

USGS Contaminant Biology Program Review
Steering Committee Report
Skamania Lodge February 24-28, 2002

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Executive Summary

The Contaminants Program conducts research, assessments and monitoring to provide the nation and its natural resource managers with information on the exposure, effects and fate of deleterious substances in the environment. The review of the Contaminants Program took place at Skamania Lodge in Stevenson, Washington on February 24-28, 2002. Based on the meeting, the Steering Committee and participants at the Review refined the interim goals into new goals and objectives for the Contaminants Program:

GOAL: Provide scientific information to protect and restore the Nation's biotic resources from the effects of environmental contaminants.

OBJECTIVES: Describe the causes and effects of environmental contamination of biota and habitats, specifically:

- I. Develop methods and determine the biological effects and exposure of environmental contaminants in organisms;
- II. Evaluate the effects of contaminants in the context of other biotic and abiotic stressors;
- III. Evaluate the effects of environmental contamination at multiple levels of biological organization and across spatial and temporal scales;
- IV. Communicate scientific information to resource managers, regulatory agencies, policy makers and the public.

Based on breakouts, discussions, and presentations at the review, the Steering Committee recommended increased scientific emphasis in these areas:

- **Emerging Contaminants** - Basic toxicology and analytical methods are needed for contaminants that are emerging as problems for biota. A workshop could prioritize a list of compounds for study, enhance communication among USGS scientists and coordination of program planning activities, coordinate analytical method development and identify facilities with research and/or service capabilities.
- **Criteria and standards** - Research is needed to evaluate the adequacy of criteria and standards for endangered species, and to develop protective criteria and standards if none currently exist.
- **Underrepresented species** - Better methods and data for toxicity to underrepresented species especially those threatened by known contaminant issues, such as freshwater mussels, crayfish, amphibians, and reptiles are needed to compare the sensitivity of these species to that of surrogate species, and begin to develop the physiological basis for predictions about the comparative sensitivity of untested species.
- **Biomarkers** –Standardization, information on variability of results, influence of other environmental stressors, specificity of species response, and effects of other factors are needed in order to increase confidence in biomarkers and determine the utility of particular biomarkers in the field. Biomarkers of interest include not only those methods applicable to organisms (genetic, genomic, molecular, cellular, physiological), but also to higher levels of biological organization (populations, communities, and ecosystem processes).
- **Joint demonstration projects** that bring together needed expertise from multiple disciplines and Programs across USGS, especially the Ecosystem Program, should be developed to further evaluate relationships between field and laboratory toxicity testing results and effects at the population and system level. Data from traditional biomarkers should be compared to population studies and newer biomarkers of ecosystem effects in a showcase demonstration site or sites. A workshop to discuss the demonstration project and the range of ecosystem processes that would be suitable as toxicological biomarkers should be explored.

- **Contaminant interactions** - Experimental data on interactions between contaminants and other stressors, and among chemicals is needed to allow scientists to place environmental contamination in context, and to broaden the suite of approaches for management and remediation of contaminated sites. Incorporation of ecological models that link contaminant exposure to ecosystem-level responses would be an important step. A synthesis of existing information is needed to help focus future research in this area.
- **Energy Research** -The Contaminants Program should increase its focus on energy exploration, development, production and use on federal lands. In collaboration with other Biological Programs, the Energy Resources Program, and land management agencies, enhanced research is needed on toxicity and decontamination of coal bed methane wastewater, drilling muds and other byproducts, along with other ecological effects of energy development. An interagency workshop on the conversion of coal-bed methane wastewater is needed.
- Improve understanding of established contaminant threats, such as-monitoring of delisted species whose listing was based on toxicity, and faunal groups that show population decline nationally, such as Amphibians or regionally, such as sea ducks. Known contaminated habitats include abandoned mine lands, and the widespread hypoxia in the Gulf of Mexico.
- **Hazardous waste sites:** Standardized methods, improved toxicological information (including toxicokinetics), better ways to estimate exposure, better methods to incorporate ecological processes (e.g. energy dynamics, carbon and nitrogen cycling, primary productivity and decomposition), improved monitoring strategies and techniques and better ways to determine if restoration is successful are needed.
- **Improve effectiveness of monitoring and interpretation** of results with better data management procedures, a database containing the locations and types of biotic and abiotic samples that are archived, a more diverse suite of endpoints like sentinel species, and methods for monitoring of particular habitats, like uplands. Enhancement of efforts to analyze and synthesize contaminant data at different temporal and spatial scales is needed to help identify data gaps like geographic blind spots. Closer cooperation and collaboration between monitoring efforts in different Programs of the USGS will help to link exposure and effects.

