US GEOLOGICAL SURVEY

BIOLOGICAL RESOURCES DIVISION

CONTAMINANTS PROGRAM

NATIONAL PROGRAM REVIEW

REVIEW PANEL REPORT

February 28, 2002
Samaria Lodge
Stevenson, Washington

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BIOLOGICAL RESOURCES DIVISION

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Report of the Review Panel

February 28, 2002

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I. INTRODUCTION

The scientific work of the Biological Resources Division (BRD) of the U.S. Geological Survey (USGS) consists of nine program elements. It is the mandate of the BRD to review two program elements at a national level per year. The Contaminants Program element has been selected for review in FY2002. The program review was organized to provide:

1. Overviews of intra- and inter-agency work that relate to the Contaminants Program;
2. Five (5) capstone presentations:
    - I. environmental toxicology and chemistry
    - II. contaminated habitats
    - III ecosystem level effects
    - IV species and population declines
    - V. monitoring and assessment
3. 14 presentations, either case studies, or program overviews within each capstone
4. Breakout groups in each capstone to discuss program goals, USGS capabilities within each goal, and how interactions among USGS scientists can be facilitated
5. Numerous posters, describing individual research projects, were on display during the review.

The Contaminants Program review took place in Stevenson, WA during February 25-28, 2002.

All BRD Science Centers, field stations, and Cooperative Fish and Wildlife Units (Co-op Units) were part of this national program review; however, BRD organizational units will undergo more detailed review every five years.

The Review Panel wishes to thank the USGS/BRD Chief Biologist, the National Program Review Coordinators, and BRD Science Center staff for their outstanding organization of the review process, general cooperation, and hospitality.

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Purpose of Program Review

The purpose of the program review as described in the Review Panel Briefing Book is as follows:

1. **Assess accomplishment within the Program Element**: Program Element Goals provide an umbrella for all science activities in a given Program Element. More scientific objectives are set under each Program Element Goal which identify the top priority BRD science efforts for the next five years. These goals and objectives serve as a "yardstick" for program review and evaluation of accomplishments. (Interim Program Element Goals have been established to serve this purpose until more refined goals are set via the Program Review process). The first objective of the Program Element Review is to evaluate the success of BRD science in meeting the existing Program Element Goals and objectives. In evaluating ongoing work and accomplishments, several measures will be used including: a) the outputs, products and services produced; b) the proportion of science relevant to priority goals and objectives; c) the significance of results in resolving partner issues; and d) the

perceptions of the scientific community regarding BRD's role, innovation, and influence on biological issues pertinent to the Program under review. In addition, the following questions will be considered throughout the review and will be useful in determining future directions:

- What are the key scientific questions and issues related to this Program Element?
- What is the current state of scientific knowledge on these questions and issues?
- What is the appropriate role of BRD in addressing these questions?
- How effective has the Program Element been in providing answers to these questions?
- Is BRD science making a difference in the scientific community?
- Is there science missing that should be present?
- Are there activities in the Program Element that are productive but should be de-emphasized in the future?

2. **Update goals, objectives, and priorities**: Program Element Goals are essential for defining the scope and focusing scientific activities within the Program as well as providing a means of measuring achievement. Program Element Goals are updated periodically considering the biological issues facing the nation, the needs of BRD's customers, the resources available to do the work, and the mission of USGS. Program Element goals limit the scope of activities in a given Program to projects that significantly contribute to accomplishment of the goal(s). Each goal must have specific objectives that identify the top priority tasks to be performed and products to be produced during the next five years. Policy and priority statements add further instructions for project initiation, conduct, and evaluation. The review team will assess the appropriateness of the current set of Program Element Goals and objectives and suggest changes deemed appropriate for the next five years.

3. **Determine the significance and relevance of BRD science:** BRD science should address the top priority biological resource issues facing the Nation. The science will range from long-term, strategic research, to cause and effect explanatory research with fairly high risk, to short-term tactical research and technical assistance needed to solve immediate problems. Site-specific projects addressing local issues with little opportunity for extrapolation are generally considered less significant than cutting-edge science addressing major issues and projects which may result in major scientific advances. Projects addressing root problems (vs. symptoms) and multiple issues with single data sets generally receive high marks on significance. Both relevance and significance can often be expanded or enhanced by collaboration with partners and integrating the work into study of a broader issue at multiple temporal and spatial scales. From the total Program Element perspective, both significance and relevance will be judged on how well BRD's efforts are meeting the needs of its partners and the Nation in providing new scientific insights and quantitative options for management.

4. **Enhance communication and collaboration among BRD scientists:** Program Reviews will bring BRD investigators together and help them gain a better

understanding of how their individual projects fit into a larger national effort including opportunities for cooperation with the larger community of scientists in USGS, other government agencies, academia, and research institutions. It is hoped that increased communication will facilitate greater scientific collaboration and integration of projects in USGS. Moreover, program reviews provide scientists with the opportunity to directly influence the future science conducted within the Program Element. Communication among BRD investigators will help create synergistic alliances among scientists from other USGS divisions, different regions, Science Centers, Cooperative Units and will promote projects with greater scope and complexity to solve problems in resource management.

5. **Provide opportunities for budget and program development:** Outcomes from National Program Element Reviews will help guide the Program for the next five years including the development of subsequent budget submissions. Program Element Reviews may identify new directions for a program that can be achieved only through a budgetary initiative, potentially creating initiatives that are jointly supported by BRD, USGS, and other agencies. Therefore, the Program Element Review process will be linked directly with the USGS program and budget development processes to effect the changes identified, as one of many forces shaping the budget.

In addition to these general Program Review guidelines, the Review Panel more specifically was asked to comment on the capstone areas with reference to:

- Program Strengths
- Program Weaknesses
- Major Program Gaps
- Major Program Opportunities
- Actions that would improve the Program

On February 28, 2002 the Review Panel provided a verbal report of their initial findings to the Program Review participants.

