

**Summary Minutes of the  
U.S. Environmental Protection Agency (EPA)  
Science Advisory Board (SAB) Regional Vulnerability Assessment Advisory Panel  
Advisory Meeting  
October 26-27, 2004 EPA Science Advisory Board Conference Center,  
Washington, D.C.**

Panel Members: See Panel Roster – Appendix A

Date and Time: Tuesday, October 26, 9:00 a.m. – 5:00 p.m. and Wednesday,  
October 27, 8:30 a.m. – 3:30 p.m.

Location: EPA Science Advisory Board Conference Center  
1025 F Street, N.W., Suite 3705  
Washington, D.C. 20004

Purpose: The purpose of this meeting was to provide advice to EPA on the  
Regional Vulnerability Assessment (ReVA) methods and web-  
based Environmental Decision Toolkit.

Attendees: Chair: Dr. Kenneth Cummins

Panel Members: Dr. Cynthia Gilmour  
Dr. Charles Hawkins  
Dr. Orie Loucks  
Dr. William Mitsch  
Dr. Michael Newman  
Dr. Ganapati Patil  
Dr. Charles Rabeni  
Dr. Mark Ridgley  
Dr. James Sanders  
Dr. David Stoms  
Mr. Timothy Thompson

EPA SAB Staff: Dr. Thomas Armitage, Designated  
Federal Officer  
Dr. Anthony Maciorowski, Associate  
Director, SAB Staff Office

Other EPA Staff: Mr. William Jenkins, U.S. EPA Region 3  
Dr. Bruce Jones, U.S. EPA ORD  
Dr. Megan Mahaffey, U.S. EPA ORD,  
NERL  
Dr. Elizabeth Smith EPA, ORD, NERL  
Mr. Tim Wade, U.S. EPA, ORD, NERL  
Dr. Paul Wagner, U.S. EPA, ORD, NERL

Others Participating:

Vicki Bowman, University of North  
Carolina – Charlotte Urban Institute  
Earl Green, U.S. Geological Survey  
Robert O’Neill, TN and Associates  
Valeria Orozco, Waratah Corporation  
Liam Tran, Florida Atlantic University

Meeting Summary:

The discussion followed the issues and timing as presented in the meeting agenda (Appendix B)

**TUESDAY, OCTOBER 26, 2004**

Convene meeting, call attendance

Dr. Thomas Armitage, Designated Federal Officer (DFO) for the Regional Vulnerability Assessment Advisory Panel (ReVA Panel) opened the meeting at 9:00 a.m. He stated that the Science Advisory Board (SAB) is a chartered federal advisory committee whose meetings are public by law. He reviewed Federal Advisory Committee Act (FACA) requirements, the panel’s compliance with Federal ethics and conflict-of-interest laws, and the Panel formation process. Dr. Armitage stated that, as DFO, he would be present during panel business and deliberations. Records of panel discussions are maintained and summary minutes of the meeting will be prepared and certified by the panel Chair.

Dr. Anthony Maciorowski, Associate Director of the EPA Science Advisory Board Staff Office, welcomed the meeting participants and thanked them for providing advice to EPA on the ReVA Program.

Purpose of the meeting

Dr. Kenneth Cummins, Panel Chair, also welcomed the members of the panel and thanked them for their participation. Dr. Cummins reviewed the charge questions to the panel and the agenda. Dr. Cummins then asked the panel members to identify themselves and their affiliations

EPA presentations on the ReVA program

EPA Staff provided a number of overview presentations on the ReVA Program.

ReVA Program Within the EPA Office of Research and Development

EPA staff presented information describing how the ReVA Program is positioned in EPA’s Office of Research and Development. EPA staff noted that the Agency uses risk assessment to evaluate and protect human health and the environment. ReVA is an

important framework for conducting comprehensive risk assessments. EPA staff described the Agency's approach to developing integrated risk assessment methods and the Agency's Strategic Plan and Ecological Research Multiyear Plan. In the context of EPA's Strategic Plan, ReVA provides improved accountability in assessing the state of the environment, ReVA enhances risk assessment approaches, and it enhances science and research to determine implications and consequences of global change. ReVA can also play a role in improved Total Maximum Load and impaired water body assessments. In addition, ReVA can also support efforts to restore ecological systems, protect natural habitats and promote sustainable practices at multiple scales.