The committee made the following programmatic recommendations:

1. **Endorse strong Program coordination** that facilitates program planning and project development, enhances teamwork within contaminants personnel, facilitates coordination across disciplines, identifies new issues, budget initiatives and other funding activities, synthesizes programmatic/institutional needs, and advocates for a strong Contaminants Program.
2. **Develop and maintain a highly skilled work force and cutting edge facilities.**
3. **Hire new scientists.** Half the contaminants biologists at PWRC are eligible to retire today; and half the contaminants biologists at CERC will be eligible to retire within five years.
4. Continued **training of scientists** will maintain the expertise and diversity of skills critical to a capable workforce. This can be accomplished through training courses

- at SETAC and elsewhere, including exchanges of personnel, periodic short stays at other laboratories, to learn new skills and develop closer relations with new researchers, or sabbaticals.
5. **Communication:** The Program should facilitate enhanced interaction and collaboration among scientists within Contaminants and elsewhere in USGS. A **series of workshops** that includes contaminants personnel, scientists from other relevant disciplines and partners would do much to foster these links. Workshop topics specifically discussed at the review include Water Quality Criteria, coal bed methane, emerging contaminants, and a contaminated ecosystem demonstration project.
 6. Centers should continue to invest in **capital equipment, skills and facilities** to maintain scientific excellence. For instance, the rapidly expanding field of genetics and genomics has great potential to enhance our ability to understand the effects of contaminants at the population level, and we need to consider how we might best use it to enhance our understanding of contaminant effects.

Contaminant Biology Program Review

Introduction

The Contaminants Program conducts research, assessments and monitoring to provide the nation and its natural resource managers with information on the exposure, effects and fate of deleterious substances in the environment.

The USGS is engaged in contaminants research in order to provide information on the cause, severity or geographic extent of exposure and effects to biotic resources and ecosystems. Biotic resources are threatened by a wide array of environmental contaminants and toxins. Mercury and other combustion byproducts deposit in our fields and streams from the air. Biologically active pharmaceuticals and runoff from urban and suburban areas elude treatment and are discharged into waterways. Pesticides, industrial chemicals, mine tailings and contaminated agricultural drainwater drift, leach or flow into nearby habitats. Nutrient-sparked algal blooms exude toxins that kill fish. These pollutants are the primary focus of the Contaminants Program. The Department of the Interior (DOI) needs this information to understand and mitigate problems that affect the lands and species that it manages in Trust for the American people. The populations of Trust Species and habitats are threatened and diminished by many forces, and the species and habitat that remain must be managed to sustain healthy populations.

Review Description

The Review of the Contaminants Program was the fourth in the first cycle of programmatic reviews conducted by the Biology Discipline of the US Geological Survey. The purposes of the review were to:

- Assess the accomplishments of the Contaminants Program and evaluate the success of BRD science in meeting the interim goals of the Program.
- Update goals, objectives and priorities of the Program
- Determine the significance and relevance of BRD science
- Enhance communication and collaboration among BRD scientists
- Provide opportunities for budget and program development

The review took place at Skamania Lodge in Stevenson, Washington on February 24-28, 2002. In preparation for the review, the Steering Committee, comprised of USGS scientists and managers, organized the program into several major categories. These categories were the organizing principle for capstone presentations during the review, and will serve as the structure for the Program in the future.. At the review, an external Review Panel reviewed material organized by the Steering Committee and prepared and presented by scientists and managers within the Program. Approximately 90 people attended the meeting, including scientists from the program, managers, USGS collaborators and external partners.

The agenda included an opening plenary session, capstones, which summarized the work of the program, and related Breakout sessions and Case Studies of particular projects. The plenary included presentations by the Associate Director and the Chief Scientist for Biology, and the Program Coordinator for the Contaminants Program and panel discussions by representatives of partner agencies, and by other disciplines within USGS. On the final day, the breakout leaders summarized their sessions and the Steering Committee and Review Panel reviewed their findings. Appendix B contains the agenda for the Review.