II. Review Panel's Overview

Strengths

The USGS BRD Contaminants Program is very strong technically and scientists in the Program are recognized internationally for their cutting-edge science. There is tremendous diversity in the skills and expertise of the scientific staff in BRD and the Contaminants Program, and this expertise is being applied to some of the highest priority natural resource management issues facing the Nation. As a consequence of these observations, the Review Panel agrees with BRD's decision to maintain the Contaminants Program as a separate and discrete Program in the USGS.

A number of the scientists in the Program have an entrepreneurial approach to science, which has allowed them to flourish and conduct innovative science, either in individual-based investigations or as part of collaborative teams with client agencies. Contacts of senior scientists in the Contaminants Program with the U.S. Fish and Wildlife Service appear to be quite strong as the Service is the dominant partner in all capstone categories of research.

Weaknesses

Perhaps the most serious weakness of the Contaminants Program is that it has not developed a unifying identity and a coherent national program. A truly programmatic approach is needed not only to provide staff with future direction, but also to help secure future funding that allows the program to invest in developing new scientists for the nation. Young scientists are not being recruited into the Contaminants Program because of the erosion of base funds. Soft money, which drives the research, is frequently used to cover only the expenses beyond salaries, and as such cannot be used for strategic investments.

There is a need for greater communication within BRD and USGS, and among DOI agencies and all federal partners. In particular, communication between staff and upper management needs to be improved. The static nature of the budget over the last 5 years represents an actual net loss in base funding, as salary and fringe benefit costs continue to increase, eroding the portion of the budget that is discretionary and can be used to fund strategic research projects (i.e., those projects that look just "over the horizon" and anticipate what the needs of clients will be in the future).

The productivity of the scientists is being hampered by the current organizational structure in USGS/BRD and the lack of a coherent national vision in the Contaminants Program to provide long term direction to the research. This is resulting in a number of lost opportunities to provide the biological science the nation needs in monitoring, declining species, emerging chemical threats, and collaborative work with other divisions of USGS.

Opportunities

The contaminants program currently has the opportunity to:

1. Use the senior scientists that currently enrich the program to develop a long-term research vision (before they retire). This is critical because these scientists have the corporate history of the program and can help avoid pitfalls of the past.

2. View issues in a broader perspective; develop ecosystem-based partnerships.

3. Collaborate with a wealth of scientific expertise that exists in other disciplines and programs of USGS.

4. Use expertise of the Contaminants Program in areas of restoration and remediation for the Department of Interior.

5. Develop a core of expertise in quantitative ecotoxicology to assess ecological risks of contamination.

6. Train and recruit young scientists, even if these must be recruited initially as term appointments.

7. Capitalize on the long term field experience of many of its scientists by putting together long term data sets to examine contaminant trends.

Recommendations:

The USGS BRD contaminants program should:

1. Establish a programmatic vision to more coherently harness the talents of the BRD Environmental Contaminants Program in service of protecting the nation's biological resources from contamination.

2. Explicitly acknowledge that there are two approaches to developing research programs--investigator driven research and programmatic/client-based research. Develop a specific vision and mission for each one and specific criteria to be used to prioritize which projects to undertake. For example, those projects that emphasize coordinated field and laboratory studies should be a high priority and be given strong organizational encouragement.

3. Re-examine the structure of the organization to reflect the larger goals and objectives of USGS as a national agency; current research reflects the fragmented nature of the organizational structure.

4. Develop performance measures and funding support that are explicitly linked to programmatic research driven mandates and management goals. This will insure accountability for the resources provided to the Program.

5. Develop a research coordination team to establish and implement priorities and communicate with client agencies that have research needs. The team should be chaired by the program coordinator with members from various research centers and client agencies within DOI and other appropriate USGS disciplines.

6. Implement a recognition and reward-based system for taking more synthetic and multi-disciplinary approaches to contaminant problems, establish points of contact at each organizational unit for dissemination of science information needs to stay current, and support the management objectives. (An example of a reward might be increased research funding for a PI that met certain programmatic criteria or the setting up of special research fund categories that reward field and laboratory combined approaches).

7. More effectively incorporate outreach into the scientific work, (beyond just the publication in scientific journals) including outreach to the resource managers in the Department of Interior.

8. Develop scientific leadership in the Contaminants Program that goes beyond the boundaries of the individual project and research center to build a national Program that is more than the sum of the individual components.

9. Systematically encourage the collaboration with other USGS research disciplines.

10. Develop a funding allocation system to implement the programmatic research goals without impeding the initiative of individual scientists.

11. Invest in developing young scientists, which are the future of the Program.

12. Develop an improved science tracking and reporting process as it was apparent that the SIS system is critically flawed.

Other Programmatic Comments

1. No matter how strong the talent and skill of the staff within the Contaminants Program, the scientific productivity will be constrained when the organizational structure fails to provide a supportive environment and culture. The Review Panel anticipated initially that their efforts would be directed largely toward the review of the science in the Contaminants Program; instead, we quickly realized that there were major issues dealing with organizational structure that needed attention. Although we do not ignore the review of the science, we also devote considerable attention to the organizational issues that require resolution.

2. The Contaminants Program, (and perhaps within BRD this is not unique to only this program), operates in almost a schizophrenic manner, attempting to integrate client-driven and investigator-driven research. The scientific staff take great pride in their ability to provide high quality, short-term expertise for their client base, and are very conscious that the client-driven projects provide reimbursable funds that help leverage base dollars. Investigators want the freedom to pursue their intellectual interests, which are frequently also justified as client-based research. What seems to be missing is a national or even regional programmatic focus for interdisciplinary work in USGS that directs work in the contaminants program of BRD. While investigator initiative is a valuable commodity and should be nurtured not squashed, there is a lack of balance in the current approach. The management within BRD should consider implementing a structure that: 1) acknowledges, distinguishes and validates these dual tracks; 2) establishes clear mandates, expectations, and performance metrics for each of them; 3) facilitates the exchange of ideas and personnel between the tracks. and 4) provides the philosophical underpinnings of research goals for a national research program that supports and utilizes the expertise of these scientists.