EPA staff summarized important cross-Office of Research and Development contributions of ReVA. ReVA provides a multi-scaled environmental targeting approach, it provides methods to extend and enhance results of existing field-based monitoring programs, it provides an approach for integration of environmental condition estimates in space, and it provides a means of assessing multiple stressors and environmental endpoints at multiple scales. ReVA also provides an approach and framework for evaluating alternative future policies and management strategies relative to: optimizing for multiple ecological resources and processes, multiple stressors that span EPA program offices, assessing economic and social consequence and feedbacks of different options, and overall quality of life and sustainability.

EPA staff concluded their presentation by summarizing the four charge questions provided to the Panel.

Panel members asked several questions the conclusion of the presentation. A panelist asked whether the National Water Quality Assessment Program (NAWQA) and ReVA are related. EPA responded that ReVA has been developed with an understanding of the activities of the National Water Quality Assessment Program.

A panelist noted the SAB Ecological Processes and Effects Committee has developed a report card document for reporting on environmental condition. The panelist asked whether the ReVA program had used this document to develop its own approach. EPA staff responded that they were not familiar with the specific information in the SAB document, but that the ReVA program has looked at a number of existing programs to develop the approach.

A panelist asked whether there is a conceptual model that describes the ReVA approach. The panelist noted that in the report, *Regional Vulnerability Assessment for the Mid-Atlantic Region: Evaluation of Integration Methods and Assessments Results*, there is a table that identifies the variables used in the integration methods applied in ReVA. The panelist asked how the data described in the ReVA documentation were used to develop the ReVA approach and whether evaluation of the variables is described in a conceptual model. EPA staff responded that the report provides a description of a number of different integration methods. The methods have been compared using the same set of regional spatial data. Recommendations have been developed for the use of integration methods in ReVA on the basis of this evaluation.

A panelist asked what the impetus is for holding an SAB review of ReVA. EPA staff responded that the Agency wants to look at the approaches to be considered for use in ReVA and to identify ways to improve the approach. EPA is considering the development of decision tools.

#### Regional vulnerability assessment: informing decisions through synthesis and forecasting

EPA staff provided an overview presentation of the ReVA Program and approach. EPA staff noted that the Agency has been working on the ReVA Program since 1998. The program is focused on the problem of addressing multiple stresses affecting multiple media. ReVA answers questions related to targeting limited resources to minimize problems and maximize benefits. ReVA's clients are the EPA program offices and Regional offices and state and local decision-makers.

EPA staff described a number of priorities that are addressed by the ReVA program including: synthesizing existing information, understanding multiple stressors, and forecasting. EPA staff stressed that ReVA is an applied research program. Partnerships have been established with EPA's Office of Air and Radiation, the Office of Water, and the Office of Environmental Information. The ReVA program is also working with EPA Regional Offices, state government agencies in Maryland and Pennsylvania, and has established cross-jurisdictional alliances with North and South Carolina councils of government. These partnerships have provided the ReVA Program with an opportunity to transfer technology. The Office of Research and Development wants to continue working with these kinds of groups.

EPA staff described how the ReVA Program can provide assistance in making decisions to reduce risks in vulnerable ecosystems. Decisions involve multiple criteria derived from stakeholder input, politics, economics, feasibility, and scientific understanding. The ReVA Program provides an approach to evaluation of tradeoffs. The program is: developing new approaches to risk assessment (comparative, cumulative, and multi-scale); looking at current and future vulnerabilities in areas that have many resources and stressors; and providing an approach for futures analysis. The program is trying to link environmental health with human health and develop new indicators. The ReVA program supports research on: new indicators, new spatial models, integration methods, socio-economics, decision tools, quantifying error and uncertainty, issues of scale, and information technology

EPA staff stated that decision support tools are important products in ReVA. These tools have been developed for multiple users. Multiple approaches and tools are provided (both web-based and PC-based). ReVA is looking at how existing tools can be improved. EPA staff outlined activities completed to develop the current version of the web-based Environmental Decision Toolkit. Data were pulled together to estimate condition across two regions (the Mid-Atlantic, and a multi-county region in North Carolina) and a number of data integration approaches were evaluated to estimate condition. New

models have also been developed to estimate future condition. The program has tried to project drivers of change. Land use change to the year 2020 has been used to project future scenarios for the Mid-Atlantic region. The ReVA program has looked at using bird migration scenarios, groundwater vulnerability, landscape indicators and nitrogen and phosphorus loadings to project futures. The program has also looked at using mining activities in permitted areas. The eight digit hydrologic cataloging unit has been used for projections. EPA staff presented a number of examples of futures analysis.

