PM causes adverse health effects.



PM From Fireplaces

Researchers at the California Institute of Technology determined that burning wood and other vegetation is a significant source of fine particle emissions to the atmosphere in many parts of the United States. The researchers conducted an extensive series of tests to determine the characteristics of emissions from burning various types of wood in fireplaces and stoves, as well as other sources such as agricultural waste. Estimates of emissions were developed on a state-by-state basis. From the estimates, the researchers determined that the most important natural source of PM is residential wood burning. The detailed organic compound source profiles developed by this study can be used by states in modeling efforts to evaluate various air pollution control strategies.





Endocrine Disruptors

There is concern that some chemicals in the environment may interact with the hormone (endocrine) system of humans and wildlife and produce adverse health effects. The endocrine system plays a key role in the development, growth, reproduction and behavior of humans and wildlife. Small disturbances to it, especially during critical stages such as pregnancy and lactation, can lead to profound and lasting effects. It has been hypothesized that endocrine disruption might result in endocrine-mediated cancers (e.g., breast, testes, prostate), reproductive disorders, birth defects, neurological impairment or other adverse effects. Chemicals that interfere with normal hormone function are called endocrine disrupting chemicals (EDCs). A broad range of environmental contaminants, including some pesticides and industrial chemicals, are either known or suspected EDCs. Evidence of potential effects from EDCs has been collected primarily through laboratory animal studies and documented effects in wildlife in specific contaminated ecosystems. Evidence in humans is much more limited.

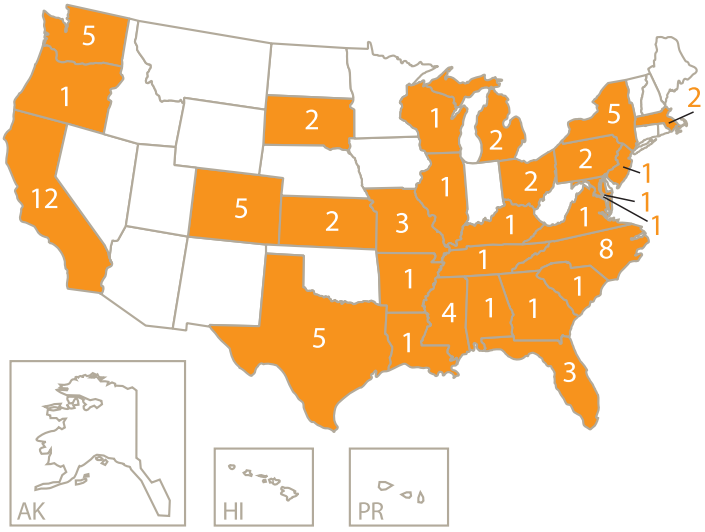
Because of the potential scope of the problem, the possibility of serious effects in humans and wildlife, and concern regarding the persistence, fate and transport of some EDCs, ORD identified research on endocrine disruptors as one of its six high priority topics in 1996. The breadth of the current scientific uncertainties related to what effects are actually attributable to environmental exposures, what chemicals are responsible for the effects, and what risk management steps need to be taken to protect public health and the environment necessitate national and international cooperation and communication.

While ORD scientists have been studying EDCs for several decades, ORD's recent research program, within its own laboratories and through STAR, has been guided by its 1998 peer-reviewed research plan and is addressing three long-term goals:

- Provide a better understanding of the science underlying the effects, exposure, assessment and risk management of endocrine disruptors.
- Determine the extent of the impact of endocrine disruptors on humans, wildlife and the environment.
- Support EPA's endocrine disruptors screening and testing program required by the 1996 Food Quality Protection Act.

The research funded by STAR grants is important to EPA as it has the potential to strengthen the scientific basis for assessing the risks to humans and wildlife from exposure to EDCs.

NCER has a total of 76 active grants in Endocrine Disruptors research.

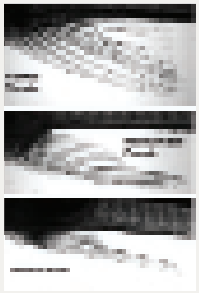


Early Puberty Observed in Girls Exposed to Chemical Pollutant

STAR researchers at Emory University conducted a study whose findings suggested that exposure before and shortly after birth to estimated high levels of polybrominated biphenyls (PBBs) may alter girls' hormone levels and lead to an earlier onset of puberty. The girls' mothers had been exposed to PBBs as a result of an accidental contamination of cattle feed in 1973 and are being followed by the Michigan Department of Community Health. PBBs are chemicals used as flame retardants and may alter estrogen and thyroid hormone levels in humans and other animals. The study evaluated over 300 girls who were exposed to PBBs in the womb and, in 60 percent of the cases, in breast milk as well. Breastfed girls exposed to high levels of PBBs in the womb started their menstrual periods (the technical start of puberty) at a significantly earlier age (11.6 years) than girls with lower PBB exposure or girls who had not been breastfed (12.7 years).

Developing Methods to Screen for Endocrine Effects: Mosquitofishes

STAR researchers at the University of Alabama-Birmingham developed a short-term *in vivo* screening system for endocrine disruption using mosquitofishes. A morphological trait (modified anal fin called a gonopodium) is used to test for androgenic (male hormone) activity. The gonopodium is not found in normal females but is readily induced to develop in females exposed to chemicals with androgenic activity. In addition to using this assay to screen chemicals in a laboratory, mosquitofish are suitable as sentinel species for the detection of endocrine disruptors in a variety of warm fresh- and saltwater aquatic environments. For example, using this system, researchers determined that effluents downstream from a pulp and paper mill contained androgenic compounds.



Developing Novel Computational Tools for Rapid Prediction of EDCs

The Food Quality Protection Act (FQPA) and the Safe Drinking Water Act Amendments of 1996 both contain provisions related to determining whether pesticides or chemical substances found in or on food or in drinking water sources, respectively, may have estrogenic (female hormone) or other endocrine effects. FQPA specifically requires EPA to develop a screening and testing program for this purpose. It is essential to have systems to assist in prioritization of the tens of thousands of chemicals under consideration for screening for endocrine disrupting activity. These systems should be rapid, predictive and economical, and use fewer laboratory animals. STAR researchers at the University of Missouri - St. Louis developed and validated an integrated array of novel computational methods including quantitative tools for modeling and predicting potential EDCs based on quantitative structure activity relationship (QSAR) models.

Supporting Epidemiology Studies

One of the critical uncertainties related to EDCs is their impact on human health. To address this data gap, EPA, in partnership with NIOSH, NIEHS, and NCI, under the auspices of the Interagency Working Group, issued a joint solicitation for research proposals that studied the relationships between exposures to EDCs and adverse human health effects, especially in development and reproduction. Collectively, 12 epidemiology studies are funded, five of which are being supported by through STAR. These studies are looking at the effects of exposures, over a variety of life stages (e.g., during pregnancy, lactation, childhood, adulthood) to certain pesticides, plasticizers, flame retardants and products of combustion on a variety of endpoints such as development of the reproductive system, immunologic function and thyroid function. The results of the studies will lead to a better understanding of the effects of EDCs on human health.

Drinking Water

Each American household uses an average of 94,000 gallons of water in one year. Americans drink an average of 1 billion glasses of tap water per day and often take this convenience for granted. But the safety of our drinking water can be threatened by both naturally occurring and human induced contaminants.

The Safe Drinking Water Act, enacted in 1974, is the principal federal law ensuring the quality of our drinking water. Under this law, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers that implement the standards. In 1996, Congress amended the Safe Drinking Water Act and directed EPA to strengthen the scientific foundation for the standards that limit public exposure to drinking water contaminants. The amendments contained specific requirements for research on arsenic, some waterborne pathogens and the byproducts created during the water disinfection process. EPA was also asked to identify and regulate drinking water contaminants that could have adverse health effects and occur in public water systems.

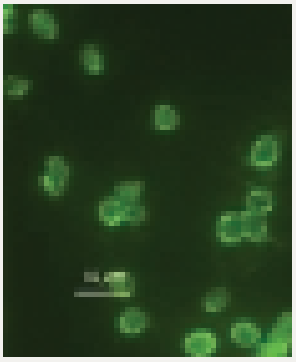
Since the1996 Amendments were passed, NCER has funded research grants to provide information across a range of drinking water priorities. STAR grants have been instrumental in understanding waterborne pathogens such as *Cryptosporidium* and Norwalk virus, disinfection byproducts (DBPs) and other harmful substances in drinking water. STAR's drinking water program is working to identify and characterize the human populations that are most susceptible to contaminants in drinking water. In response to an emerging research area, STAR is now supporting research to evaluate the occurrence and effects of antibiotics, hormones and pharmaceuticals in water.

STAR research has helped to support regulatory and other activities to ensure safe drinking water. It has provided information to upgrade drinking water treatment approaches and improve our understanding of the risks posed by contaminants in drinking water. In the future, STAR's drinking water research program will be used to improve both our understanding of the risks posed by microorganisms in source and drinking waters along with developing innovative tools and improved technologies to support decisions on formerly unregulated contaminants.

NCER has a total of 88 active grants in Drinking Water research.

Cryptosporidium: A Public Health Threat

In 1993, an estimated 400,000 people became ill in Milwaukee, Wisconsin, after drinking water contaminated with *Cryptosporidium parvum*, a waterborne pathogen that can contaminate drinking water supplies and is highly resistant to traditional disinfection processes. Infection results in diarrhea in healthy people but has more severe consequences for the very young, elderly and those with compromised immune systems.



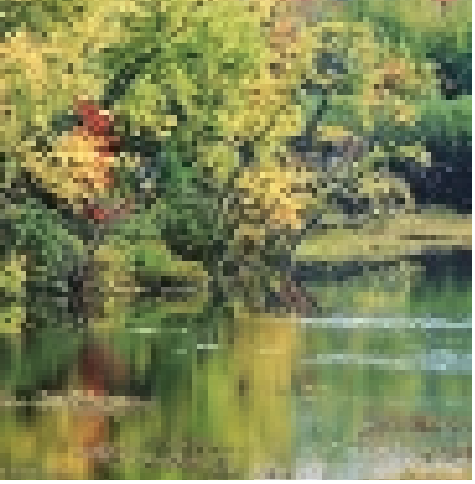
STAR researchers at the University of Texas Health Science Center looked at different types of *Cryptosporidium* to better understand its ability to infect and cause diarrhea in healthy people. They found that these different types varied widely in their abilities to both infect and cause diarrhea, and that only partial immunity was gained against reinfection. The results of this research are proving essential to EPA's Office of Water for estimating the benefits of additional regulations to prevent future outbreaks from water contaminated with *Cryptosporidium*.

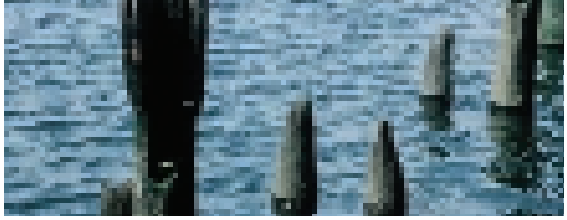
A New Technique for DNA "Fingerprinting"

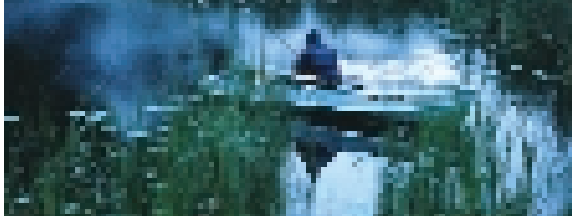
How can we tell if harmful microbes are in our drinking water? STAR researchers at Battelle Memorial Institute developed a new, rapid and low-cost technology to detect microbial pathogens in various water sources. They designed a DNA array that "fingerprints" different types of *Cryptosporidium parvum*, detecting differences at the genetic level. The ability of this technique to discriminate between live and dead pathogens in water means it can indicate if a water source is contaminated with *Cryptosporidium* that could actually cause disease. The technology can potentially be adapted to fingerprint other disease-causing organisms in water or air—whether they are naturally occurring or intentionally placed. Therefore, one extremely important possibility for this technology is to serve as an early warning system to identify pathogens related to bioterrorism incidents in water supplies.