3. Meeting the needs of client agencies within DOI is one of the major functions of the USGS BRD Contaminants Program (though not the only one). These clients, include US Fish and Wildlife Service (USFWS), the National Park Service (NPS), the Bureau of Land Management (BLM), the Bureau of Indian Affairs (BIA) the Minerals Management Service (MMS) and the Bureau of Reclamation (USBR). At the program review the NPS, USFWS, and BLM had representatives observing and participating in breakout sessions while MMS, BIA, and the USBR did not. This seems to reflect the emphasis within BRD for working with the other DOI agencies. The BRD and the Contaminants Program need to find a way to build stronger relationships with all their DOI partners. Current work by the BRD contaminants program appears to address principally the needs of USFWS, which accounts for roughly a third of all collaborations. The NPS is another distinct customer and accounts for approximately 5% of collaborations. BLM has many needs related to mine reclamation, mercury contamination, coal bed methane, acid mine drainage, and soil and water contamination that need to be addressed. The USFWS also has many information needs regarding contaminant impacts to trust resources, particularly endangered species, and also needs strong scientific partners in pursuing its Natural Resource Damage Assessment program. The USBR has many research needs regarding the impact of contaminants to the water resources they manage and while there are some BRD projects with USBR these are primarily related to a handful of irrigation drainwater

investigations. The impact of contamination to the ecosystems managed by the National Park Service are of vital interest to the nation and deserve more systematic attention of the contaminants program in collaboration with all of the USGS science programs.

III. GENERAL FINDINGS

A. General Observations

The Contaminants Program consists of numerous projects loosely bound together around the theme of investigations focused on the exposure, effects, and fate of deleterious substances in the environment. For the National Review, individual projects were grouped into five capstone categories that included chemistry and toxicology, contaminated habitats, ecosystem level effects, species and population declines, and monitoring and assessment. Because these classifications were largely artificial and done on a post hoc basis, redundancy and overlap existed among these capstones, and their sub-groupings. A serious challenge facing the Contaminants Program is to build upon the existing research capabilities and integrate the BRD contaminants program into the broader efforts of USGS, provide them with a collective identity, and embed them within a cohesive, overarching Program that is consistent with the national goals of USGS without at the same time destroying or discouraging initiative of principle investigators, which is a major strength of the program. The scientists in this Program have been exposed to considerable change over the past six years, and this organizational instability appears to have influenced the morale of staff in the Program. The scientists with a more entrepreneurial-oriented mentality have flourished in this fragmented, dynamic environment; however, this situation is not producing a crop of young scientists to replace those for whom retirement is a short few years away.

The experience of the senior scientists in the agency could be better used in providing scientific leadership in the Contaminants Program. Management needs to provide them opportunities to become engaged and empowered as well as informed of the Department of Interior's science needs for the nation. This science leadership is at the level of principal investigators. These are the scientists that are writing the proposals to receive funding to conduct work for clients. They appear to work largely in isolation. The Contaminants Program has the potential to answer the "so what" rhetorical question of biological relevancy of contaminant concentrations found in water and sediment generated by data collection efforts by other USGS Divisions. Structural changes are needed to create scientific leadership teams and research coordination teams beyond the level of the Research Centers to better meet the science needs of the Department of Interior for understanding and managing environmental contamination issues effecting Interior's trust resources.

Despite the considerable scientific talent embedded within the Contaminants Program, there are many challenges facing the Program in the future. We have partitioned those challenges into either scientific or process (Fig. 1), and discuss them in more detail below.

B. Program Goals

The briefing book for the National Program Review for Contaminants, "From Laboratory to Landscape", contained interim goals of the USGS BRD Contaminants program. Briefly these interim goals were summarized as:

1. To evaluate the ecological risk posed by contaminants.

2. To investigate the contaminant sensitivities of all trust resources managed by DOI.

3. To determine the linkage between contaminants and multiple environmental stressors on selected fish and wildlife species.

4. To synthesize contaminant information on broad temporal and geographic scales.

Comments of the review panel on program goals:

Overall we believe the goals should be adjusted to reflect not only the current capabilities of the EC program but the unique role that USGS BRD, as the biological research arm of DOI, must play in the future of resource management. While this unique role is sometimes captured in the discussion under each goal it is lacking in the summary statements. We agree with keeping the number of goals limited to a handful of broadly stated objectives.

Goal 1: We suggest goal 1 might be modified as follows "To evaluate the ecological risk posed by contaminants to provide the scientific basis for DOI to make risk-based decisions regarding contamination threats to trust resources."

Goal 2: This goal seems like a sub-set of goal 1 and could be perhaps be better distinguished as a separate goal to provide an integration of laboratory and field approaches to understanding the contaminant sensitivities and vulnerabilities of DOI trust resources.

Goal 3: Perhaps greater importance should be placed on diagnosing the relative importance of causes of ecological impairment, community alteration and population decline and the interaction of contaminants with other stressors such as disease and habitat fragmentation. Rather than focus on "linkages" we suggest alternative wording : "To determine the role of multiple stressors in ecological degradation of trust resources." The biological level of interaction of multiple stressors that appears to have the greatest need for understanding by DOI managers is at the population, community and ecosystem levels, though research to provide mechanistic understanding at lower levels of biological understanding is also something BRD can and should provide.