EPA staff noted that ReVA is turning spatial data into information that can be used by decision-makers. The ReVA Program provides web-based interactive integration and visualization tools, an approach for data diagnostics and data preparation, an approach for integration of data in selectable subgroups, weighting in support of multi-criteria decision-making, and access to data summarized by reporting unit. EPA staff noted that ReVA offers an approach for addressing multiple assessment questions including: what makes an ecosystem vulnerable (condition, sustainability, and value to society), and what drives risk management decisions (feasibility, clear options, and economics).

EPA staff described planned future work in ReVA, research needs, and research opportunities. Planned future work includes: water supply modeling with the USGS, work in EPA Region 4 to evaluate the vulnerability of human and wildlife populations to air toxics, and pilot work in EPA Region 5 to support decisions concerning hazardous wastes mitigation and internet services supporting compliance reporting and analysis. Research needs include: work on indicators and model domains of scale, work on the issues associated with changing reporting units, quantifying error and uncertainty, incorporating thresholds into ReVA, approaches to minimizing degradation, and use of translators where data do not address questions specifically. The ReVA program has identified research opportunities in the following areas: investigation of broad to fine scale applications, new interpolation methods, use of model output as surface maps, cross-media trading, and estimating error.

EPA staff noted that they are working to enable incorporation of the ReVA approach into decision-making. They are building client partnerships at a number of different levels, they are demonstrating application of the approach and information at different scales, and they are working to provide easy access to ReVA data and tools.

At 10:15 a.m., following EPA's overview presentation on ReVA, the Chair of the Panel called for a 15-minute recess and reconvened at 10:30 a.m.

#### Spatial data and landscape models in ReVA

EPA staff provided a presentation of the spatial data and landscape models that are used in ReVA. Spatial data used in ReVA include raster and line data. Data have been included to describe elevation, land cover, streams, and roads. EPA staff described variables and model outputs used in ReVA. These include such variables as: percent forest, percent agriculture on slope, percent agriculture along streams, nitrogen and phosphorus loadings to streams, nitrate concentrations in groundwater, ozone values,

non-native species potential distribution, and neo-tropical bird migration. Drivers of change considered in ReVA include: land use change, pollution, non-indigenous species, resource extraction, and climate change. Endpoints considered in ReVA include: forest productivity, water quality, and biodiversity.

EPA staff described how data are aggregated in ReVA. Eight digit U.S. Geological Survey watershed units are used to aggregate data. For raster and point data, watershed values are determined by averaging all grids or points within a watershed polygon. EPA staff described the pros and cons associated with using these hydrologic units to aggregate data. The disadvantages associated with this approach are that: a single value for each variable is applied to a watershed, this value cannot be applied to every point in the watershed and it cannot automatically be scaled down. The advantages associated with this approach are that: the average over a watershed has less uncertainty, land use classification errors are smaller at larger scales, and in general spatial models provide more accurate estimates using this approach.

EPA staff described the ReVA analytical tools interface for landscape assessment (ATtILA). ATtILA uses raster data to derive landscape metrics (such as percent of crop land, percent of pasture, percent of agricultural use, percent of forest, etc.) for hydrologic units. Data are placed in a table that can be used in integration methods. ATtILA can provide multivariable landscape metrics and can look at riparian zones. ReVA uses the genetic algorithm for rule-set prediction (GARP) to develop the potential distribution of nonindigenous species. GARP uses a set of “if-then” rules to provide the distribution of species within a watershed. ReVA also uses models to project biodiversity. EPA staff described how bird habitat quality is projected.

EPA staff described a number of new techniques that are being applied to improve the outputs from models to provide a better output based on habitat conditions. One technique is calculating Mahalanobis distance for each cell in a study area. EPA staff also described work completed in the ReVA Program to model ozone levels and nutrient export from watersheds. Work to model groundwater was also described. A groundwater model was used to predict the probability of exceeding a nitrate threshold in watersheds within the Mid-Atlantic region.