Minimizing Risks From Disinfection Byproducts

One of the major public health advances of the 20th century is the chemical disinfection of drinking water to prevent microbial contamination. But while disinfectants effectively control many harmful microorganisms, they can also react with natural materials in the water to form disinfection byproducts (DBPs). Some DBPs pose health risks of their own, and one of the most complex questions facing water suppliers is how to provide safe drinking water while reducing the risks from toxic DBPs. STAR researchers at Arizona State University have developed computer models to help predict DBP formation using various disinfectants under different water conditions. Currently, these models are being validated as part of the EPA's Water Treatment Simulation Model, which is used to evaluate control strategies for DBPs. Once validated, these models will enable treatment plant operators to consider many specific characteristics of their source waters and essentially "try out" different treatment processes on the computer to find the best approach for minimizing DBPs while still ensuring safe water. Because treatment can be tailored to specific water conditions, applying these models will also help reduce the costs of chemicals used to treat water.







Water and Watersheds

We all need clean water. Healthy watersheds—the geographic areas where water drains to a common body such as a river, lake or wetland—help give us clean water supplies, reduce flooding and sustain aquatic life. To ensure that we continue to enjoy these benefits, human and natural activities that affect water quality must be identified and analyzed.

STAR is supporting watershed research that helps implement the Clean Water Act's mission "to restore and maintain the chemical, physical and biological integrity of the nation's water." STAR's watershed program focuses on the following:

- Integrated watershed research
- Nutrient fate and transport models
- Models that describe the interactions of multiple pollutants
- Classification schemes to categorize watersheds by their similarities.

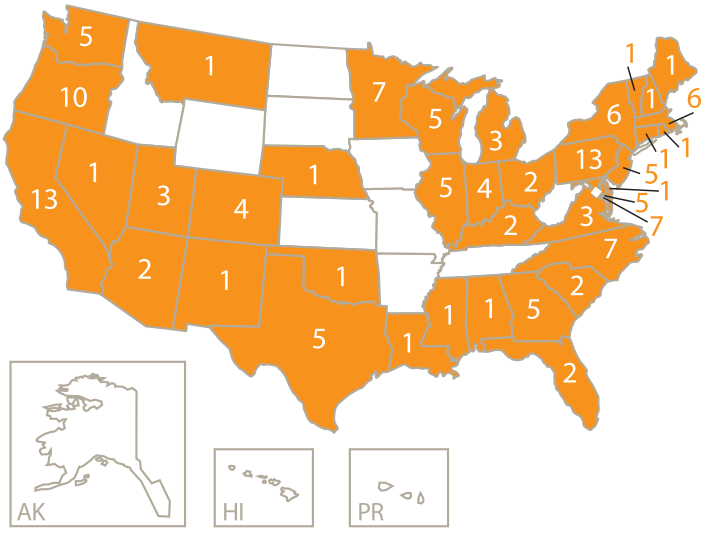
STAR's research spans diverse geographic regions with a broad scope of watershed impairments. For example, STAR grants in the Pacific Northwest studied sedimentation and its effects on salmon spawning. All these grants involved integrating the physical, biological and social sciences and strongly promoted a community-based approach with active stakeholder involvement.

To identify land-use practices that will keep harmful nutrients out of streams, STAR researchers are modeling the transport, transformation and deposition of these nutrients. Excessive nutrients most often come from agricultural runoff and produce algal blooms that reduce the available oxygen for aquatic animals, resulting in massive fish kills. These models will be extremely valuable to local governments planning development projects.

Streams and their wildlife can be impacted by multiple stressors, including nutrients, sediment runoff, toxic chemicals, invasive species, and increased water temperature. STAR researchers are developing models that can predict how fish and other organisms would respond to changes in these stressors. Such models will enable watershed managers to identify the most important stressors to control through remediation activities.

Monitoring and assessing water quality is expensive and labor-intensive. If watersheds could be classified based on similar characteristics, such as stream flow, soil, slope and vegetation, they could be managed as a group, rather than individually. STAR research is developing classification schemes to enable managers to monitor, assess and restore watersheds in a cost-effective manner.

NCER has a total of 140 active grants in Water and Watersheds research.



Ecological/Economic Model for Land-Use Decisions

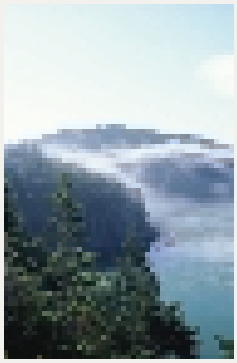
Similar to many local governments across the country, Calvert County, Maryland, is grappling with the effects of rapid population growth and suburban development. County officials had developed a comprehensive land-use zoning plan and wanted to assess its impact on water quality, specifically on nitrogen levels. STAR researchers at the University of Maryland developed an ecological/economic model evaluating the forces and consequences of land-use change. Based on recommendations from the modeling results, the county commissioners adopted measures they felt would improve the environment and maintain the general quality of life in the county. Other local governments are now looking at this model to see if they can apply it.

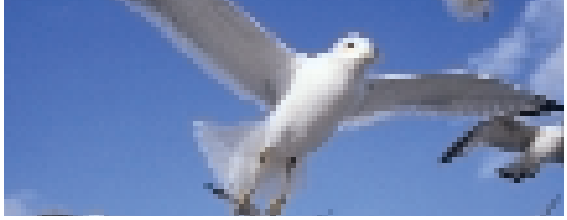
Protecting Streams During Construction

STAR researchers at the University of North Carolina at Chapel Hill studied enforcement procedures and their impacts on sedimentation rates before, during and after construction projects. Results indicate that current regulations are adequate to protect water quality, but tighter enforcement of these regulations on small projects would result in less damage to streams because they are exempt from some regulations. The cumulative sediment deposited by small construction sites can be greater than that caused by larger sites. The report concludes that onsite inspections for all construction sites should be frequent, with enforcement actions swift and strict. In addition, a close working relationship between the developers and the inspectors encourages development while protecting stream quality. As a result of this study, North Carolina's Division of Water Quality and Sedimentation Control Commission has increased enforcement activities to reduce the amount of stream sedimentation.

Successful Watershed Partnerships

With continued economic and urban growth come more complex environmental problems and greater conflict among people and institutions over the use of scarce water resources. Partnerships among local officials, citizens and interest groups have been formed across the country to address the socio-economic issues associated with watershed management. Some partnerships are more effective than others, and STAR researchers at the University of California at Davis wanted to know why. They conducted detailed case studies of 50 watershed partnerships in California and Washington to understand how they resolve resource management conflicts and then implement solutions. The researchers found that trust, funding and the length of the partnership are the most important predictors of overall success. Another important result indicated that success in reaching agreements and implementing projects depends on active participation by state and federal agencies.





Monitoring Our Nation's Water Bodies

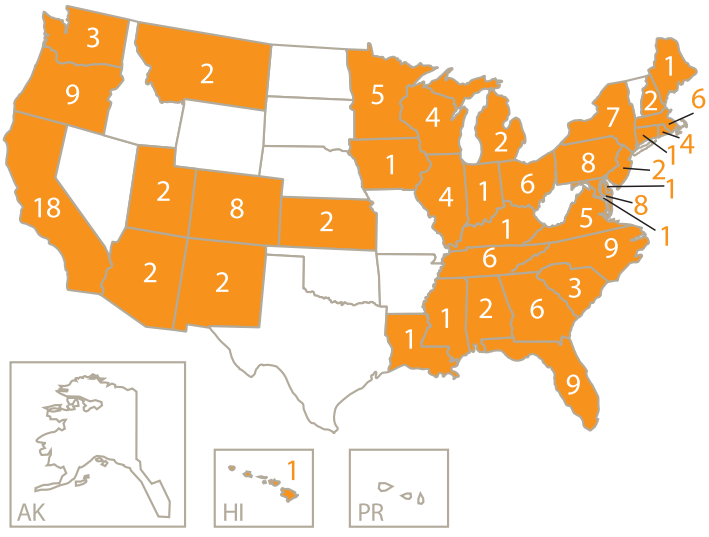
Pfiesteria hysteria, fish consumption alerts, "no swimming" signs and fish kills have become common terms in the American vocabulary. These water quality problems underscore the importance of the research being done to support the Clean Water Act (CWA). The objective of the CWA is to "restore and maintain the chemical, physical and biological integrity of the nation's waters."

Development of biological criteria (biocriteria) for evaluating the condition of aquatic resources within the United States is central to implementing the CWA. Biological criteria require indicators, reference conditions and classification systems. Since 1995, the STAR ecological research program has worked to develop ecological indicators to assess the health of our aquatic ecosystems. STAR is also funding research to classify aquatic ecosystems and develop reference conditions showing pristine or best attainable conditions for specific water bodies. Comparing a stream to its reference stream, for example, will allow a resource manager to determine its degree of impairment. Classification systems will give managers the ability to decide which bio-indicators are appropriate across a geographic area or "ecoregion." This research complements EPA's Environmental Monitoring and Assessment Program, which develops and transfers to the states monitoring designs and methods to assess the ecological condition of our nation's water bodies.

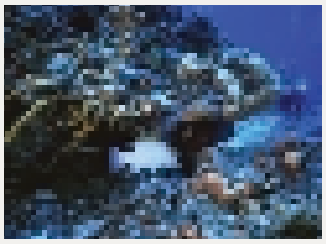
A large thrust of the ecological indicator research has been focused on coastal zones known as estuaries—transition zones between land and water that are critical habitats for many animals and plants. Tens of thousands of birds, mammals, fish and other wildlife depend on estuarine habitats as places to live, feed and reproduce. Estuaries are essential spots for migratory birds to rest and refuel during their journeys. Because about half the U.S. population now lives in coastal areas, human-induced stresses have resulted in a host of other human health and natural resource problems. To respond to the need to protect these valuable areas, STAR created the Estuarine and Great Lakes (EaGLe) Program in 2001/2002. The EaGLes are developing the next generation of environmental indicators so that state governments can use them to assess the biological health of estuaries and the Great Lakes.

In the future, STAR will continue to support research to develop the next generation of ecological indicators, with particular focus on landscape and genomic indicators. This approach will build on the explosive growth of technology in these areas. STAR will also fund a new EaGLe research center that will focus its efforts on ecological and economic indicators for the great rivers of the U.S. central basin.

NCER has 156 active grants for monitoring the condition of our nation's water bodies.



Coral Reef Protection and Restoration



Coral reefs are among the most diverse and productive ecosystems on Earth. Recent scientific evidence suggests that coral reefs are under significant amounts of stress from a variety of environmental factors, including sediment and nutrients. A STAR researcher at the University of Guam has developed environmental indicators that can detect when coral reefs are likely to undergo decline. Recommendations from this research for protecting coastal water quality surrounding coral reefs have been implemented in several jurisdictions in the South Pacific, along with guidelines for reef restoration.

Managing the Great Lakes Ecosystems

The Great Lakes are the largest system of fresh, surface water on Earth. Despite their large size, these lakes are sensitive to the effects of a wide range of pollutants from agricultural lands, cities, industrial area, and disposal sites. STAR researchers at Johns Hopkins University developed a computer model to characterize the effects of nutrients, fisheries and habitat policies on the ecological health of Lake Erie. This Lake Erie Ecosystem Model (LEEM) allows users to weigh the tradeoffs between lake productivity (such as fish harvest) and environmental indices (such as water clarity). For example, a resource manager might ask, "What are the potential stresses to the Lake Erie ecosystem as a result of expansion of exotic invader species?" The model shows that changes in the variety of fish species and the size of their communities in Lake Erie were more likely to be the result of historical fisheries management decisions and less likely to be the result of changes in nutrient loadings or the zebra mussel invasion. Scientists on the Lake Erie Committee of the Great Lakes Fishery Commission have used LEEM to study how the zebra mussels could affect the benefits of ecological research and fishing limits. This research also helped the USEPA/Environment Canada Lake Erie Management Plan define the ecological goals for restoring Lake Erie.