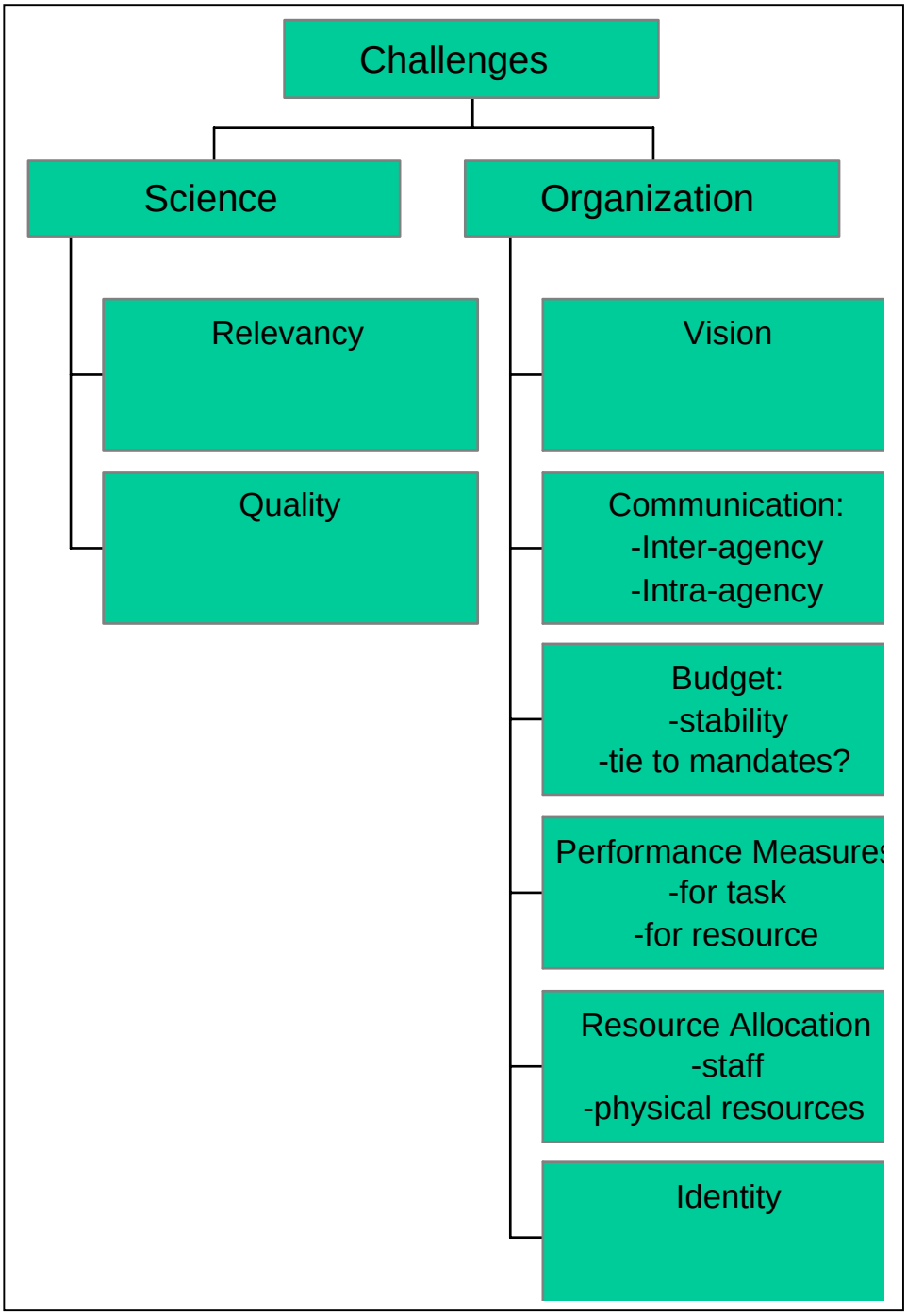
Goal 4: We suggest a modification to add the purpose of synthesizing contaminant information on broad temporal and geographic scales such as ...."to synthesize and integrate contaminants information to provide resource managers with the scientific

basis of evaluating changes in contamination threats in both time and space in relation to management goals and needs.

A suggested mission statement:

The EC Program will take leadership in BRD for conducting the research to determine the effects of environmental contaminants on the health and viability of DOI trust species and their habitat.

Fig. 1. Flowchart of major challenges facing the Contaminants Program.



The scientific challenges facing the Contaminants Program fall into the categories of scientific relevancy and scientific quality. The future success of the Contaminants Program requires that the work being conducted is both relevant and rigorous.

Scientific relevancy: It is essential that the science in the Contaminants Program remains relevant. Areas of focus for the future, which may help in this regard, include predictive modeling, ecosystem-level partnerships, restoration and remediation ecology, and investigations of contaminant related causes of species declines. At times during the review the panel found it difficult to determine the overall objective of a project. Many of the projects would benefit from utilizing a risk-based, predictive approach that provides the scientific basis to make resource management decisions. There has to be more purpose to an investigation than to generate data. For what purpose is the data being generated? In utilizing the data, what decisions will be made?

Scientific quality: The overall quality of science in the Contaminants Program is high. The publication rate is very good and Program papers appear in high quality, peer-reviewed journals. Some of the investigators in this Program are internationally recognized. To maintain a Program that produces high quality science, it is critical that the core issues of communication, resource allocation, and budget be resolved.

The organizational challenges facing the Contaminants Program are subdivided into 6 classes: vision, identity, communication, budget, performance measures, and resource allocation.

Vision: The Contaminants Program is in need of more proactive leadership that can provide a concrete vision for the group. At present, this lack of vision has resulted in an atmosphere of confusion; although some investigators operate well in this environment, many staff are unsure of direction.

Identity: Research on contaminants is conducted at numerous agencies throughout the federal government, at universities, and in the private sector. Why do it within the BRD contaminants Program? Every staff member should be able to answer that question in a clear and concise manner. The absence of a unifying identity, around which staff can rally and feel ownership, needs timely resolution. Client agencies feel they can obtain the long term commitment from a sister agency that they cannot obtain from Universities where issues with data ownership and lack of continuity and conflicts of interest may arise.