EPA staff concluded the presentation, noting that there is a need to consolidate and integrate available data, and make it available to decision-makers ReVA is working to do this.

Panelists asked a number of questions. A panelist asked whether the main purpose of ReVA is to show what can be done with data that has already been collected. EPA staff responded that ReVA is looking at ways to synthesize data that is already available. ReVA is not in the business of monitoring.

A panelist noted that in ReVA, dissolved phosphorus is defined using suspended sediment in streams and is modeled from land cover. He asked why this approach was used. EPA responded that ReVA used the available data to evaluate integration methods.

In some cases surrogate data were used in ReVA to evaluate integration methods. EPA does not plan to use sediment as a surrogate for phosphorus when doing an assessment

A panelist noted that the ReVA Program has focused on evaluating data integration methods. The panelist asked how EPA decided what endpoints to use in ReVA for assessing ecosystems. EPA staff responded that the Agency has used data that were available at a regional scale to conduct an evaluation of data integration methods. At some point it will be important to look at better indicators. EPA staff stated that the Agency welcomes recommendations from the panel in this regard. The panelist stated that additional information is needed to document how areas were scored in ReVA.

A number of questions were asked about the data layers and models used in ReVA. A panelist asked whether EPA conducted any quality assurance or quality control activities before using data. EPA staff responded that existing data were assembled but the ReVA Program did not conduct an in-depth evaluation of the data. The panelist asked whether there is a single list of all the data layers assembled for use in ReVA. EPA staff responded that there is an appendix in the report, *Regional Vulnerability Assessment for the Mid-Atlantic Region: Evaluation of Integration Methods and Assessments Results*, that identifies the data layers. The panelist noted that this appendix provides information on all of the available data layers. A panelist asked EPA staff whether the Agency used a process of validation to select models for use in ReVA, or whether the models were selected for use arbitrarily. The panelist asked why there is no mention of validation needs in the report provided to the Panel. EPA responded that the Agency is beginning to look at the factors affect the variables used in the models.

Panelists asked a number of questions about the scale of analyses conducted in ReVA. A panelist noted that ReVA is described as a multiscale operation, he asked EPA to define multiscale. EPA staff responded in ReVA they are trying to combine fine and broad scale information. EPA is interested in knowing whether the eight digit hydrologic unit scale data can be taken down to a smaller scale. Panelists asked how spatial boundaries are defined and considered in ReVA. Panelists asked whether spatial boundaries were developed with regard to ecosystem characteristics. EPA responded that spatial boundaries are not necessarily based on ecological factors. They can be driven by emissions data. Panelists asked why EPA has chosen to use eight digit hydrologic units instead of 11 digit units. EPA staff responded that data were not available for anything less than the eight-digit unit.

Panelists asked a number of questions related to the overall ReVA approach and development of the ReVA Program. A panelist asked when EPA began developing ReVA. EPA staff responded that EPA started working in the Mid-Atlantic region in 1998. A panelist asked EPA to describe what the “ReVA approach” is. EPA staff responded that the ReVA approach is a way of pulling together and integrating data. Through ReVA, EPA is developing spatially explicit landscape models. ReVA is bringing the data together and making it available. EPA is also developing endpoints of interest.

The panel asked questions about data and models and spatial units used in ReVA. A panelist noted that one way to validate ReVA models is to use a “backcast” approach. EPA staff responded indicating that they have considered using this approach to validation in the Sustainable Environment for Quality of Life (SEQL) program. EPA is considering using available data from North Carolina and South Carolina to see if predictions hold. A panelist asked whether EPA had to merge data in ReVA, and noted that merging EMAP and NAWQA data can be problematic. EPA responded that the Agency has worked with algorithms for creating surface maps based on coverages. It has been difficult to validate models. Some work has been completed to determine how lumping or reaggregating data can improve model performance. A panelist asked whether EPA has used Landscan. EPA staff responded that they had not used it.