Control of Harmful Algal Blooms Using Clay

Harmful algal blooms such as those caused by red tide and *Pfiesteria* pose a serious threat to marine ecosystems, fisheries, human health and coastal economies. STAR researchers at Woods Hole Oceanographic Institution investigated the use of clay as a strategy for controlling these blooms. Certain clays can actually scavenge particles, including algal cells, from seawater and carry them to bottom sediments where they are buried and decomposed. Lab results suggest the use of clay on Florida red tide blooms will not cause any increased toxic threat, relative to that already present from the red tide. Additional funding has been obtained, and the next step is to design pilot-scale field experiments to test the effectiveness of clay for controlling blooms in the environment. Although more extensive testing will be needed before large-scale applications can be made in the environment, clay has the potential to be the first effective tool developed to mitigate harmful algal blooms.

Mercury

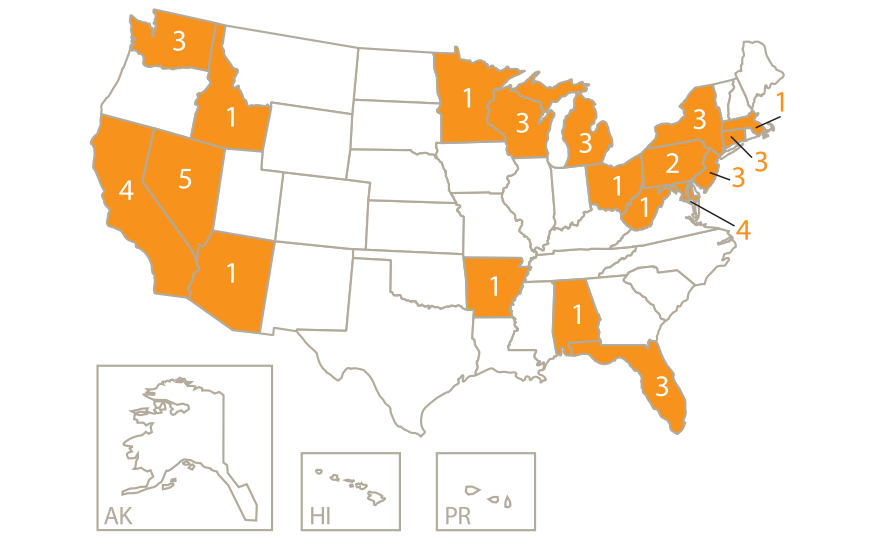
Mercury, a silvery metal that is very poisonous, concentrates in animal tissues as it moves up the food chain. It can have adverse effects on mammals, fish and birds including behavioral and neurological abnormalities, impaired growth and development, fetal deformities and complete reproductive failure in some cases.

Since mercury is a naturally occurring metal, it will always be in the environment in one form or another. According to EPA's 1997 Mercury Study Report to Congress, mercury fluxes and budgets in water, soil and other media have increased by a factor of two to five over pre-industrial levels. Coal-fired power plants, municipal waste incinerators, chlor-alkali plants and commercial and industrial boilers emit it. Mercury can be deposited from the atmosphere via rainfall. On land, mercury can bind to organic and inorganic matter in soil including the sediments where bacteria transform it into methylmercury. Mercury is the most frequent reason for fish advisories, and almost 79 percent of all public health advisories on fish consumption in the United States are due, at least in part, to mercury contamination.

STAR researchers are studying the risks created by mercury in our environment so that we can better understand how to eliminate them. Since 1999, STAR grantees have studied the processes that influence the fate and behavior of mercury in water and watersheds. STAR researchers are also developing models to understand how the ecosystem responds to changes in mercury inputs from emission sources. Results of this research will increase our ability to trace mercury from its entrance into the ecosystem, understand how it changes to toxic methylmercury, and how it finally concentrates in fish and human tissues.

Understanding why and how atmospheric mercury becomes part of the food chain is also important for mercury control. With that in mind, STAR recently funded several grants to help us understand the local and global causes of mercury deposition. Scientists are working with information from around the globe to develop a better understanding of the natural and manmade emissions of mercury to the air and the atmospheric processes that affect the transport, transformation and deposition of those emissions.

NCER has a total of 44 active grants in Mercury research.



Mercury in Coastal Waters

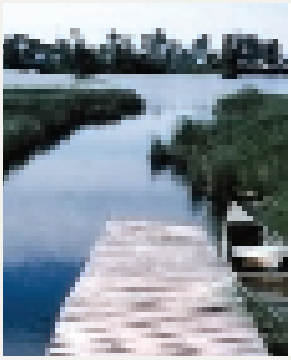
Most mercury research focuses on freshwater systems. However, STAR researchers at the University of Connecticut have conducted some of the only research on the behavior and fate of mercury in the marine environment. Their work in coastal waters, such as Long Island Sound, confirmed the prominent role of mercury production and emissions in marine systems. They also demonstrated how careful documentation of the historical deposition of mercury in the sediments of coastal waters such as Long Island Sound can be an indicator of the status and trends of mercury pollution in these complex environments.

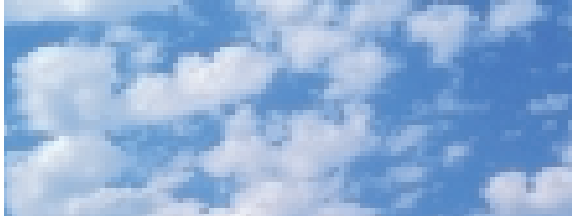
Mercury Accumulation in the Great Lakes Watershed

STAR researchers at the University of Michigan and Princeton University have changed all previous theories about the estimates of how quickly mercury volatilizes to the atmosphere. Another component of their work describes which parts of a watershed are the most likely sources of mercury re-emission to the atmosphere (e.g., clear versus murky lakes). This information is key to helping states model their ability to decrease mercury contamination in fish and other organisms in a given watershed.

Mercury and Fish Exposure Pathways

Methylmercury—the form of mercury that can adversely impact human health—has been found in fish in northern temperate lakes, including the Great Lakes. STAR scientists at the Universities of Wisconsin-Madison and the University of Minnesota are studying the factors that influence mercury levels in water and aquatic life, especially fish. These researchers have shown that mixing zones, the areas where different types of waterbodies come together, can potentially provide significant pathways for methylmercury to enter the Lake Superior food web. They are continuing to investigate other possible places and conditions where methylmercury is produced and evaluating how it moves to nearshore sediments or coastal wetland zones and is ingested by fish.





Global Change

Scientists have observed a warming trend across the Earth since the late 19th century, with the most rapid warming occurring over the past two decades. If emissions of greenhouse gases continue unabated, some scientists say humans may change global temperature and the planet's climate at an unprecedented rate. However, many questions remain about the cause, pace and consequences of these changes. NCER's STAR program is working towards EPA's research goal of understanding the possible consequences of global change on human health, ecosystems and social well-being. Our global change research has been designed to provide scientific information to stakeholders and policy-makers so that they can make informed decisions about whether and how to respond to global change.

Researchers funded by the STAR program have contributed significantly to the development of methods to assess both the risks and the opportunities presented by global change, as well as ways to improve society's ability to effectively respond to them. To date, STAR research has focused on the potential impacts of global change on human health, water and air quality, ecosystems and agriculture.

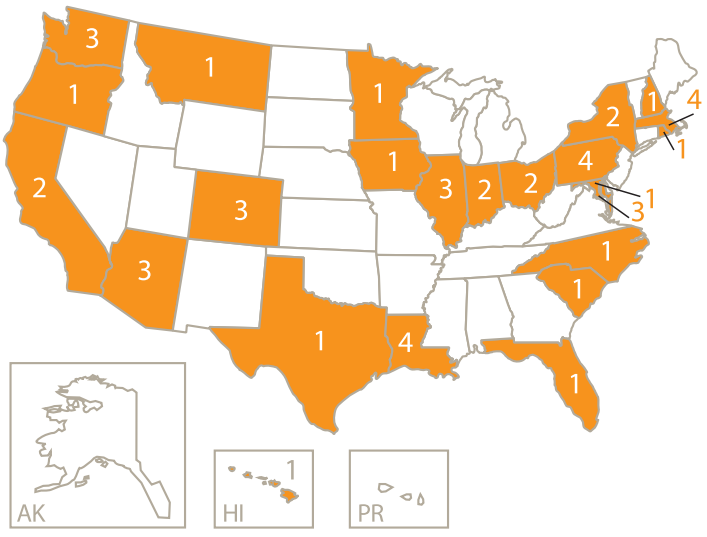
Completed research explored the implications of changes in the nature, timing and distribution of precipitation. By specifying regional vulnerabilities and developing new tools for integrated assessments, STAR projects have produced scientific tools that local and state decision-makers can use in long-range planning for infrastructure, water resources, and habitat restoration.

The intensity of the current policy debate on global change has only underscored the vital need for more research and understanding. Much remains to be learned—particularly the regional and local impacts that global change could bring. Research projects, both completed and continuing, include the impact of climate change to agriculture.

Future research will focus on global change impacts on aquatic ecosystems by developing and applying methods for linking global changes to local changes in physical, chemical, biological and ecological conditions in selected watersheds.

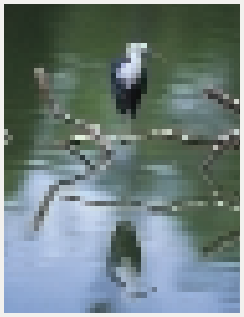
STAR researchers will also focus on the impact of global change on air quality seeking to understand the consequences of global change for air pollution and link complex, dynamic models across multiple scales. Improved understanding will enable decision-makers to assess potential impacts and identify effective options for reducing adverse effects.

NCER has a total of 47 active grants in Global Change research.



Global Change and Public Health

Researchers led by Johns Hopkins University assessed the potential impact of global change on important public health issues, including waterborne diseases such as *Cryptosporidiosis* and cholera, and vector-borne diseases such as Hantavirus, Dengue fever, and Lyme disease.



Hantavirus was discovered among previously healthy persons in the southwestern United States in 1993 and has a very high death rate. The study compared the environmental characteristics of sites where people were infected to those where people were not infected. Results indicated that high-risk areas for Hantavirus Pulmonary Syndrome could be predicted over six months in advance using satellite-generated risk maps of vegetation. The methods, developed in partnership with the Centers for Disease Control and Prevention and the Indian Health Service, are in use for disease prevention in the Southwest by the U.S. Department of Health and Human Services.

Climate Change Impacts on Florida Everglades Restoration

Since as early as the 1800s, more than half of the Florida's Everglades wetlands were lost to development, and water management practices designed to prevent flooding were sending valuable freshwater to sea. The Comprehensive Everglades Restoration Plan (CERP), a 20-year, $7.8 billion plan, will capture freshwater destined for sea—the Everglades' lifeblood—and direct it back to the ecosystem to revitalize it. A team of scientists at the University of Miami is currently evaluating the potential effects of climate change on restoration efforts.

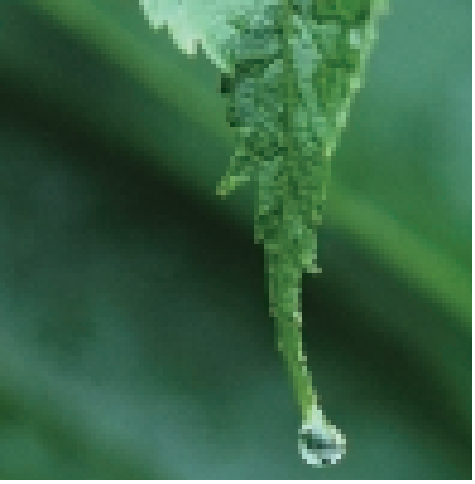
Using cutting-edge computer models, researchers are manipulating stressors to evaluate potential impacts on conditions such as the flow of surface water and groundwater; the abundance and distribution of wading birds within the Florida Everglades; the freshwater inputs into Biscayne Bay and associated changes in salinity; the health of seagrass and bottom communities; and the size and behavior of fish populations. Results from this research will provide managers and scientists with new tools to better evaluate the potential effects of climate change on the performance of proposed restoration activities before they are implemented.