Steering Committee Members

Dr. Jill Baron - Midcontinent Ecological Science Center
 Herb Buxton - Office of Water Quality
 Dr. Christine Custer - Upper Midwest Environmental Sciences Center
 Dr. John French - Patuxent Wildlife Research Center
 Dr. Sarah Gerould (Program Coordinator) - Headquarters Science Staff
 Dr. Chuck Henny - Forest and Rangeland Ecosystem Sciences Center
 Dr. Chris Ingersoll - Columbia Environmental Research Center
 Mr. Tom Muir, (Review Coordinator) - Headquarters Science Staff
 Dr. Reynaldo Patino - Texas Fish and Wildlife Cooperative Research Unit

Review Panel

Steve Schwarzbach, Chair - U.S. Fish and Wildlife Service,
 William Benson - Director, National Health and Environ. Effects Research Lab., Gulf Breeze Division
 Kathleen M. Johnson USGS Program Coordinator, Mineral Resources Program
 Derek Muir -Environment Canada

John Stein - NOAA- Northwest Fisheries Sciences Center
Alan Steinman - Robert B. Annis Water Resources Inst.

Contact information for the Review Panel and Steering Committee Members may be found in Appendix G.

Panel of Partners

A panel of representatives from partner agencies provided information on the scientific needs of the partner Agency or Bureau. Bob Alverts from Bureau of Land Management (BLM), Bill Jackson from National Park Service (NPS), George Noguchi from U.S. Fish and Wildlife Service (FWS), and Wayne Munns from U.S. Environmental Protection Agency (EPA) were represented on the panel. Written statements from each panelist may be found in Appendix C.

Bureau of Land Management - Bob Alverts described science needs of BLM that are related to contaminants. He described BLM's involvement in the Federal Energy Policy and the high priority BLM places on science needs related to accelerated development of energy reserves on BLM lands. The BLM needs technical assistance and research that is often in a rapid response mode. Specific capabilities and tools include toxicology capability to assist with needs on demand, and applied science techniques to address soil and water contaminants. Land management issues of particular interest to BLM and for which the Contaminants Program has expertise are acid mine drainage (e.g., arsenic and heavy metals), mine reclamation and restoration, particularly of mercury contamination, off-site disposal versus on-site repositories, and coal bed methane. BLM also cited the need for passive, low cost, low maintenance water treatment systems for coal bed methane.

National Park Service - Bill Jackson discussed the needs of NPS related to contaminants. Information on hazardous materials and ecological risk assessment are needed to support protection of the parks and regulatory responsibilities related to National Environmental Protection Act, Natural Resource Damage Assessment and Restoration (NRDAR), monitoring associated with the Clean Water Act and reclaiming costs associated with damages from chemical spills. NPS also needs better information to understand the effects of energy development for oil and gas, and abandoned minelands. The Air Quality Division seeks better information on the effects of air pollutants on park ecosystems. Bill specifically mentioned site-specific assessments of contaminant problems in parks, cleanup standards that support Park purposes, bioremediation of hazardous chemicals and ecosystem monitoring. Bill illustrated NPS research needs with a list of sixteen specific proposals. Of the sixteen, seven concerned assessment of fish contamination, and five out of the sixteen involved mercury in fish. Mixtures of organic chemicals (emerging contaminants), for which little toxicity information exists, were the focus of five of the proposals. Hazardous waste sites were the subject of six proposals, of which three involved oil and gas. Three proposals

involved watercraft and two proposals centered on abandoned mines. NPS would welcome a more formalized process for identifying and addressing Park contamination research needs. He noted that success of the water quality assessment partnership in this regard was in part due to dedicated funds for the issue.

U.S. Fish and Wildlife Service - George Noguchi discussed the importance of information to support FWS activities in prevention, assessment and remediation. The Bureau is required to meet the regulatory requirements of the Endangered Species Act (ESA), Migratory Bird Treaty Act, Fish and Wildlife Coordination Act, and National Wildlife Refuge System Improvement Act. Regulatory and legal requirements drive FWS activities related to refuge contamination, integrated pest management, preacquisition surveys, spill response, irrigation drainwater, TMDLs, NRDAR and law enforcement. The FWS needs enhanced information related to risk assessment, ESA consultations on Water Quality Criteria and pesticides, effects of mixtures of chemicals, development of sediment and wildlife criteria, determination of how clean is clean in restoration, biomarkers of exposure and effects, implications of cellular and molecular biomarkers for higher levels of organization, fate and effects of new pesticides, comparison of laboratory and field effects, chemical analysis and sampling devices, toxicity and fate of emerging contaminants, and long-term monitoring (BEST).