A panelist asked why EPA chose to use hydrologic cataloging units in ReVA as opposed to some other spatial unit. EPA staff responded that most of the data that is included in ReVA is water related. A panelist noted that hydrologic cataloging units do not show intermittent streams. Runoff comes from roads, and since roads cross-hydrologic cataloging units, this is a source of uncertainty. EPA staff responded that they have used road networking. The use of hydrologic cataloging units is a way of partitioning the surface, but EPA has also looked at using finer grid scales. EPA staff noted that they have considered using ecoregions, but this has not reduced variability very much. People in EPA Regions are familiar with the use of hydrologic cataloging units.

The Panel Chair asked EPA for the next presentation on data integration methods

#### Data integration methods

EPA staff provided a presentation on analysis and interpretation of data integration methods for use in ReVA. Data integration methods have been evaluated using data available from the Mid-Atlantic region. EPA staff stated that ReVA’s first strategic priority is integration of existing data. From existing data, EPA can obtain estimates of resources, variation in sensitivities, and distribution of stressors. EPA staff described some of the issues associated with data integration (such as discontinuity, skewness, imbalance, and interdependency) and noted that the Agency looked at 150 variables to be used in ReVA analyses. EPA noted that they did not want to include variables that had high correlation. Those that were very highly correlated were deleted, leaving 50 remaining variables. All variables were normalized and EPA evaluated eleven methods used to integrate the Mid-Atlantic data. EPA staff described these methods, noting that the methods ranged from very simple approaches to multivariate statistics. EPA staff noted that they have looked at integration methods that rank condition, methods that measure distance from reference, methods that rank vulnerability, methods that group like units, and a method that identifies worst stresses and most vulnerable resources. EPA used existing methods, although some of the methods used are new to the literature.

EPA noted that the evaluation of integration methods showed that some methods produced similar results and some of the methods complemented each other. EPA concluded that a suite of integration methods should be used. Methods that compensate

for the limitations of others can be coupled for use. EPA determined that if similar results are obtained using different methods, the simplest methods should be used. EPA noted the need to test the integration methods in other regions.

Panelists asked a number of questions about the data integration methods. A panelist asked how EPA could avoid letting the public choose the method that provides the most favorable results. EPA staff responded that the Agency wants to develop guidelines on selecting methods, but has not yet completed this. A panelist noted that EPA should consider how methods should be linked together. A panelist asked how EPA selected reference areas for use in some of the integration methods, and whether this was done at the watershed or hydrologic cataloging unit scale. EPA staff responded that the purpose of the evaluation was to demonstrate an approach. For this purpose, EPA used a watershed that had the highest level of stressors and resources.

Panelists asked a number of questions about the normalization, distribution and transformation of data used to evaluate integration methods. EPA staff noted that the Agency looked at the range of data. The data were normalized and some transformations were explored. The Panel discussed whether all of the variables used were on a ratio scale. The panel discussed the theoretical basis for use of different models and how data outliers affected the meaning of results obtained from simple models.

A panelist noted a contradiction between EPA's risk assessment method and ReVA. The panelist noted that in risk assessment it is important to spend time on risk characterization. In the ReVA material there is no discussion of why the forecasts should be believed. EPA staff responded that they have struggled with differences between the risk assessment paradigm and ReVA. It has been difficult to fit the ReVA program into the traditional risk assessment framework. EPA welcomes recommendations about how this could be accomplished.

A panelist noted that the use of existing data in ReVA renders the program susceptible to being viewed as a failure. The panelist noted that the public should not be responsible for selecting the ReVA integration methods that are to be used. The panelist noted that there is a danger in allowing people to decide which data sets are the correct ones to use. EPA needs to provide more guidance in this area.

Following the discussion, the Chair asked EPA for the next presentation on the agenda. EPA staff presented information on future vulnerability assessments.

#### Future vulnerability assessments

EPA staff presented an overview of the Agency's work to conduct future vulnerability assessments based on non-indigenous invasive species, air pollution, and land cover change and resource extraction. EPA staff indicated that a predictive model, the genetic algorithm for rule-set prediction (GARP) is used in ReVA to describe relationships between occurrence and environment using multiple rules. A genetic algorithm, an artificial intelligence application, is used for generating rules. An example of the

potential distribution of giant salvinia was presented. EPA staff described use of a global climate model to predict potential distribution of this species. EPA staff also presented an air quality example of predicting future vulnerability. Design values for eight-hour ozone and particulate matter (PM<sub>2.5</sub>) were estimated for the year 2020. EPA staff described a land cover example which applied Landsat data, an urban growth model, new and expanded roads, and permitted mining activities in Pennsylvania, Virginia, and West Virginia to develop estimates of future vulnerability. The Slope, Land use, Exclusion, Urban Transportation, Hillshading model (SLEUTH) was used in this analysis. Thresholds were used to evaluate new urban development. EPA staff presented the results of the analysis projecting future areas of vulnerability in the Mid-Atlantic region.