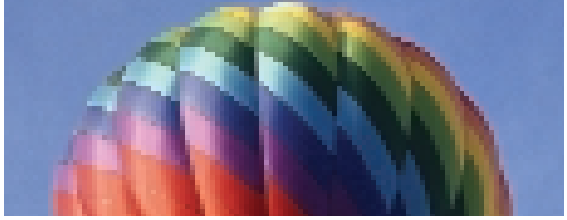
Modeling Global Change Impacts on Wildfire Cycles

A research team led by the University of Arizona is building a geographic information system (GIS) model that layers and integrates data for fire history, fuels and climate to produce wildland fire risk maps. Although the model, which focuses on four areas in the southwestern United States, is still in development, the project's website (http://walter.arizona.edu) is already providing useful information. The model and website have been enthusiastically received by fire managers attending the annual fire-climate workshop; the Interagency Wildfire Management Team in Los Alamos, New Mexico; and participants at the Arizona FIREWISE Communities workshop.

Global Climate Change Impacts on California's San Joaquin River Basin

The San Joaquin River Basin in California is the source of drinking water for more than 20 million people in cities from San Francisco Bay to San Diego. It also supports one of the most important agricultural regions in the world. Researchers led by the University of California-Berkeley are assessing the vulnerability of the basin's water supply, ecological resources and rural economy to climate change and extreme weather. Results from this research have already produced a unique model that predicts effects of climate change on long-term agricultural productivity as a result of potential reduction in water supplies caused by climate change and soil salinity. This model is being used for resource planning activities.





Economics and Decision Sciences

Human behavior is both the cause of and cure for so many environmental problems; to improve the environment, we can change behavior or develop new technical solutions. While our society wants and needs a clean environment, there are limits to what we will spend to protect it. To find more cost-effective means of environmental protection, we need a better understanding of individual, corporate and community environmental behavior. This understanding will tell us what incentives will work at each level to give the public the environmental protection it desires.

The STAR economics and decision science research program focuses on market mechanisms and incentives, corporate environmental behavior, the effectiveness of government interventions, and the valuation of ecosystem and human health benefits.

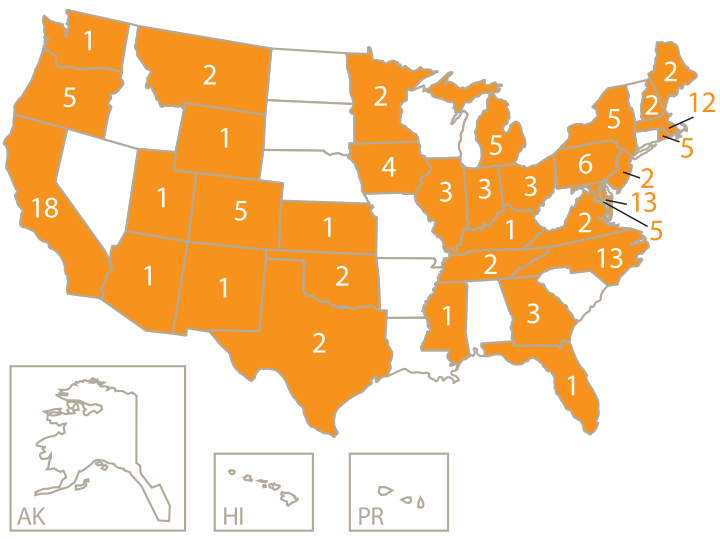
STAR's economics and decision sciences research is becoming more critical as EPA and the states move to alternative approaches—such as markets, information dissemination and voluntary agreements—to solve environmental problems. As federal and state environmental agencies continue to develop a more diverse set of environmental tools, they need to know whether alternative programs will improve on or complement regulatory approaches. Under-standing how regulated entities respond to different incentives offered by enforcement, information, compliance assistance and voluntary programs is essential for picking the right tool to get the job done.

While we know that tradable pollution permits can achieve environmental objectives such as pollution reduction and habitat preservation at a lower cost, we need to understand how to design other programs to achieve the most cost-effective environmental protection. This research area is still new, and its outcomes can mean and billions of dollars in environmental benefits and environmental policy success.

Valuation research is particularly important for regulatory programs that must conduct cost-benefit analyses. Because there are extensive gaps in what we know about how people value wildlife, habitat, biodiversity and ecosystem services, ecosystem valuation is one of the top research priorities for EPA rule development. There are also many health effects limited by EPA regulations that cannot currently be valued, and considerable questions remain about how people value premature deaths caused by environmental problems. Improved value estimates for ecosystems and health effects will enable decision makers to make better-informed decisions among different policy options.

Taken as a whole, STAR's economic and decision sciences program will lead to new, effective ways of achieving results and better understanding about the outcomes of different environmental policy approaches.

NCER has a total of 135 active grants in Economic and Decision Sciences research.



Market Behaviors

Massachusetts Institute of Technology researchers showed that a sulfur dioxide (SO_2) cap-and-trade program for utilities is actually effective at reducing SO_2 emissions faster and at a lower cost than traditional command-and-control methods.

Does it make any difference whether marketable air pollution permits are auctioned or given away to polluters? STAR researchers with Resources for the Future say it does—both the public and industry are winners if pollution rights are auctioned. Results from this research have been used as the basis of proposed legislation to develop an emissions trading system to control acid rain and disease-causing nitrogen oxides.

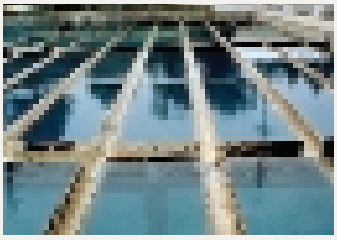
Corporate Behaviors

Do polluters overcomply with water quality regulations to avoid penalties? University of Maryland research illustrates that manufacturing facilities and sewage treatment plants are truly overcomplying with their permits, and not simply compensating for uncontrollable, random discharges. This project predicts that even in the absence of discharge randomness, plants will only pollute at about 60 percent of their permitted level, because of both community pressure and operator uncertainty. It also shows that private manufacturing facilities tend to overcomply or have lower discharges than sewage treatment plants, which are usually publicly owned.

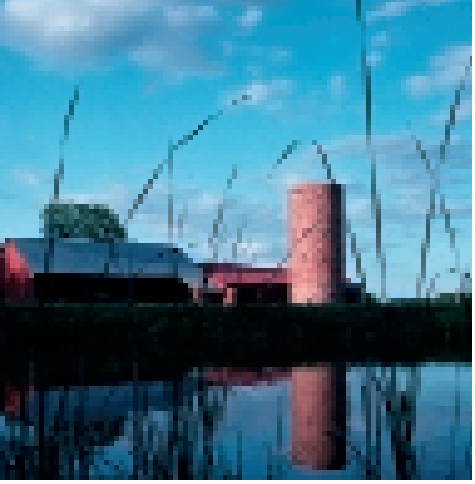
Do environmental regulations cause companies to be more innovative and develop new technologies faster? Apparently so, according to STAR researchers at the University of Rhode Island who studied the offshore oil and gas industry. Their research found that regulations made firms more efficient at jointly producing environmental and market outputs. While environmental regulations did not cause improved production of oil or gas alone, they did encourage firms to do a better job of producing both energy resources and improved water quality.

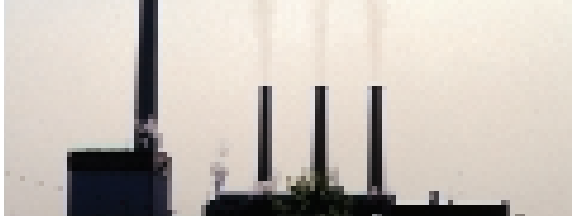
Human Behaviors

Can you assign a value to protecting or extending peoples' remaining lives based on their age or current health condition? STAR researchers at Resources for the Future refute the Quality Adjusted Life Years (QALY) approach advocated by some in government and business to evaluate environmental, health and safety policies. QALYs give lower values to reducing fatal risks for the elderly, the infirm or the physically challenged. STAR research shows that a person's willingness to pay to extend his or her life—the right measure to use in a free, market-based society—does not decline with either age or physical condition.



How do parents value children's health? Using original cutting-edge models of parents' decision-making and data from the Centers for Disease Control and Prevention National Maternal and Infant Health Survey supplemented with actual cost data, researchers at the University of Wyoming found that pregnant mothers attach twice the value to their child's health as to their own. They also find that curing a child's asthma, chronic lung, or upper respiratory problems is valued about three times as much as curing allergies or the flu.





Pollution Prevention

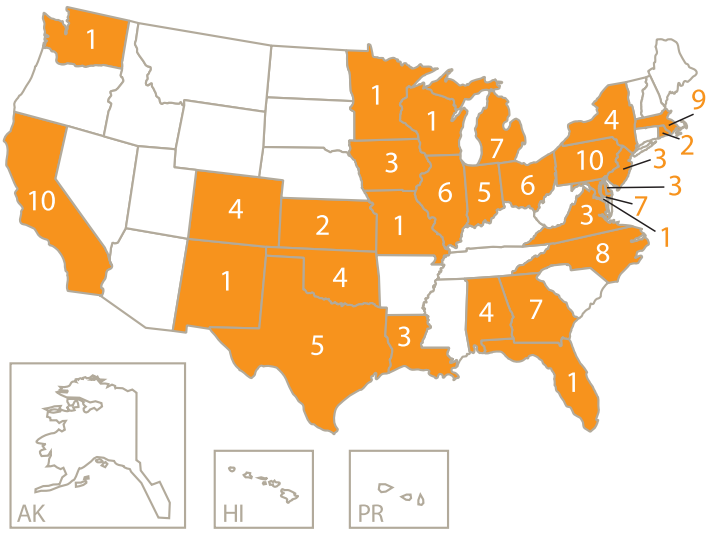
For some time, pollution prevention has been recognized as the preferred strategy for preventing and minimizing wastes. But we are now starting to understand the value of pollution prevention as an environmental strategy and a critical component of sustainability.

In 1990, the Pollution Prevention Act formally established a national policy to prevent or reduce pollution at its source whenever feasible. According to this act, pollution prevention is "...the use of materials, processes or practices that reduce the use of hazardous materials, energy, water or other resources and practices that protect natural resources through conservation or more efficient use". This policy helps companies become more competitive by lowering resource and energy needs and reducing waste and emissions control costs. Even more important, preventing pollution is one of the keys to protecting public health, sustaining resources and protecting the environment while maintaining a strong economy.

The road to preventing pollution at its source is not always quick or easy. Often fundamental changes must be instituted in the way chemicals and other products are made. Technology for a Sustainable Environment (TSE), a partnership between EPA and the National Science Foundation (NSF), has funded 164 grants since 1995, accelerating the pollution prevention revolution. The primary goals of this partnership include replacing hazardous solvents, making chemical reactions occur faster and more efficiently, converting waste biomass into useful products, changing chemical reactions so that they are less harmful, modifying processes in a manufacturing plant to reduce pollution, using a systems approach to focus on the life cycle of a product, and instituting recycling and reuse in production processes. The ultimate aim of this multi-pronged effort is to design pollution out of a system before it occurs.

STAR's TSE program serves a wide range of EPA objectives that are based on the authority of not only the Pollution Prevention Act but also the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act. Pollution prevention is a bridge-builder to sustainable development. The results from early TSE grants have led industry to invest in process changes that prevent pollution. As industries become nonpolluting, the nation itself becomes more sustainable and secure, with profound economic and social implications.