U.S. Environmental Protection Agency - Wayne Munns introduced portions of EPA's ecological research program and the current collaborations and research needs that would meet several common goals of EPA and USGS related to environmental monitoring and protection of fish and wildlife species. He emphasized the need to consider risks of contaminants in the context of multiple stressors in real landscapes. Core methods are needed to assess risks to populations of wildlife and aquatic species that support development of chemical criteria for environmental regulation. Development of methods for extrapolating across species, endpoints, and stressors will help reduce the need for new data collection. Approaches for defining ecologically significant adverse effects will help answer the "so what" question of toxicity testing and responses measured in the field. Methods are also needed to diagnose and predict risks of chemical and non-chemical stressors, including habitat alteration, in combination. Wayne also indicated the value of monitoring and assessment approaches and data to characterize resource condition.

Capstone Presentations

The capstones talks summarized the research efforts of the Contaminants Program. Each capstone presented an overview of the topic by defining the range of projects, the reason for conducting them, quantifying the level of effort, and identifying major themes, gaps strengths and future potential for the endeavor. The capstones reflected the various organizing principles used in studies of contaminants. The titles of the Capstones were:

Environmental Toxicology and Chemistry

Contaminated Habitats: Urban Wastewater, Mining and Metals, Biological and Chemical Controls and Agriculture, and Industrial

Integration of Ecological Stressors

Species Decline

Ecosystem Level Effects

Monitoring and Assessment

Environmental Toxicology and Chemistry Studies are basic scientific building blocks: toxicological and analytical methods that are fundamental to the entire program. Habitat scale studies of contaminated sites that may integrate multiple stressors are grouped by the source of contamination: urban wastewater, mining, agriculture, and industry. Integration of Ecological Stressors include studies at coarser geographic scales, and is divided by level of ecological organization into two categories, Species Decline and Ecological Level Effects. The latter includes studies at the community or ecosystem level of organization. Studies with a temporal focus and assessments based on available data are grouped into Monitoring and Assessment. More detail on the composition of the capstones may be found in Appendix D.

Case Studies

Case studies were selected for inclusion because they represented good examples of the diversity of work that is done in the Contaminants Program. A list of the case studies can be found in Appendix B.

Poster Sessions

Posters were presented at two sessions and clustered corresponding Capstones presentations in each half of the program. A complete listing of the Posters may be found in Appendix E. Poster abstracts can be found at http://contaminants.usgs.gov/whats_new.htm

Breakout Groups and Goal Setting

The breakout sessions allowed Review participants to examine and discuss the status and future of the Contaminants Program by providing input to the development of goals that will guide the Contaminants Program in the development of the 5-year plan. Each of the Capstones was associated with one or more breakout sessions, as follows:

Capstone	Breakout Group
Environmental Toxicology and Chemistry	Wildlife Toxicology

	Aquatic Toxicology (aquatic, sediment, ecological and behavioral toxicology)
	Biomarkers (pathology and reproductive toxicology)
	Environmental Chemistry
Contaminated Habitats (The capstone itself was divided into the same categories as the breakout groups)	Urban Wastewater
	Mining and Metals
	Biological and Chemical Controls and Agriculture
	Industrial
Ecosystem Level Effects	Ecosystem Level Effects
Species Decline	Species Decline
Monitoring and Assessment	Monitoring and Assessment

Three questions were asked in each breakout session.

1. What are the **goals** (gaps, needs and emerging scientific issues) associated with this capstone topic?
2. What are the capabilities (scientific expertise, facilities and equipment, or organizational) needed in USGS to address these goals? What capabilities are currently in place, and what capabilities need to be enhanced to achieve the proposed goals?
3. How can we facilitate interactions among USGS scientists, programs and activities to achieve these goals? (or with other DOI agencies, Federal agencies, State and academic organizations or others?)

Each of the breakout sessions were asked to produce a short written summary of the discussion, including goals, potential partners, scientific questions, resources needed and points of still in contention. The results of the breakout sessions were used by the Steering Committee in formulating the goals and recommendations for research within the program.

Results of the Review

Goals and Objectives

When the programmatic structure within Biology was established, general interim goals were formulated for each program. Contaminant Review provided input for a new set of goals for the Contaminants Program. The input will help the Program as it develops its 5-year plan over the next few years. The goals are general enough to encompass the work we will do within the Contaminants Program, and completion of a tiered structure will

allow it to be specific enough to provide durable direction to our activities and accomplishments over the next five years. The Program and its goals reflect the dual importance of responsiveness to National needs for Contaminant information, and the importance of continuing to increase the understanding of exposure and effects of contaminants. During the Review, breakout groups, capstones, and reports from the Steering Committee and Review Panel provided input to the formulation of these goals.