Communication: Any organization is doomed to fail unless it is able to communicate effectively. Communication breakdowns were evident in the Contaminants Program between staff and management, among staff within the Program, among Programs within BRD, and among Divisions within USGS. We were surprised and disappointed that the Contaminants Program - as a unique

program, did not yet have a web page to disseminate information both to their own staff and to their clients.

USGS BRD contaminants investigators should seek to take responsibility for making their science accessible by providing synthesis and relevance of scientific findings regarding environmental contaminant threats that effect management of fish and wildlife, and public lands to the public and those responsible for management of those resources. Publication in scientific journals alone is not enough.

Performance Measures: Accountability is a critical component of any public agency. Performance measures provide a mechanism that addresses accountability, but also provide a tool to help market one's scientific product. We recommend that performance measures be adopted in the Contaminants Program that address both the actual task associated with a project as well as the overall resource-based question. For example, if a project involved the assessment of the effect of a pharmaceutical product on a population of freshwater mussels, a possible task-based performance measure would be to conduct research to determine the threshold concentrations for growth and survival. The resource question might be, "what is the spatial extent and viability of mussel populations in nature and how do they vary with chemical concentrations of the pharmaceutical product observed in nature".

Budget: The failure of the budget to keep pace with the cost of living, let alone experience an actual net increase, has placed great stress on the Program's infrastructure and ability to operate effectively. It is a credit to staff that they have maintained their productivity and scientific excellence in this budgetary environment. Even more distressing is that for most of the prior six years, the budget climate for science in Washington D.C. has been favorable; what is the fate of the Contaminant Program's budget when this climate turns less favorable? The responsibility for ensuring a stable budget falls both on upper management and staff. Upper management must effectively communicate the essential functions of the Program to leaders in Washington, and the staff must be feeding this information to management and their clients on a regular basis and in a form that can be used effectively by managers. Management needs to engage and empower its scientists in this task.

Staffing and Resource allocation: This challenge involves both human resources (staff) as well as physical resources. It is unclear how these allocations are made within BRD for the Contaminants Program. It is essential that a structure or structures be implemented that provide guidance and criteria for these allocations.

Age structure of the workforce - The review panel noted that it has not been possible to invest in human capital by recruiting new scientists that can replace key positions when current staff retire. While an occasional graduate student post doc or temporary employee may be temporarily engaged in work via research work orders, the last new permanent scientist at either Patuxent or Columbia was hired 9 years ago.

IV. COMMENTS ON CAPSTONE TOPICS

A. Environmental Chemistry and Toxicology

This capstone area consists of 8 core capabilities (1) aquatic toxicology, (2) wildlife toxicology, (3) biomarkers and pathology, (4) behavioural toxicology, (5) reproductive toxicology, (6) sediment toxicology (7) ecological toxicology, and (8) environmental chemistry. It is a large program with 142 SIS documents describing research projects at 12 BRD Centers/Coop Units. In many respects these core capabilities are central to the entire Contaminants Program of BRD and provide the foundation for other "capstones" such as contaminated habitats, species and populations declines, and monitoring and assessment.

Strengths

1. This capstone represents a core group of experienced scientists in the above disciplines many of whom are national and international leaders in these areas of research.

2. The research conducted within this capstone has resulted in the development of productive and long-term partnerships with client organizations. Of particular note, are partnerships developed with USFWS, EPA, Parks Service.

3. Good spin offs of research and practical applications e.g. sediment toxicity research and application at contaminated sites.

4. Environmental chemistry group has made unique world class contribution on passive sampling device development and uses.

5. The research has resulted in the capacity to identify and measure a wide range of contaminants in biological matrices and examine a wide range of biochemical endpoints in wildlife and fish.

6. The research has resulted in the capacity to conduct avian and fish toxicology studies and to combine field and lab approaches to solving environmental contaminant problems.

7. The predictive, risk-based approach taken with some of the projects were clearly useful in providing the scientific basis to make resource management decisions.

Weaknesses

1. Ability to determine concentrations of new "emerging" chemicals in biota appears to be limited by lack of equipment and lab capacity.

2. It is unclear as to whether the outstanding scientific results in the environmental chemistry and toxicology area are being effectively communicated to senior decision makers within USGS or to the interested public and NGOs.

Major Gaps

1. Stressors with similar mechanisms of toxicity (i.e., cholinesterase inhibitors) should be assessed for their additive effects.

2. Lack of a lab with a mandate to conduct contaminant measurements, both routine and exploratory, in biota for the whole program. Individual scientists thus employ various labs and collaborations to get chemical measurements done. There are potential problems with the quality assurance and quality control (QA/QC) of data when multiple laboratories are involved. It was not apparent how this issue is being addressed at the programmatic level.

3. There appears to be a lack of a population-level relevancy that would be necessary to make scientifically sound resource management decisions.

Opportunities

The issue of new" emerging" chemicals was widely discussed at the review session and in breakout sessions (e.g. under the environmental chemistry, contaminated habitats, industrial discussion groups). This issue could be an important focus for environmental chemists and toxicologists within the contaminants program and for collaboration within USGS over the next 5 years. NAWQA has identified a long list of "new" chemical contaminants in US surface waters e.g. pharmaceuticals, antibiotics, and current use pesticides. EPA has concerns about new PBT chemicals such as perfluoro acids (like PFOS or "Scotchgard") and brominated diphenyl ether flame retardants. What is needed initially is a prioritization process using QSAR and expert judgement, to tentatively identify the most persistent and bioaccumulative compounds on the list. EPA also has a prioritization process underway for new contaminants and coordination of this effort with EPA, the National Marine Fisheries Service and the US Fish and Wildlife Service would be highly desirable. Once a priority list is established there are numerous tasks which scientists and science centers within the Contaminants Program are well equipped to undertake. These include analytical method development for determining exposure of fish and food webs, toxicity testing of priority chemicals, field studies at contaminated sites, and biomarker development to try to identify specific responses.