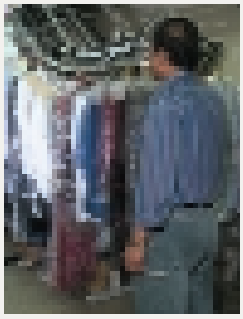
NCER has a total of 122 active grants in Pollution Prevention research.



Reducing Carbon Monoxide

Reducing emissions of carbon monoxide (CO) is an important part of EPA's strategy for cleaner air. CO is a colorless, odorless and poisonous gas formed when carbon in fuels is not burned completely. When carbon monoxide enters the bloodstream, it reduces oxygen delivery to the body's organs and tissues, causing a serious health threat, particularly for those who suffer from cardiovascular disease. In addition, CO contributes to ground-level ozone concentrations. A STAR researcher at the University of Colorado has developed controls to optimize the operation of electric arc furnaces that reduce CO emissions while minimizing energy consumption.

Reducing the Use of Toxic, Organic Compounds



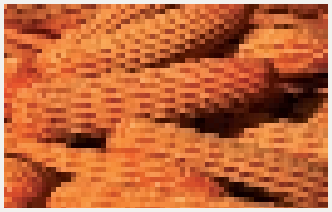
Organic chemicals are widely used in cleaning processes, from dry cleaning to metal degreasing operations. Eye and respiratory tract irritation, headaches, dizziness, visual disorders and memory problems are among the immediate symptoms that people may experience soon after exposure to some organics. Some organics are also carcinogenic. A TSE researcher at the University of North Carolina has developed and marketed a surfactant that dissolves in carbon dioxide, eliminating the use of harmful organic solvents in dry cleaning known to pollute air and groundwater. He is currently working on environmentally benign cleaning processes for use in the printed circuit/electronics industry.

Preventing Pollution From Paper Manufacturing

The pulp and paper industry generally uses toxic, organic chemicals as solvents to separate different wood materials. Researchers with the University of Alabama have developed an extraction method that requires no organic solvents and results in a safe, environmentally benign pulping process. Less energy is consumed by this new process and fewer toxic sulfur compounds are emitted.

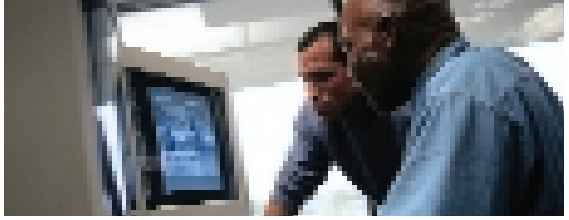
Using Natural Materials in Manufacturing

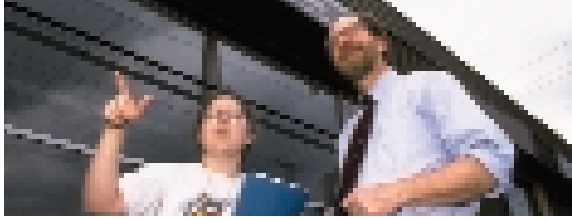
Most glues and resins are manufactured with petroleum-based feedstocks. Researchers with the University of Delaware are using "bio-based" materials, such as plant oils and chicken feathers, to make high-performance, low-cost resins and adhesives. Biobased feedstocks are used in place of petroleum-based feedstocks, thereby reducing our reliance on nonrenewable materials and minimizing emissions of carbon dioxide to the atmosphere. Recent achievements include the manufacture of the first agricultural equipment parts for John Deere and Company using soybean oil. Because of the low cost of plant oil and natural fibers, these new environmentally friendly, high performance materials are currently the world's cheapest composites, and they present significant opportunities for new applications.



Electronic Tags for Product Life Cycle Management

Researchers with Princeton University are developing low-cost electronic tags that help manage product recycling and reuse and can also be used as a tool for research on product life cycles. These tags have the potential to provide detailed data on product distribution, consumption, use, disposal and recycling. Potential applications include end-of-life management for products containing lead, cadmium, mercury, and other hazardous materials, as well as end-of-life management of hazardous chemicals used by households, institutions, businesses and industry, including solvents, pesticides, oil-based paints, and rust removers. Electronic product tags could broaden the range of options for waste management, making approaches less expensive and more feasible.





Small Business Innovation Research

The 22 million small businesses in the United States employ about 51 percent of the private work force and develop most of the country's new technologies. These innovations are the primary source of new technologies that can provide improved environmental protection at reduced cost with better effectiveness and performance. Years ago, Congress realized the need to strengthen the role of small businesses in federally funded research and development and passed a law creating the Small Business Innovation Research (SBIR) program for businesses with no more than 500 employees. EPA's highly-competitive SBIR program offers critical financial support to small businesses to develop the best, new, innovative technologies. SBIR also helps spawn successful commercial ventures that improve our environment and quality of life, create jobs, increase productivity and economic growth, and enhance the international competitiveness of the U.S. technology industry.

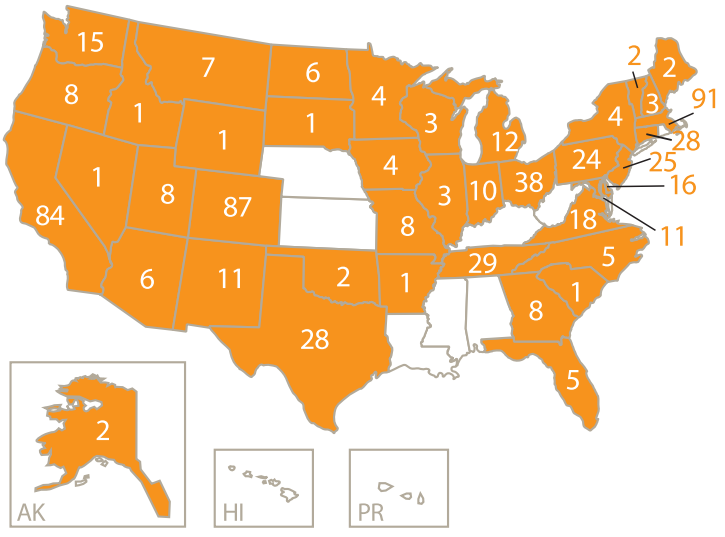
EPA's SBIR program focuses on important areas related to environmental protection, including clean air and water, hazardous and solid waste, pollution prevention, remediation and monitoring. Recent issues include bioterrorism, arsenic in drinking water, diesel emissions and stormwater runoff. The SBIR program's technology priorities come from the special needs of EPA's regional offices, as well as EPA and state regulatory and compliance needs.

Each year, EPA's SBIR program makes approximately 40 new (Phase I) awards for "proof of concept" and about 15 (Phase II) awards to further develop technologies. EPA tries to encourage new firms to take advantage of these opportunities and, in 2000 alone, nearly half of EPA's Phase I contracts were awarded to newcomers. Dozens of small businesses have successfully developed new technologies and products under the Agency's SBIR program.

The selection of SBIR winners includes a rigorous review to ensure that the projects meet EPA's needs and program priorities, have significant environmental benefits and have broad application and impact. Review begins with a technical peer review of the proposal by panels of experts not affiliated with the Agency. The care taken in the screening process has paid off in strong projects.

EPA's SBIR program works with similar programs in the U.S. Department of Energy, National Institutes of Health, U.S. Department of Agriculture, National Science Foundation and U.S. Department of Transportation. Also, SBIR and EPA's Environmental Technology Verification program are collaborating to help businesses develop the information needed for successful technology commercialization.

NCER has a total of 623 active grants in Small Business Innovation research.



"Dust Collector" for Particulate Emissions

Fine particulate matter, which is associated with adverse health effects, is difficult to remove from the gaseous waste streams of manufacturing plants. Most mechanical separators that can remove fine particles, such as electronic precipitators, are expensive and require extensive operation and maintenance. LSR Technologies, Inc, in Acton, Massachusetts, has developed a mechanical dust-collecting device called a Core Separator. This device is able to remove particles as small as one micrometer, much less than the particle size of 2.5 micrometers referenced in EPA's regulations. The Core Separator is compact, reliable, simple to operate, and easy to maintain. In 1996, the Core Separator was selected for the *R&D Magazine* prestigious R&D 100 Award as one of the world's best new technologies of the year. More than 65 units have been sold to companies in the United States and abroad.

Cleaning Up Indoor Air

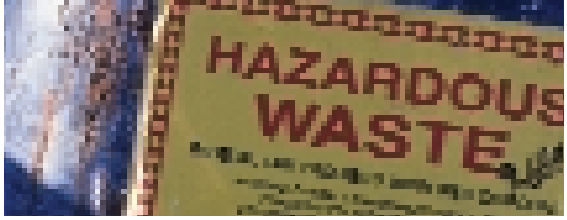
Recent events have caused an increased concern for the vulnerability of our buildings to chemical, biological and radiological threats. Atmospheric Glow Technologies (AGT) of Rockford, Tennessee, has developed and is commercializing an air filtration system designed to destroy all microorganisms, including anthrax and smallpox, in a matter of seconds using ionized gas or plasma. It is designed for commercial and residential heating, ventilation and air conditioning systems to produce no harmful byproducts or damage to sensitive materials. Since 2001, the company has been negotiating with various federal agencies to incorporate the technology into federal buildings and mass transit systems. AGT received one of *R&D Magazines* R&D 100 Awards and the U.S. Small Business Administration's 2001 Tibbett's Award for success.

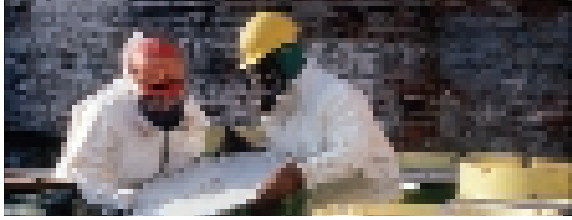
Detecting Lead in Paint

Lead is a naturally occurring metal that can be especially harmful to children under the age of six. Lead poisoning has been linked to reading and learning disabilities, IQ deficiencies and hyperactivity. NITON LLC, headquartered in Billerica, Massachusetts, has developed and commercialized a unique instrument to detect lead in paint that is rapid, compact, lightweight, accurate and effective regardless of paint composition, thickness or substrate. Called the NITON XL-309, the instrument can also be used to detect lead in soil, dust wipes and air filters. This instrument has become the industry standard for lead in paint analyses and can also be used for lead in soil. NITON received the *R&D Magazine* prestigious R&D 100 Award and Lead Tech Product of the Year Award in 1995.

Reducing Wastes From Metal Coating Processes

Metal surfaces are often coated with certain heavy metals, such as chromium and nickel, to protect them from wear and corrosion. Traditional coating involves electrochemical processes in large tanks filled with water and chemicals. Surface Treatment Technologies, Inc. of Baltimore, Maryland, has developed two environmentally friendly metal coating methods that reduce hazardous waste generation and provide efficient production using robotics and fiber optics. The U.S. Army is applying this technology to weapons manufacturing; it is also being used for aluminum engine cylinders. Applications to other metal and ceramic industries are under development.





Remediation

As of 2000, some 1,200 sites made toxic by contaminants such as lead and mercury, volatile organic compounds, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides and herbicides were on the EPA National Priority List (NPL). In addition, there are thousands of former manufacturing facilities and other sites known as Brownfields that represent a major challenge to and opportunity for national urban redevelopment.