The new goal and objectives for the Contaminants Program are as follows:

GOAL: *Provide scientific information to protect and restore the Nation's biotic resources from the effects of environmental contaminants.*

OBJECTIVES: *Describe the causes and effects of environmental contamination in biota and habitats, specifically:*

- V. Develop methods and assay the biological effects and exposure of organisms to environmental contaminants;
- VI. Evaluate the effects of contaminants in the context of other biotic and abiotic stressors;
- VII. Evaluate the effects of environmental contamination at multiple levels of biological organization and across spatial and temporal scales;
- VIII. Communicate scientific information to resource managers, regulatory agencies, policy makers and the public.

The goals and objectives are closely related to the program structure defined by the Steering Committee, and specifically relate in the following way.

Environmental Toxicology and Chemistry

- I. Develop methods and assay the biological effects and exposure of organisms to environmental contaminants;

Contaminated Habitats, Integration of Ecological Stressors, Monitoring and Assessment

- II. Evaluate the effects of contaminants in the context of other biotic and abiotic stressors;
- III. Evaluate the effects of environmental contamination at multiple levels of biological organization and across spatial and temporal scales;

Applicable to all parts of the program

- IV. Communicate scientific information to resource managers, regulatory agencies, policy makers and the public.

Program Strengths

The Program is blessed with experienced, highly skilled and widely respected researchers. Scientists have excellent entrepreneurial skills and grassroots connections with stakeholders. The Program has extensive expertise in a range of habitats, animals and geography and has developed extensive capabilities in biomarkers and other tools. Personal working relations between researchers allow them to integrate laboratory and field studies. The Contaminants Program, working with expertise in other Programs, has the expertise to address issues at all scales and to address multiple stressors, though it often lacks the funding to do so.

Scientific Recommendations

Objective I. Develop methods and assay the biological effects and exposure of organisms to environmental contaminants;

Sensitivity of Underrepresented Species – Research to develop better methods and more information to assess contaminant sensitivity in species of National interest that are underrepresented in toxicity assessments.

Justification: Contaminant research has traditionally focused on a limited number of sensitive surrogate species and relied on well-developed methods for a limited number of species. Methods and data for assessing toxicity to many groups, such as freshwater mussels, crayfish, amphibians, and reptiles are unavailable or inadequate. National land and resource managers require toxicity information and data on these groups for Natural Resource Damage Assessments, land management, endangered species opinions and other management activities.

Areas of Increased Emphasis: Research on better methods and data for freshwater mussels, crayfish, amphibians, and reptiles to enable scientists to compare the sensitivity of these species to sensitivity of surrogate species which are comparatively data rich, and begin to develop the physiological basis for predictions about the comparative sensitivity of untested species. Epidemiological approaches with multilayered GIS should be used to visualize demographic patterns in relation to contaminant distribution.

Chemically-Based Criteria- Determine if water quality criteria, wildlife criteria, or sediment quality guidelines protect species of National interest, including endangered species.

Justification: USEPA and the States have established criteria or standards designed to protect most species most of the time from some chemicals of concern. Land and resource managers within DOI and state agencies are required to review criteria to ensure that contaminants do not pose a threat to endangered

species and thus violate the Endangered Species Act. A USGS/FWS workshop to discuss information gaps should be conducted.

Areas of Increased Emphasis: Research is needed to understand whether the existing criteria and standards are adequate for species of national interest, and to develop approaches to formulate protective criteria and standards if none currently exist.

Emerging Contaminants - Determine the fate, bioavailability and effects of contaminants of emerging concern.

Justification: Emerging contaminants are clearly one of the major, growing challenges for the contaminants Program. A proactive approach to protecting biotic resources requires better information on the occurrence and effects of new chemicals in the environment. Compounds such as new pesticides and industrial chemicals, pharmaceuticals, personal care products, hormones, flame retardants, plasticizers and their metabolites enter the environment in various ways, including human and industrial wastewater, agricultural runoff, and atmospheric deposition.

Areas of Increased Emphasis: A prioritized list of compounds for study should be developed. Basic toxicology and analytical methods are needed for these emerging contaminants. Analytical methods should include the major environmental matrices and biota. Improved toxicity information should focus on single chemicals and on mixtures commonly found in the environment. A workshop to enhance communication among USGS scientists across programs that analyze chemicals is needed identify facilities with research and/or service capabilities for researchers, increase coordination of program planning activities, and increase coordination of development of new laboratory methods to measure these compounds in various environmental and biological matrices.