Genomics represents a new technology, which may prove useful to contaminants researchers. However, rather than pursuing genomics simply because it is a new technology, the review panel urges contaminants researchers to critically evaluate why and how such new technologies can be used in a directed effort of value to USGS.

Actions that would improve the Program

Seek to identify chemical agents responsible for the response observed in more recently developed biomarkers. Specifically, there is limited research in environmental chemistry (generally, not just within BRD) linking biomarkers and chemical agents using a field and laboratory approach.

Translate toxicological endpoints to relevant population, community, and ecosystem metrics, particularly as they relate to declining species and ecosystems under management by DOI.

Assist client agencies to develop predictive and decision-support models that integrate ecological risks from contaminants with risks from other stressors.

B. Contaminated Habitats

This capstone covers a wide range of contaminants: metals, industrial chemicals, biological control substances, pesticides, complex mixtures in urban wastewater, and nutrients. The sources of these contaminants come from several land use categories: mining, agriculture, and urbanization. Concordantly there is a large set of projects in this capstone consisting of at least 153 SISs. A theme running through this capstone is involvement of Program scientists in Natural Resource Damage Assessment and Restoration (NRDAR) activities for mine lands, urban/industrial areas, and marine systems.

Within the context of NRDAR there are large opportunities to improve scientific tools to identify and quantify ecologically significant injury to species, which is the basis for defining the damages from the contamination. With regard to contaminants associated with specific land uses, there are substantial data gaps, such as on the sublethal effects of pesticides and pesticide mixtures on key physiological processes in wildlife and fish. Additionally, in contaminated habitats, toxic chemicals are often only one of multiple stressors degrading the ecological integrity of an ecosystem. Thus, it is clear that there are major opportunities for multidisciplinary studies that will put the effects of contaminants in perspective with respect to other stressors and thereby lead to more effective ecosystem-level restoration strategies.

Strengths

1. The strong linkage of field and laboratory studies conducted by the Program is essential in establishing relationships between contaminants and biological effects.

2. The interdisciplinary nature of many studies allows multiple species to be investigated in NRDAR cases and thus an enhanced ability to demonstrate contaminants effects through a food web.

3. The Coeur d' Alene NRDAR investigation was a good example of taking a data-driven approach in developing a model to relate contaminant exposure to biological effects that were significant at a population level.

4. The efforts to standardize sediment bioassays are important in their acceptance for use in NRDA assessments.

5. The sediment triad approach to evaluating contaminated sediments is a good example of an approach that integrates environmental chemistry data, with biological tests (bioassays) and field assessment of community structure to provide an assessment of exposure potential and effects at more then one level of biological organization.

Weaknesses

1. Given the wide spread use of pesticides in agriculture and in urban/suburban landscapes, and the number of new agents being introduced, the level of research in the Program is not proportionate to the ecological risk posed by these substances.

2. The need for improved coordination within USGS to be able to better understand how physical processes, such as hydrology, are regulating the fate and effects of contaminants in an ecosystem.

3. A wide range of studies are possible in the area of contaminated habitats. Since there are limited resources in the Program to address the full range of issues on contaminated habitats, criteria are needed to prioritize sites for investigation. Possible criteria could include: species at risk, sensitivity of the landscape to degradation by contaminants, and the potential for successful restoration or management actions to alter impacts from contamination. Using a GIS approach to apply the criteria could be very valuable to both researchers and managers for identifying patterns of contamination that overlap with species declines.

Major gaps

More effective interactions and linkages between the Contaminants Program and other USGS Disciplines and Programs are needed. Establishing these linkages would allow contaminants to be integrated into system level processes (See Ecosystem Effects Capstone). Because many of the projects in the Contaminated Habitats capstone are driven by client-based research needs it is difficult for individual researchers to make these linkages. It will take the initiative of senior and mid-level managers to create the atmosphere for meaningful scientific interaction between the Contaminants and Ecosystem Disciplines.

Opportunities

Increase coordination with geologists, hydrologists, and engineers in USGS to explore new strategies to remediate contaminated sites posing the greatest risk to trust resources.

USGS has an opportunity to play a leadership role in the science supporting NRDA. The BRD contaminants program should provide an objective scientific forum to synthesize "lessons learned" and research needs from NRDAR projects. These projects address cause and effect and an assessment of biological/ecological impact of contamination. A number of different approaches have been used by Program scientists. Holding a workshop to review the successes and failures could be very instructive in identifying key research needs to be able to better quantify the extent of contaminant injury to a population. Assessing injury is a difficult task, particularly when multiple stressors are present because it becomes an exercise in partitioning impact. Assessing injury is central to the question of what are ecological risks from exposure of a population to contaminants.

There is a clear need to develop ecologically sound control/eradication approaches, where possible, for invasive species. Herbicides are frequently being used to control noxious weeds. Because invasive plants can have as great or often greater impact on a species or its habitat than contaminants it is critical that the approach for control or eradication via herbicides be as benign as possible to nontarget species. The ecotoxicological data for these types of evaluations are nearly non-existent.

Actions that would improve the Program

Consider establishing a cross-Center team with a restoration ecology focus. This could provide a framework for investigating contaminated habitats and to facilitate synthesis of data generated from individual projects. By increased collaboration and coordination between investigators conducting NRDA studies, "lessons learned" from an investigation can be used to improve future investigations.

C. Ecosystem Level Effects

This capstone area covered 28 SIS's, a relatively small number compared to the other capstones. The field of ecosystem science is growing and maturing, and represents one of the key opportunities for growth and collaboration in the Contaminants Program. However, it is clear that at present, many of the ecosystem-related efforts in the Contaminants Program deal with ecosystems in only a peripheral way, and are not truly integrated into system-level processes. This may reflect the unique cultures of the contaminant and ecosystem disciplines, but it is clear that the marriage of these two disciplines is an unexploited area, and if done correctly, could be a very rewarding effort.