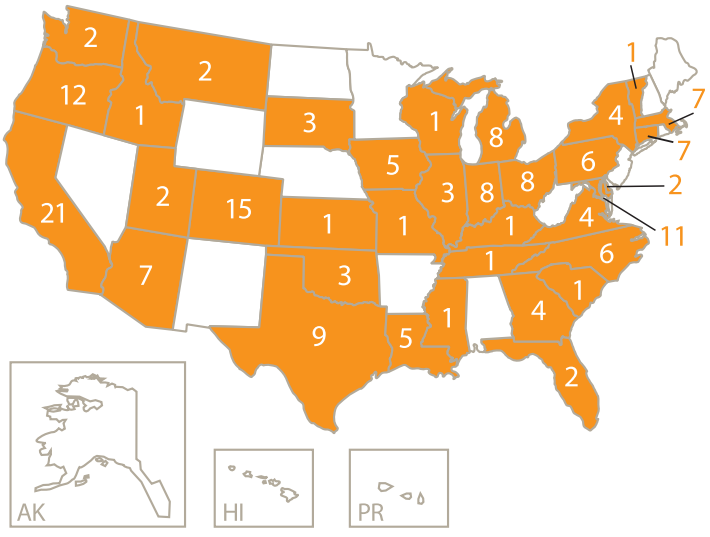
The cleanup of contaminated sites is a complex, costly and time-consuming process. One of EPA's objectives is to find cheaper, faster and better ways to remediate these contaminated sites to prevent harm to people and the natural environment and to restore them to uses appropriate for surrounding communities. To achieve this goal, STAR funds research in the detection, assessment and remediation of environmental contaminants.

The focal point of STAR's remediation research supports five multi-university Hazardous Substance Research Centers (HSRCs) that conduct research on the manufacture, disposal and cleanup of hazardous substances. The HSRC program was established in 1989 to conduct basic and applied research and has been designed to address remediation research needs at a regional level. The centers also disseminate research results, coordinate training and technology transfer and provide technical assistance and outreach to benefit communities, organizations, and individuals involved with hazardous substances management.

Seventy percent of the funding for the centers is directed toward hazardous substance research, and 30 percent goes to outreach. The outreach responsibilities of the centers include EPA's Technical Outreach to Communities and the Technical Assistance to Brownfields programs.

In addition to the HSRC program, NCER funds remediation research through other competitive programs. Fourteen grants have been awarded through a joint program in bioremediation with the National Science Foundation, U.S. Department of Energy (DOE) and the Office of Naval Research. Three phytoremediation grants were funded under a partnership with the National Science Foundation. Through these two interagency programs, more than $7 million has been awarded for research focusing on innovative, cost-effective alternatives for contaminant detection, assessment and remediation.

NCER has a total of 175 active grants in Remediation research.



In-place Groundwater Cleanup

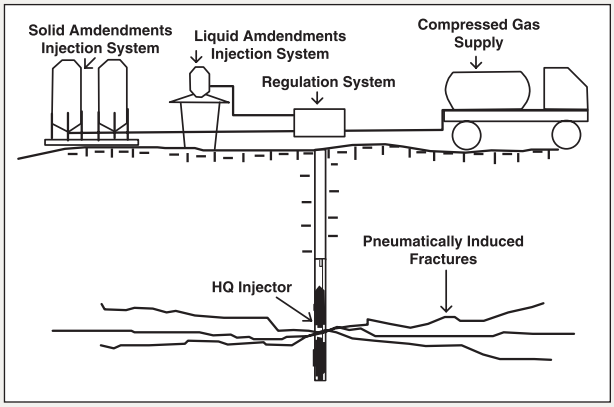
Removing contaminants from groundwater is difficult, and often the water must be pumped to the surface, treated and then returned. STAR researchers at the Western Region HSRC have shown that simple gas injection into a well can result in the *in situ* removal of volatile organic compounds (VOCs) from groundwater without bringing the water to the surface. This method volatilizes the VOCs and removes the contaminants as vapors. Significant cost savings are possible because this method does not require removal, handling, treatment and disposal of contaminated groundwater. Researchers have already proved the effectiveness of this technology in cleaning up groundwater contaminated with trichloroethylene at Edwards Air Force Base near Lancaster, California, and the Savannah River Site, a Department of Energy facility near Aiken, South Carolina.

Plants Soak Up Explosives

At abandoned military bases and munitions plants, undetonated explosives in the soil present a costly and difficult cleanup challenge. Phytoremediation, the use of plants to assimilate and detoxify hazardous substances, is one of the promising cleanup methods field tested by the South & Southwest HSRC. Researchers at this center designed, constructed and operated a pilot-scale plant lagoon to simulate field conditions that would occur during remediation of TNT-contaminated soil. The average amount of TNT removed by the aquatic plants was about 94 percent.

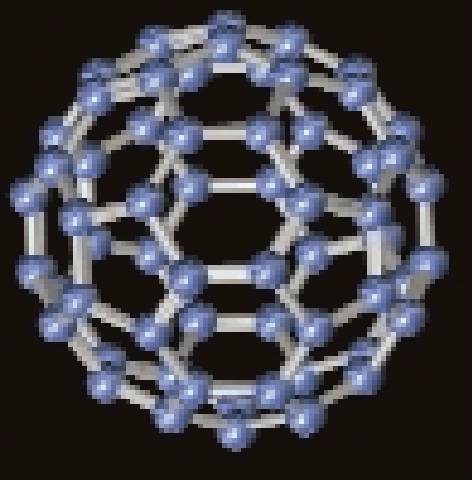
Accelerating Removal of Hard-to-Reach Contaminants

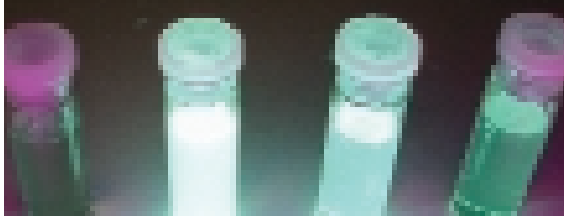
STAR researchers at the New Jersey Institute of Technology (NJIT) are using pneumatic fracturing with high-pressure air to help remove and treat contaminants from formations such as clay or certain rocks that resist conventional clean-up techniques. In cooperation with McLaren/Hart Environmental Engineers, NJIT has field tested the technology at McGuire Air Force Base, New Jersey, and a Kansas City, Kansas, industrial facility. The technology substantially improves the recovery of hard-to-reach contaminants and has been licensed by McLaren/Hart, Inc.

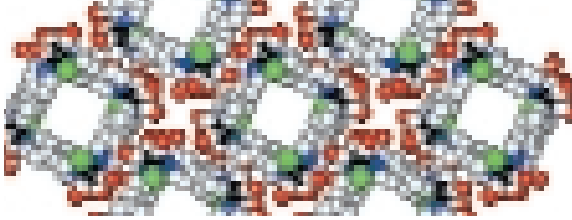


Strengthening Microbes Cuts Clean-up Costs

Some microbes can break down dangerous contaminants as effectively—and at far less cost—as other treatment systems. But the growth of these organisms often is inhibited by native bacteria in the groundwater where they are injected. In a field demonstration, STAR scientists at the Great Lakes/Mid-Atlantic HSRC found a way to give these bacteria a competitive advantage against the native species. By modifying groundwater contaminated with carbon tetrachloride, the non-native microbes were able to break down this pollutant at a cost four times cheaper than that required by conventional treatment methods.







Nanotechnology

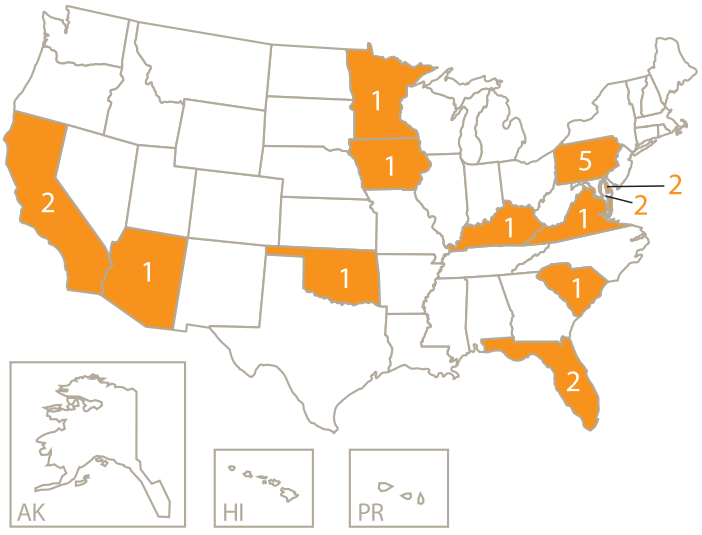
Nanotechnology can be described as the ability to work at the molecular level, atom-by-atom, to create structures with fundamentally new functions and characteristics. The structures created are at the nanometer scale—one billionth of a meter—but they are not so small that they can escape detection by a scanning tunneling microscope or an atomic force microscope. These tools not only see single atoms but, with a nanoscale-sized arm, can push and pull them into place, like putting up a building brick by brick.

Nanotechnology could make many products lighter, stronger, cleaner, less expensive and more accurate. It also has the potential to significantly improve environmental protection. Useful applications of this emerging technology could include revolutionary advances in sensors, waste treatment, remediation, manufacturing and pollution prevention–an environmental toolkit for the 21st century. The National Nanotechnology Initiative, an effort to coordinate nanotechnology research across the federal government, began in Fiscal Year (FY) 2001 and helped to double the funding for nanotechnology research from FY 2000 to FY 2001. EPA joined this effort in FY 2002 through its STAR grant program and participation in the government-wide Nanoscale Science, Engineering and Technology subcommittee.

STAR researchers are pursuing "green" nanotechnology that puts this fast-developing knowledge to work for a cleaner environment. Scientists and engineers are experimenting with nanocrystals that degrade contaminants, self-assembling nanolayers, nanotubes stronger than steel, protein machines that control the flow of tiny volumes of liquid and materials that change shape.

With a vision of nanotechnology that could lead to major advances in environmental protection come questions related to the potential environmental concerns that could be associated with this new technology. Could hazardous materials be released into the environment during nanotechnology manufacture, disposal or use? Could nano applications lead to biological harm by possibly accumulating in cellular material? STAR research grantees will begin to address these issues in FY 2003 under a request for applications on the environmental implications of nanotechnology. Research topics include toxicity, exposure and bioavailability, fate and transport, and transformation of manufactured nanomaterials. Future STAR research in this area should answer many of our questions and determine the utility of nanotechnology as a vital new tool for protecting the environment and human health.

NCER has a total of 20 active grants in Nanotechnology research.

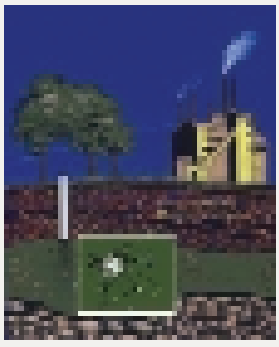


Detecting Toxic Metals in Drinking Water

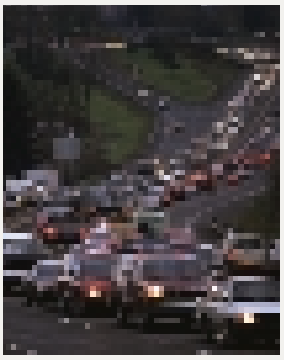
Exposure to arsenic and chromium are associated with skin changes, blood vessel damage, reduced nerve function, increased cancer risk and irritation of the stomach and intestines. While about 80 percent of U.S. water supplies have less than two parts per billion (ppb) of arsenic, two percent of supplies exceed twice EPA's allowable limit of 10 ppb. Chromium concentrations are more difficult to measure. STAR researchers at the University of California-San Diego are developing new, selective, solid-state sensors that use nanotechnology to detect toxic forms of chromium and arsenic in water. The sensors are being designed to provide real-time, remote detection to facilitate the process of monitoring and treating these pollutants.

Cleaning Up Groundwater

Cleaning up groundwater and subsurface environments is often difficult, expensive and time consuming. STAR researchers at Lehigh University are optimizing the synthesis of nanosized particles for use in groundwater cleanup. Field demonstrations have shown that nanoparticles injected into a groundwater plume containing chlorinated organic contaminants can reduce the contaminant levels by up to 96 percent. The potential benefit of this technology for remediation stems from the fact that it is portable, the nanoparticles are highly reactive, and it can be scaled to fit the pollution problem. This technology could be used for a wide variety of common contaminants, including chlorinated hydrocarbons, pesticides, explosives and other toxic contaminants.