Biomarkers - Develop and validate biomarkers of exposure and effects in the field.

Justification: Assessment and monitoring of contaminants requires a well-characterized suite of methods. Biomarkers help link chemical exposures and deleterious effects in fish and wildlife populations. Their application to DOI issues has been critical to the success of a number of resource management outcomes. Development of standard methods through a consensus-based process such as ASTM will further increase their value, especially in litigation.

Areas of Increased Emphasis: Standardization, and information on inherent variability of the results, influences of other environmental stressors, specificity of species response, range of responses typical in different habitats, and effects of other factors are needed in order to increase confidence in biomarkers and validate the utility of particular biomarkers in the field. Biomarkers of interest include methods applicable to organisms (genetic, genomic, molecular, cellular,

physiological), and also to higher levels of organization (populations, communities, and ecosystems). Integration of studies on biomarkers with population studies in a showcase site would help to develop ecosystem biomarkers of contaminant effects.

Objective II. Evaluate the effects of contaminants in the context of other biotic and abiotic stressors;

Multiple Stressors - Investigate the biological effects of contaminants in the context of multiple environmental stressors.

Justification: Assessments of contaminated sites have often focused narrowly on contaminants, but in many sites contaminants and other stressors interact to result in effects that are explainable only by examining a larger suite of variables.

Areas of Increased Emphasis: Increased emphasis on interactions between contaminants and other stressors, and among chemicals is needed to allow scientists to place environmental contamination in context, and to broaden the suite of approaches for management and remediation of contaminated sites. A synthesis of existing understanding is needed to help focus future research in this area.

Energy - Improve understanding of contaminant risk of development and use of energy sources, such as coal bed methane and oil and gas development.

Justification: The national emergencies created by September 11th have strengthened the resolve of the administration to develop domestic energy supplies. Energy development has the potential to release toxic materials and alter the landscape, and land and resource managers need scientific information to understand and resolve potential impacts and conflicts related to energy development on Federal lands and trust species.

Areas of Increased Emphasis: Working closely with other Biological Programs and the Energy Resources Program, and land management agencies, the Contaminants Program should focus expertise to respond to accelerating energy exploration, development, production and use on federal lands. Enhanced research is needed on toxic characteristics and decontamination of coal bed methane wastewater, drilling muds and other byproducts, and the other biological and ecological effects, including placement of water in new locations on arid lands. A interagency workshop on the conversion of coal-bed methane wastewater is needed.

Damage and Risk Assessment - Enhanced scientific support for evaluation, remediation and restoration of contaminated sites, i.e. Natural Resource Damage Assessment and Restoration and ecological risk assessment.

Justification: Land management and regulatory agencies are working to assess risk and damages, remediate, restore, and monitor the legacy of contamination across the landscape. In order to answer, “How clean is clean?” and to select appropriate management strategies, they need better methods and more complete toxicity data.

Areas of Increased Emphasis: Standardized methods, improved toxicological information (including toxicokinetics), better ways to estimate exposure, better methods to incorporate ecological processes (e.g. energy dynamics, carbon and nitrogen cycling, primary productivity and decomposition), improved monitoring strategies and techniques and better ways to determine if restoration is successful are needed. Particular attention to contaminants related to mined areas: arsenic, mercury and other metals is important to DOI bureaus.

Areas of Known Toxicity:

Justification: Scientific information is needed where toxicity is obvious, exposure to compounds of known toxicity is high, or contaminants are implicated in population declines. High priority should be given to understanding and providing data to help mitigate these immediate and likely threats to biotic health.

Areas of Increased Emphasis: These issues focus on species and habitats. Threatened and endangered aquatic species (e.g. freshwater mussels, crayfish, etc) including monitoring of delisted species whose listing was based on toxicity, entire faunal groups that show population decline (e.g. Amphibians), and regional populations of species (e.g. sea ducks) are of heightened concern. Contaminated habitats include abandoned mine lands and the hypoxic zone in the Gulf of Mexico.

Objective III. Evaluate the effects of environmental contamination at multiple levels of biological organization and across spatial and temporal scales.

Monitoring - Continue and enhance monitoring at multiple scales.