Strengths

1. Very few ecosystem studies truly integrate the impacts of contaminants. This is true whether one views the problem from a top-down or a bottom-up perspective. As a consequence, the Contaminants Program could fill a potentially important and unfilled niche.

2. The Contaminants Program has a long and successful track record at integrating laboratory and field studies. This mechanistic-based approach to problem solving can be adapted to ecosystem-level problems as well.

4. Current studies are being conducted at a variety of sites and habitats around the country.

5. The Collaborative atmosphere within the Contaminants Program should help support an effort to develop multidisciplinary teams needed to solve ecosystem-level problems

6. There is a real need for contaminants research and ecosystem science to integrate, as this linkage can help provide answers in the critical fields of restoration ecology, multiple stressors interactions and predictive modeling.

Weaknesses

1. There is relatively little ecosystem science expertise currently within the Contaminants Program.

2. There is a need to develop the appropriate contacts and network with ecosystem scientists to develop collaborations.

3. Need to identify appropriate role of Contaminants Program in these collaborations.

Major Gaps

1. There is a need for developing the appropriate linkages between contaminant effects and ecosystem impacts. This can be done through either empirical or modeling efforts, or ideally, a combination of the two.
2. Current ecosystem efforts within the Contaminant Program are very localized. There needs to be better coordination among these efforts, so scientists working at this scale have an internal network and can share ideas and strategies for new opportunities.
3. Communication between the more traditional contaminant-based scientists and ecosystem-based scientists needs to increase. These disciplines attack problems from different directions, so there may be fundamental differences in their methods, language, and cultures.
4. There is a need to synthesize the existing information relating contaminants and ecosystem processes, in order to make informed decisions about what directions require attention and those that do not.

Opportunities

The integration of contaminant effects into an ecosystem framework, or vice versa, is an exciting and unique opportunity. The ability to provide a mechanistic understanding of how contaminants influence species/population declines, and the cascading impacts on system-level dynamics is exciting and relevant.

Specific research arenas that would benefit from the marriage of these disciplines include restoration/remediation ecology and predictive modeling.

Actions that would improve the program

The redirection of the Contaminants Program to a more ecosystem-based orientation can be accomplished via several models. One model is to develop an

in-house expertise in ecosystem science. The review panel believes this model would not be a wise allocation of resources, as it would result in redundancy with ecosystem scientists elsewhere. The second model builds on what has already taken place, albeit to a limited degree, whereby BRD scientists team with the ecosystem scientists already present in the federal government and in university settings. A strong ecosystem component also exists within the hydrology program of USGS and linkages with this program should be expanded.

Greater emphasis should be placed on developing more sophisticated predictive models that would help integrate contaminant-based effects with ecosystem-level processes. This ability has considerable intellectual appeal given the challenges inherent in the task, as well as broader societal appeal, as a tool of this nature would help resource managers, elected officials, and planners to make more informed decisions.

Greater emphasis on remediation/restoration science. What constitutes restoration is a critical question facing ecologists and managers today. It is possible to reduce contaminants to a known level, but ultimately resource managers want to know if the impacts have been mitigated at the species, population, community, and ecosystem levels. Microbial remediation has profound implications for nutrient cycling, which in turn influences eutrophication of water bodies. There are natural linkages here to be developed across a wide spectrum of ecological disciplines and scales.

A workshop should be held to explore how best to integrate contaminant research and ecosystem processes. This workshop should include representatives from both disciplines and also senior management within BRD to ensure the ideas are grounded in political and fiscal reality.

A “showcase” system should be identified to integrate contaminant and ecosystem research. The purpose of this showcase system is to provide quick successes highlighting this linkage, identify emerging issues, and evaluate challenges. Ideally, this system will have an established data base, enabling researchers to: 1) identify the key contaminant issues in the system; 2) quickly establish relevant and tractable hypotheses; and 3) conduct the experimental and modeling research to test the hypotheses.

D. Species and Population Declines

In comparison to other capstones "Species and Population Declines" has relatively few SISs (n = 49) and they predominately focus on aquatic species but do include investigations of a number of bird species. The capstone presentation emphasized that it is often the situation that there are multiple possible causes for the decline of a species or a population, and there is often great uncertainty regarding the role, if any, of exposure to and deleterious effects from chemical contaminants. Determining whether contaminants are a significant cause for decline, and the

resulting level of reduction in contaminant exposure necessary to allow recovery of the species are critical pieces of information for developing effective recovery plans. Another area that needs additional research is in developing monitoring protocols to determine whether management actions are having their intended effect on either the quality of habitat critical to the species or the biological condition of the species and whether strategies being pursued to reverse these declines are the most efficient or effective. There are clear opportunities and research needs for improved management of species in decline.

Strengths

1. The Contaminants Program has a strong track record of demonstrating that contaminants can have detrimental effects on reproduction and survival of a range of species.

2. The Program's emphasis on coupled field and laboratory studies provides the appropriate scientific framework for establishing whether contaminants are a factor for decline of a species and for identifying the mechanism of action, if contaminants are involved.

Weaknesses

1. There is a need to expand research on sublethal effects to include endpoints that can be readily incorporated into population models, such as effects on behavior (e.g., altered predator avoidance).

2. Collaborative research with quantitative conservation biologists is needed to assess the population consequences of sublethal effects of contaminants on survival and reproductive performance, food web implications, and ecosystem services.

3. Lack of studies integrating contaminants and ecosystem-level processes to determine causes for decline of an at-risk or ESA listed species.

Major Gaps

1. There is a lack of contaminant studies on reptiles and most of the studies that have been done have focused on turtles and alligators. Snakes and lizards are under-represented in toxicological research. While amphibian research efforts have increased, more research is still needed on amphibian declines and the potential role of contamination in that decline.

2. Data are needed for many chemicals to determine if current water quality or aquatic life criteria are sufficient to allow recovery of a species or a population in decline. Data needs go beyond the standard toxicity tests currently being employed.