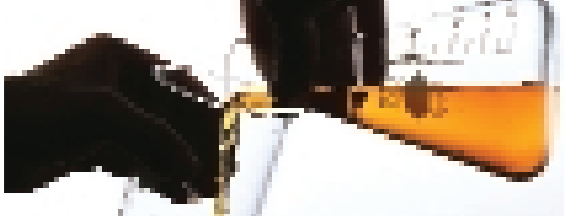
Reducing Air Pollution

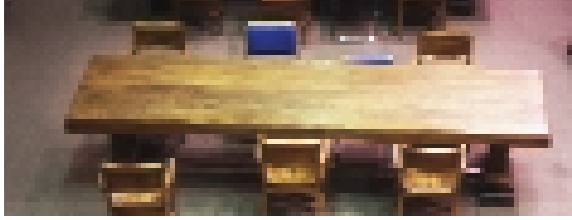


Nitrogen oxides (NO_x) are greenhouse gases, components of particulate matter and contributors to ground-level ozone. In addition, these compounds contribute significantly to acid rain and pollution in water bodies caused by too many nutrients. While five of the six priority air pollutants regulated by EPA have decreased, NO_x has increased approximately 10 percent since 1970. STAR researchers at the University of Delaware are studying the potential of nanotechnology to treat automobile exhaust gas by replacing the expensive platinum group metals in catalytic converters with nanomaterials. These materials are more effective and less expensive for reducing NO_x emissions. 1999 NO_x Sources.

Improving Methods for Pollution Reduction

Zeolites are crystal-shaped minerals widely used as catalysts in a processes for reducing pollution or sensing contaminants. Researchers with the University of Iowa are synthesizing nanosized zeolites for use in environmentally benign catalytic reactions. These zeolite structures are much smaller than the conventional ones, providing enhanced features including easier adsorption and desorption properties, optical transparency and the ability to form dense films useful for many separations applications. In the automotive and chemical industries, these zeolites can be used as catalysts to reduce NO_x emissions; for the photocatalytic decomposition of volatile organic compounds; and for the development of real-time, accurate, sensors that can operate at extremely low detection levels.





Fellowships

One of NCER's highest priorities is ensuring that we have an adequate and well-trained scientific workforce that can address tomorrow's complex environmental issues. To respond to this need, NCER supports several fellowship programs focusing on current and future environmental professionals.

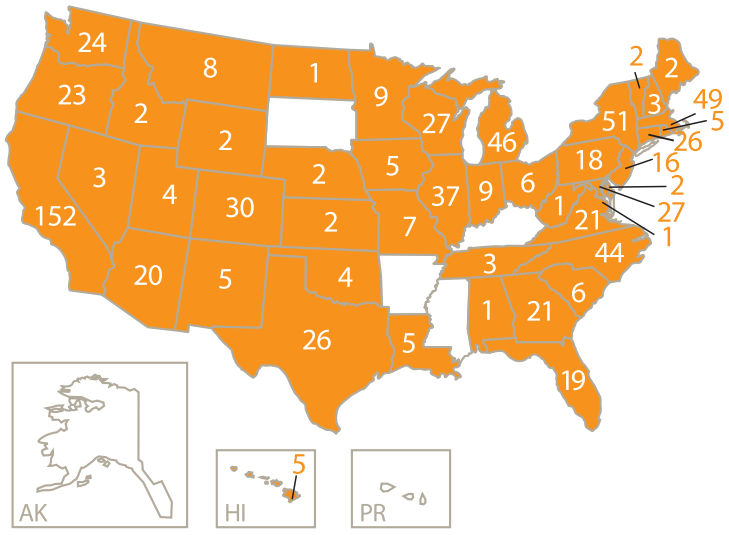
The STAR Graduate Fellowship Program supports some of the nation's most promising masters and doctoral candidates. More than 1,300 applicants compete each year for approximately 100 fellowships through a rigorous merit review process. Students can pursue degrees in traditionally recognized environmental disciplines as well as other fields such as social anthropology, urban and regional planning and decision sciences.

Recognizing that there is a disparity between the percentage of minority students in the national population and the number of minority students pursuing degrees and career in environmental fields, NCER strongly encourages promising students to apply to all of the fellowship programs offered by EPA. In addition, the Greater Research Opportunities (GRO) program helps to build capacity in universities with limited funding for research and development by awarding both undergraduate and graduate fellowships to students studying in environmental fields.

Policy-makers are often criticized for making decisions that are not fully based on sound science. To address this charge, NCER supports the Science and Engineering Fellows Program, which places highly qualified, articulate, technical professionals in EPA headquarters for up to two years. They develop a better understanding of the needs of decision-makers and learn how to make their own future research more meaningful to the regulators who depend upon it. Meanwhile, decision-makers gain a greater understanding of how science works and how to communicate with the technical community.

NCER monitors its fellowship programs to ensure that they continue to address our most important environmental workforce needs. Program goals for the future include reviewing the disciplines for the STAR fellowship program and developing an additional fellowship program to address the growing need for environmental health professionals with medical experience.

From 1995 to 2001, the STAR Fellowship Program has awarded 784 fellowships to students across the country.



NCER Fellows Shine

Andrea Huberty, a STAR fellow at the University of Maryland, was awarded the John Henry Comstock Award at the Entomological Society of America Eastern Branch meetings in March 2003. Each of the five branches of the Entomological Society selects one outstanding graduate student to receive this highly competitive award in recognition of his/her achievements and excellence during his/her graduate career. Ms. Huberty's work has been published in *Nature*, the *Journal of Applied Physiology*, *American Naturalist*, *Ecology*, and *American Entomologist*. Ms. Huberty specifically credits the STAR Graduate Fellowship program for her success.

Cristina Rumbaitis-del Rio is a STAR graduate fellow pursuing her Ph.D. in forest ecology at the University of Colorado at Boulder. Her research, showing that damage to forests from catastrophic wind storms is less of a threat than the salvage logging that usually follows such storms, has challenged traditional forest management assumptions. Ms. Rumbaitis-del Rio studied tree "blow-down" in the 25,000-acre Routt National Forest of Northern Colorado, where millions of trees were toppled and uprooted during a storm in October 1997. She presented her findings at the fall 2002 meeting of the American Geophysical Union.

The research of former STAR graduate fellow **Erika S. Zavaleta, Ph.D.** is attracting attention in the world of integrative and evolutionary biology. As a result of her dissertation research on the influences of climate and atmospheric changes on a grassland habitat, she was awarded a David H. Smith Environmental Research Fellowship from The Nature Conservancy. The purpose of the fellowship is "to sponsor outstanding young scientists with whom it is truly exciting to interact." For her new fellowship project, Dr. Zavaleta is working with renowned population biologist Carla D'Antonio on "the biodiversity effects of adding and removing single invaders in exotic-dominated systems: *Genista monspessulana* in California coastal prairies."

STAR fellow **Chad Hammerschmidt** used the Long Island Sound as a "nearshore laboratory" to discover some striking results about methylmercury, a significant contaminant of shell and fin fish that poses serious health risks to humans and all other life forms. Mr. Hammerschmidt presented his preliminary findings at the National Meeting of the American Chemical Society in April 2002 and four other society meetings. He was awarded Best Graduate Student Presentation at the Annual Meeting of the New England Estuarine Research Society in Groton, Connecticut, in October 2002.

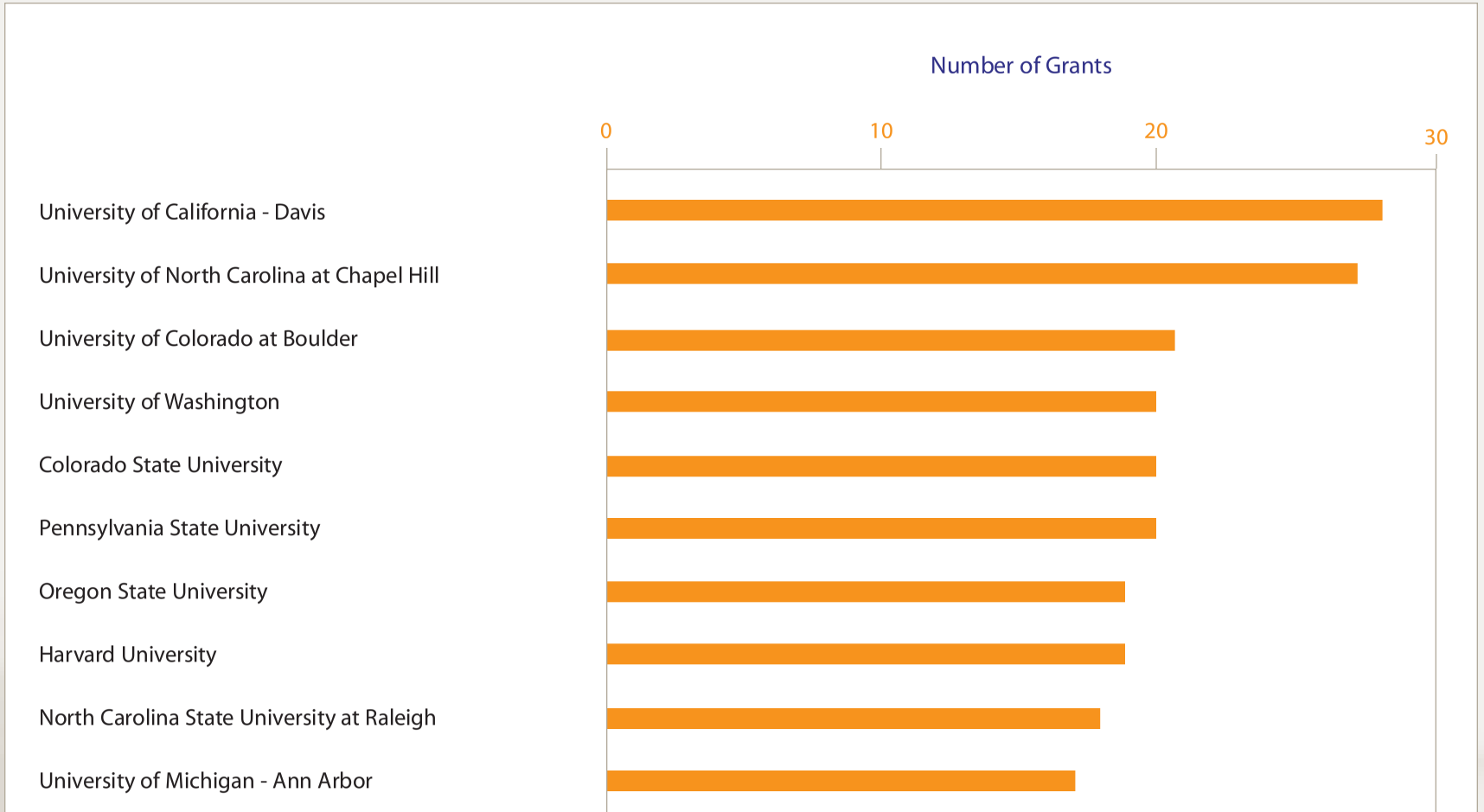
As part of her work as an American Association for the Advancement of Science (AAAS) fellow in NCER, **Tina Masciangioli, Ph.D.** published an article in the March 1, 2003 edition of *Environmental Science and Technology*—the premier publication on current and emerging research, technology and policy trends in the environment. The article, "Environmental Technologies at the Nanoscale," is a comprehensive and highly readable account of the current status of research in this revolutionary new field. Dr. Masciangioli speculates about the potential benefit of nanotechnology for several areas of environmental protection including pollution prevention, remediation and detection methods.