Justification: National land and resource managers make decisions about the impacts of contaminants at national, regional, and local scales and over time. These decisions require information from a comprehensive set of methods, approaches, databases, designs and activities. Monitoring provides an important source of information to improve resource management and to focus scientific research by identifying activities and processes that may affect biota and new contaminants that may be toxic at field concentrations.

Areas of Increased Emphasis: Effectiveness of monitoring and interpretation of results could improve with better data management procedures, a database of the locations and types of biotic and abiotic samples that are archived, a more diverse suite of endpoints like sentinel species, and methods for monitoring of particular habitats, like uplands. Enhancement of efforts to analyze and synthesize contaminant data at different temporal and spatial scales will help to identify data gaps like geographic blind spots. Close cooperation and collaboration between monitoring efforts in different Programs of the USGS will help to link exposure and effects.

Population to Ecosystem level Effects - Address the influence of contaminants in environments by incorporating population, community, and ecosystem-level effects.

Justification: Contaminants affect individual organisms, but effects are also propagated to higher levels, including populations, communities, and ecosystems. Ecosystem processes, such as energy flow, nutrient dynamics, and community dynamics, are the foundation on which Earth's life support systems rest. At present we do not understand how contaminants influence these processes. Land and resource managers should have this type of information to understand the ultimate impacts to the systems that sustain trust species.

Areas of Increased Emphasis: A joint demonstration project that fosters collaboration from multiple disciplines and Programs across USGS, especially the Ecosystem Program, should be developed to enable the USGS to connect field and laboratory toxicity testing results to effects at the population and system level. A synthesis of existing information is needed to help to focus research in this area. The Demonstration Project will test hypotheses with laboratory and field experiments of effects on species and ecosystem processes, and develop ecological models that link contaminant exposure to ecosystem-level responses. Additional studies will help to test the relationships developed between exposures that cause physiological effects and ecological responses at higher levels. A workshop on the goals of such a demonstration project and the range of ecosystem processes that are suitable as toxicological biomarkers, should be explored.

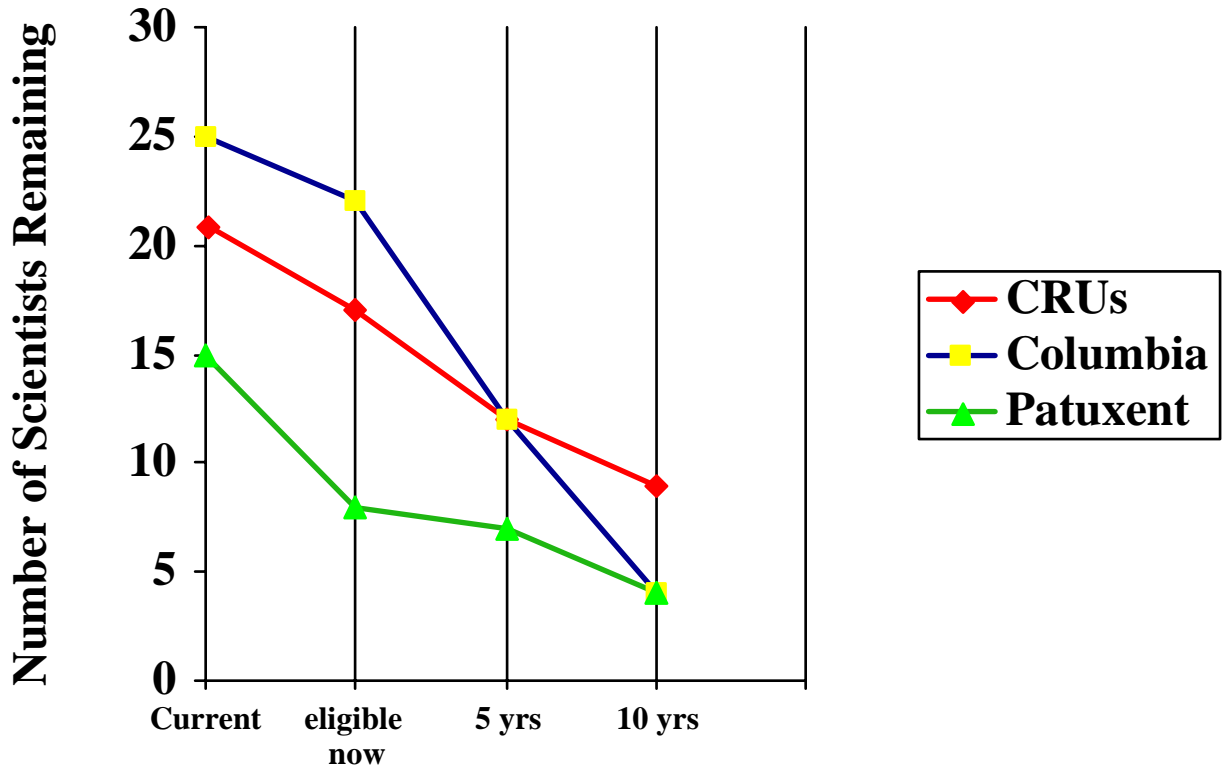
Programmatic Recommendations to Meet Goals:

- 1. Endorse strong Program coordination that facilitates program planning and project development, enhances teamwork within contaminants personnel, facilitates coordination across disciplines, identifies new issues, budget initiatives and other funding activities, synthesizes programmatic and institutional needs, and advocates for a strong Contaminants Program.**

Enabling our scientists to see their part in a larger Contaminants Program will strengthen the ability of the USGS to meet National goals and serve the national interest. A better understanding of the part played by each study in the coherent

framework of contaminants work would help scientists use site-specific studies that are our bread and butter to acquire and communicate the new insights gained from those areas, and identify gaps in understanding and ultimately improve our service to the Nation. Increased involvement between USGS and partner agencies at the program level to formulate and discuss research needs will facilitate development of a comprehensive plan for meeting their needs.

2. Develop and maintain a highly skilled work force and cutting edge facilities:



Many scientists with contaminants experience are nearing retirement. Indeed, half the contaminants scientists at Patuxent are eligible to retire now, and half the scientists at Columbia will be eligible to retire within five years. In one of our major centers for contaminants research, the last PhD level Contaminants scientist was hired 8 years ago. As a program we cannot afford to lose the expertise represented by those scientists. Centers should commit to regular program of hiring to maintain expertise and bring in fresh ideas. We should be investing in young scientists, so that as scientists retire, the period of overlap helps maintain continuity of expertise. Even without these retirements, augmentation of expertise in several areas, especially toxicogenomics, multiple stressors and toxicology at the ecosystem scale). Stimulating collaboration between toxicologists and ecologists is also an important element in developing our ability to conduct research on toxicology at the ecosystem scale.

3. **Training** of scientists will also help to maintain the expertise critical to a capable workforce and maintain a diversity of skills. This can be accomplished in many ways, including exchanges of personnel, sabbaticals, training courses at SETAC, periodic short stays at other laboratories to learn new skills and develop closer relations with new researchers.
4. **Communication** is also vital to maintaining the capabilities of our workforce. Much of the coherency of the Contaminants Program was lost when the two main centers of contaminants research, Columbia and Patuxent, lost field stations to other centers. The Program should act to fill the clear need to facilitate enhanced collaboration among scientists within Contaminants, and among environmental toxicologists and ecologists, geologists, hydrologists and other disciplines on specific topics, including water quality criteria, a demonstration site for ecological Contaminant effects, and analysis of emerging contaminants. The emphasis on collaborative science demands that we provide opportunities for scientists to interact, both within the Contaminants program and among contaminants personnel, other disciplines and our partners. Increasing communication with partners will help the program maintain its understanding of contaminant issues on the landscape and its links to client support. The program should create a fact sheets for partners, Congressional types, higher management etc., summarizing the results of review and summarizing the program and its goals. A **biennial workshop** that is focused on a group of topics, and includes contaminants personnel, scientists from other relevant disciplines and partners would do much to foster these links. Potential workshop topics include Water Quality Criteria, coal bed methane, analytical chemistry of emerging contaminants, and a contaminated ecosystem demonstration project.
5. The ability of our scientists to perform is also limited by the equipment and facilities they have available. Centers should continue to invest in capital equipment and facilities to enable scientists to maintain excellence. For instance, the rapidly expanding fields of genetics and genomics have great potential to

enhance our understanding of effects of contaminants at the population level, and we need to develop our capabilities and facilities to enhance our scientific program in this area.

Acknowledgments

The Steering Committee wishes to thank the Review Panel for its interactions with scientists over the course of the review, and for the generous gift of its wisdom. We are tremendously grateful for the considerable efforts of Emily Tracy, whose support of the Committee was unfailingly cheerful, thoughtful, efficient and thorough. We also would like to thank Debbie Polzel from Skamania Lodge and Cathie Sevilla for arranging facilities and registration.