3. The lack of criteria and a decision-support tool to identify critical data gaps and uncertainties for species or species assemblages that are at-risk of significant population decline or for which contaminants are a likely risk factor for the decline. While the review panel recognizes that a petition to list a species will often drive research agendas, there is a need to be proactive in identifying management actions that could halt or reverse a decline in species that have not yet been listed under the ESA.

Opportunities

An epidemiological approach that incorporates the use of GIS analysis of data on species of concern, environmental levels of contaminants, sources of contaminants/land use and other physical or biological data layers to be able to focus research on those species or populations where contaminants are most likely to be a significant risk factor for population decline.

The ability to provide a mechanistic understanding of how contaminants influence species/population declines, and the cascading impacts on system-level dynamics is very exciting.

The recent MOU between the USFWS and USEPA to consult on water quality criteria and other efforts to create a system to expedite consultations on pesticide registrations creates a tremendous need for information on contaminants effects to threatened and endangered species by the major DOI partners of the BRD contaminants program.

Species that have been proposed for delisting from federal protection under the endangered species act require a 5 year monitoring effort after delisting. This presents an opportunity to the BRD contaminants program to provide the scientific support in those instances where contaminants were a major factor in the original listing (Bald Eagle, Peregrine Falcon etc.).

More often than not contaminants will be only one of multiple stressors suspected of contributing to a species/population decline. This is a strong argument for linking contaminants (ecotoxicology) with system level studies (conservation biology and ecology). Areas of opportunity are presented in the Ecosystem Effects Level section.

The role of emerging chemical threats upon species declines is relatively understudied.

Actions that would improve the program

Increased emphasis on linking field and laboratory investigations to population models that can incorporate sublethal endpoints. Utilizing a model as an organizing framework can be very effective in directing research to fill those data gaps that have the greatest uncertainty in predicting population level impacts. Filling these

data gaps will provide the basis to determine with greater certainty whether criteria for environmental levels of contaminants are sufficient for recovery.

Increased emphasis on studies that address multiple species, indirect effects, and food web interactions

Expand the focus of investigations to provide tools for resource managers to distinguish whether a species decline is due to contaminants or some other factor such as loss of habitat.

E. Monitoring and Assessment

The monitoring element of this capstone is consistent with the 4th interim goal of the contaminants program to synthesize contaminant information on broad temporal and geographic scales. It seeks to examine broad temporal and spatial trends, discover new contaminants in the environment, identify significant ecotoxicological data gaps and to develop tools and techniques to enhance these activities. Monitoring studies as summarized in SIS involved 73 BRD staff from 21 centers and facilities and collaborations with 71 partners.

The assessment element of this capstone is consistent with the 1st goal, which is to evaluate ecological risks of contaminants. This process seeks to predict the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. The SIS documented 19 risk assessment studies involving 23 BRD staff from 14 centers and facilities and collaborations with 24 partners.

There are many different types of monitoring. Three types highlighted by the Contaminants Program included: 1) broad scale periodic monitoring; 2) more frequent and regional scale monitoring, which is statistically based on a stretch of the landscape; and 3) intensive monitoring of specific management actions.

Strengths

1. The BEST Program has been, given its limited budget, particularly well focused on methods development and coordinating with monitoring conducted by other federal agencies.

2. One of the unique roles that government science can play is to provide long term monitoring. Regional scale databases are also a strength (Rio Grande, Mississippi, Columbia).

3. Willingness and ability of staff to develop robust methods to support monitoring of environmental contaminants.

4. History of the program in both aquatic and wildlife monitoring give it unique opportunities for creating meaningful databases to identify biologically important contaminant trends.

5. BRD is the only agency involved in monitoring terrestrial vertebrates at the national scale.

6. The tiered approach of broad scale status and trends monitoring, regional monitoring, and more intensive monitoring to determine cause and effect or monitor effectiveness of management actions provides a good framework for effective use of the always limited funds for monitoring.

Weaknesses

1. The lack of a consistent sample archiving program limits the ability to assess long term trends in contaminant levels or biochemical indicators of exposure and to conduct retrospective studies when new techniques are developed or new questions or chemicals of concern arise. .

2. BEST program is grossly underfunded for a national scale monitoring program.

3. Lack of a unified monitoring database within the Contaminants Program or within BRD.

Opportunities

1. Collaboration with NAWQA to provide fish health information and other effects information into surface water monitoring programs has the potential to better answer the rhetorical "so what" questions. Increased collaboration would also provide more biological meaning to the monitoring efforts of this program.

2. The BRD Contaminants Program could be supporting existing monitoring programs in the USGS with the suite of biological assessment skills unique to BRD contaminants program.

4. The BRD Contaminants Program should explore could partnering with the National Institute of Standards and Technology (NIST) on sample archiving. NIST is currently conducting specimen archival programs.

5. Interactions with NAWQA could be increased to better utilize skills of BRD contaminants scientists in the assessment of the health of aquatic species.

Major Gaps

The GIS needs of the Program are large, but the capabilities within Contaminants Program are minimal.

There is a lack of linkage between monitoring contaminant threats and the monitoring of the abundance and diversity of species.

Actions that would improve the program

Monitoring data can be better used to direct hypothesis driven research. The Contaminants Program needs to increase capabilities in broad scale geographic analysis and risk assessment or improve partnerships with those that have these capabilities.

More effectively communicate why the monitoring done by the Program is valuable in managing DOI trust resources. In addition, develop more transparent linkages of the monitoring programs to federal mandates, which should provide greater justification for the monitoring programs and thus potentially increase available resources to the monitoring projects.

As mentioned in previous sections, there are opportunities to better connect ecotoxicological findings with investigations of ecosystem-level dynamics A specific area would be to connect findings of trends in chemical contaminant levels to species declines or system level dynamics. .

Creation of a unified, integrated database management for all monitoring studies within the Contaminants Program, would be an excellent start. This database could then be linked to monitoring studies within BRD (perhaps via NBII).