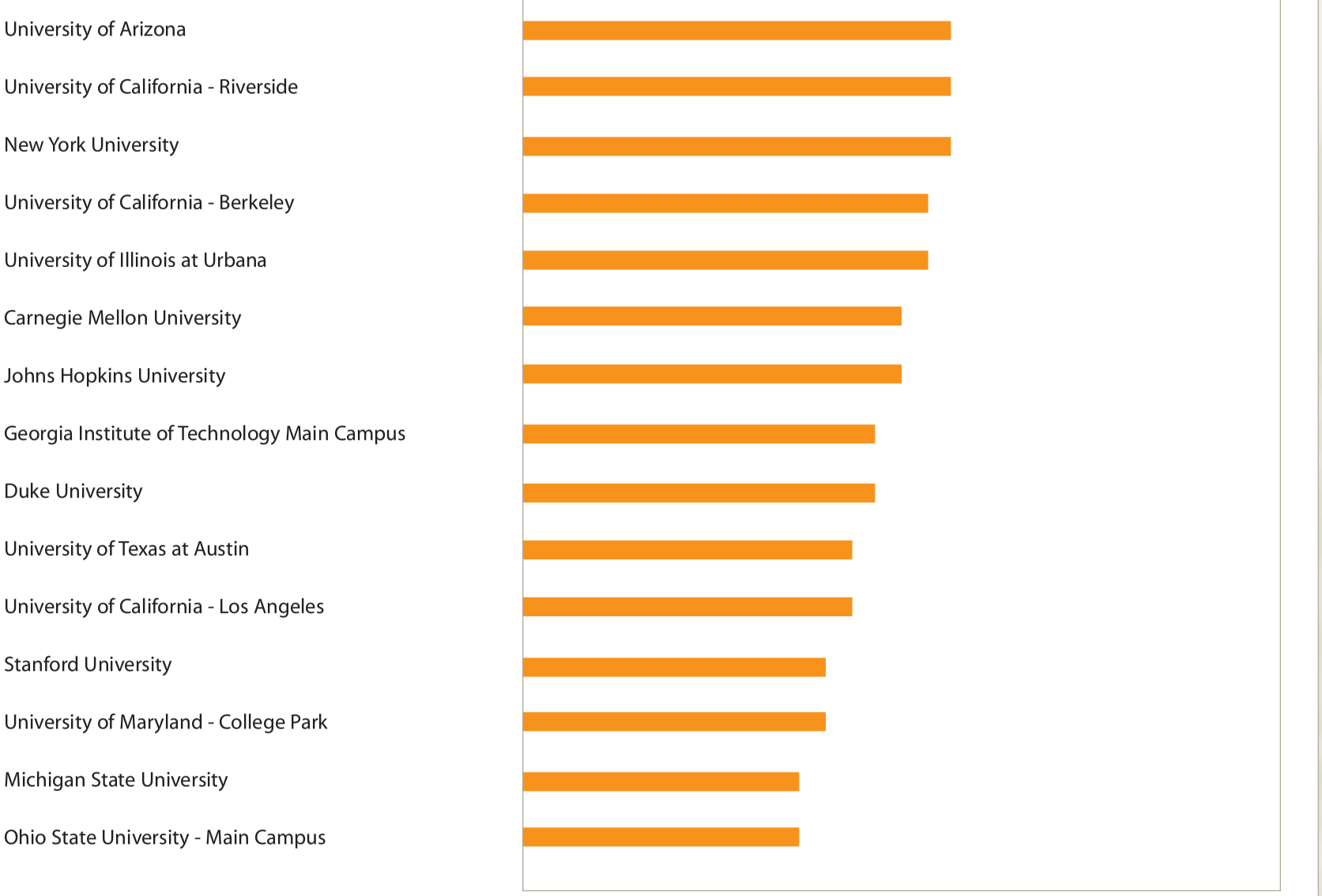
Na'Taki Osborne decided to pursue a career in environmental protection based on her experiences as an EPA Minority Academic Institutions (MAI) fellow while an undergraduate at Spelman College. She received her master's in Environmental and Occupational Health at Emory University and since then co-founded the Center for Public Awareness, a nonprofit environmental education and leadership development training organization. She currently works as a Sustainable Communities Organizer with the National Wildlife Federation. Among her many honors, in 1997 she received the Presidential Environmental Service award, and her work has been featured in prominent national magazines.

Appendix A

25 Universities Receiving the Largest Number of Grants

The STAR grant awards are highly competitive, attracting researchers from many of the top universities in the nation. The table below lists a diverse group of institutions that have received the largest number of grants since the beginning of the STAR program.




University of Arizona
University of California - Riverside
New York University
University of California - Berkeley
University of Illinois at Urbana
Carnegie Mellon University
Johns Hopkins University
Georgia Institute of Technology Main Campus
Duke University
University of Texas at Austin
University of California - Los Angeles
Stanford University
University of Maryland - College Park
Michigan State University
Ohio State University - Main Campus

Appendix B

1995-2001 STAR Graduate Fellowships

From 1995 to 2001, the STAR Graduate Fellowship Program supported some of the nation's most promising masters and doctoral candidates by awarding 800 fellowships in traditionally recognized environmental disciplines, as well as in other related fields, such as urban and land use planning and decision sciences.

Discipline	Number of Fellowships
Atmospheric Sciences	12
Chemistry	41
Earth Sciences	49
Ecology	194
Economics	50
Engineering	127
Entomology	11
Environmental Science	10
Forestry/Botany	14
Geography	21
Health/Risk Assessment/Toxicology	82
Math & Statistics	7
Molecular Biology/Genetics/Microbiology	35
Natural & Life Sciences	4
Oceanography/Marine Sciences	37
Social Sciences	64
Urban & Land Use Planning	18
Zoology	24

Highly Cited STAR Researchers

The Institute for Scientific Information (ISI) has identified the following NCER-sponsored researchers as "Highly Cited Researchers." The citing of scientific papers is an important benchmark used to determine the progress and the state of scientific research. Inclusion in ISI's list is a distinct honor signifying the influence of the cited researcher's work. To learn more about ISI and how the list is compiled, please visit <www.isihighlycited.com>.

Aber, John D.
Abriola, Linda M.
Anderson, James G.
Arey, Janet
Bollag, Jean-Marc
Brusseau, Mark L.
Cass, Glen R.
Driscoll, Charles T.
Edwards, Gerald E.
Ehrlich, Paul R.
Eisenreich, Steven J.
Estes, Mary Clarke Kolb
Galloway, James Neville
Giesy, John P.
Grosjean, Daniel
Hamers, Robert J.
Hites, Ronald Atlee
Hornberger, George M.
Huston, Michael A.
Jacob, Daniel J.
Katritzky, Alan R.
Kitanidis, Peter K.
Klaassen, Curtis Dean
Komarneni, Sridhar
Landrum, Peter F.
Lauenroth, William K.
Likens, Gene E.
Lindberg, Steven E.
Lioy, Paul J.
Lippmann, Morton
Logan, Jennifer A.
Luthy, Richard G.
McCarty, Perry L.
McCullagh, Peter
Murdoch, William W.
Neuman, Shlomo P.
Nriagu, Jerome O.
Pankow, James F.
Paquette, Leo Armand
Parton, William J.
Patrick, William Hardy
Pielke, Roger A.
Pignatello, Joseph J.
Raskin, Ilya
Reddy, K. Ramesh
Reinhard, Martin
Rittmann, Bruce E.
Roberts, Paul V.
Safe, Stephen H.
Schwartz, Joel David
Seinfeld, John H.
Shugart, Herman H.
Simoneit, Bernd R.T.
Speizer, Frank E.
Spengler, John D.
Tiao, George C.
Tiedje, James M.
Turco, Richard P.
Weber, Walter J.
Wierenga, Peter J.
Winer, Arthur M.
Zepp, Richard G.

Appendix D

NCER Partners and Associated Research Topics

Since its inception, NCER has leveraged its resources through partnerships with other federal agencies and private sector organizations to allow 35 percent more grants than would be possible with EPA resources alone.

Year	Topic	Partners
1995	Decision Making and Valuation for Environmental Policy; Technology for a Sustainable Environment; Water and Watersheds	National Science Foundation
1996	Bioremediation	Department of Energy National Science Foundation Office of Naval Research (Department of Defense)
1997	Arsenic Health Effects	American Water Works Association Research Foundation Association of California Water Agencies
	Terrestrial Ecology and Global Change	Department of Energy National Science Foundation National Aeronautics and Space Administration U.S. Department of Agriculture
	Harmful Algal Blooms	National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research (Department of Defense)

Year	Topic	Partners
1997 Continued	Bioremediation	Department of Energy National Science Foundation Office of Naval Research (Department of Defense)
	Ecosystem Restoration	National Aeronautics and Space Administration
	Water and Watersheds; Technology for a Sustainable Environment; Decision Making and Valuation	National Science Foundation
1998	Hexavalent Chromium	American Electroplaters and Surface Finishers
	Ecological Effects of Environmental Stressors	National Oceanic and Atmospheric Administration National Aeronautics and Space Administration
	Environmental Statistics	National Science Foundation
	Water and Watersheds	National Science Foundation U.S. Department of Agriculture
	Children's Health Chemical Mixtures	National Institute of Environmental Health Sciences
	Technology for a Sustainable Environment; Decision Making and Valuation	National Science Foundation
	Bioremediation	Department of Energy National Science Foundation

Appendix D - NCER Partners and Associated Research Topics (cont'd)

Year	Topic	Partners
1998 Continued	Bioremediation	Office of Naval Research (Department of Defense)
	ECOHAB/Algal Blooms	National Oceanic and Atmospheric Administration National Aeronautics and Space Administration National Science Foundation Office of Naval Research (Department of Defense) U.S. Department of Agriculture
1999	Endocrine Disruptors	National Institute of Environmental Health Sciences Department of the Interior National Oceanic and Atmospheric Administration Office of Science and Technology Policy
	Decision Making and Valuation; Environmental Statistics; Water and Watersheds; Technology for a Sustainable Environment	National Science Foundation
	ECOHAB/Algal Blooms	U. S. Department of Commerce National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research (Department of Defense) National Aeronautics and Space Administration

Year	Topic	Partners
1999 Continued	Environmental Justice	National Institute of Environmental Health Sciences U. S. Department of Commerce National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research (Department of Defense) National Aeronautics and Space Administration
	Cancer Risk Assessment Methods	National Institute of Occupational Safety and Health
	Genetic Susceptibility	National Institutes of Children's Health and Human Development/National Institute of Dental and Craniofacial Research National Institute of Environmental Health Sciences
2000	Environmental Indicators	National Aeronautics and Space Administration
	Environmental Statistics	National Science Foundation
	Complex Chemical Mixtures	National Institute of Occupational Safety and Health National Institute of Environmental Health Sciences
2001	Endocrine Disruptors	National Institute of Occupational Safety and Health

Appendix D - NCER Partners and Associated Research Topics (cont'd)

Year	Topic	Partners
2001 Continued	Endocrine Disruptors	Centers for Disease Control and Prevention National Cancer Institute National Institute of Environmental Health Sciences National Institutes of Health
	Technology for a Sustainable Environment; Decision Making and Valuation	National Science Foundation
	Children's Health	National Institute of Environmental Health Sciences
	Phytoremediation	National Science Foundation Office of Naval Research (Department of Defense) Strategic Environmental Research and Development Program
	ECOHAB Algal Blooms	National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research, (Department of Defense) National Aeronautics and Space Administration
	Ecological Indicators	National Aeronautics and Space Administration
2002	Nutrient Science/Watershed Management	U.S. Department of Agriculture

Year	Topic	Partners
2002 Continued	ECOHAB Algal Blooms	National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research (Department of Defense) National Aeronautics and Space Administration
	Decision Making and Valuation	National Science Foundation
2003	ECOHAB Algal Blooms	National Oceanic and Atmospheric Administration National Science Foundation Office of Naval Research, (Department of Defense) National Aeronautics and Space Administration
	Technology for a Sustainable Environment; New Technologies for the Environment	National Science Foundation
	Children's Health	National Institute of Environmental Health Sciences

For More Information

For more information about the National Center for Environmental Research, please visit our website at <www.epa.gov/ncer>. This comprehensive and interactive site has current information about research opportunities, grants and fellowships. You can browse our database of projects and use keywords to search abstracts, progress reports and annual reports of current and past projects. To order hard copies of this document, please contact:

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