The panel asked a number of questions about the analysis. A panelist asked for clarification concerning use of the GARP model. EPA staff responded that the GARP model is used to describe species habitat. It predicts where there will be habitat for introduced species. A panelist asked what ozone threshold was used for non-attainment in the air pollution model. EPA staff responded that a threshold of 80 parts per million was used. A panelist asked EPA to describe what data were used to apply the SLEUTH model. EPA staff responded that land cover data are used in the model. The SLEUTH is an improvement of the urban growth model. In SLEUTH, users can define spatial and temporal resolution. SLEUTH tells users the probability of land conversion from rural to urban uses. The model has been improved to include other land cover changes, but the conversion to urban land was the biggest driver in the Mid-Atlantic region. All processes in SLEUTH are evaluated on a 30-meter grid.

A panelist noted that the analysis projected 50% increase in mining coverage by 2020, and that this was surprising. EPA responded that this represents an increase in the permitted area only. Another panelist noted that the future vulnerability assessment appears to have three elements: GIS layers of data, models that independently express the base data spatially, and integration methods. The panelist noted that this analysis is very similar to the previous presentation of the process used to apply integration methods. EPA responded that in the future vulnerability analysis incorporates an interactive phase. What has been presented is a “straw man” to demonstrate the approach of using models, putting them together, and integrating the data to project into the future. The future vulnerability assessment is not intended by EPA to be an assessment of the region. It is a demonstration.

A panelist asked whether EPA thinks that clients who populate the model with data would conduct future vulnerability assessments. EPA staff responded that clients could populate the model with data. ReVA is not in the business of doing the assessments, but it does provide the tools for clients to conduct assessments. A panelist noted that the scientific community could help EPA to get science organized to support ReVA, but decision-makers should not drive the science, and managers should not decide what the scientific questions are. EPA staff noted that in ATtILLA, EPA is providing a tool with the flexibility to populate models but not a standard set of data. EPA staff also noted that coverages have been developed to balance the needs of clients with science.

The panel asked a number of questions about how integration methods were used to create future vulnerability scenarios. A panelist asked which of the eleven integration methods were used. EPA staff responded that none of the integration methods were used to create future scenarios. Current and future data are integrated to create change maps, but the integration methods described previously are not used.

A panelist noted that a fast Internet connection is needed to generate the ReVA maps and asked whether the speed would be upgraded in the future. EPA staff responded that the application will be moved to the Research Triangle Park server and it may be somewhat faster in the future.

Panelists asked questions about how EPA intended to use ReVA. A panelist asked whether ReVA could be used at a small scale to evaluate conditions that change abruptly or, for example, to evaluate effects on threatened and endangered species. EPA staff responded that ReVA is not designed to look at sudden events. EPA would like to develop ReVA for use at local scales. The research version of ReVA can provide quite a bit of information about the distribution of threatened and endangered species and it may be possible to look at what might be affecting these species.

Panelists asked a number of questions about the integration methods used in ReVA. A panelist asked why specific research needs have been associated with particular integration methods. EPA staff responded that the list of research needs provided was not an exhaustive list, but some examples were provided in the document describing the methods. A panelist asked what additional research was needed to further develop cluster analysis. EPA staff responded that the Agency is trying to determine which patterns provide signatures from ecological condition, and which patterns provide signatures from the noise of data.

At the conclusion of the discussion, the Chair asked EPA for the next scheduled presentation on the ReVA Web-based Environmental decision Toolkit.

#### ReVA's Web-based Environmental Decision Toolkit (EDT)

A representative from EPA's contractor, Waratah Corporation, described the environmental decision toolkit (EDT). A "guided tour" of the EDT was presented by displaying information available in the EDT and the results of analyses conducted using the EDT. It was stated that the EDT is not a decision system. The EDT contains software to assist users in making informed decisions. It was noted that the EDT provides tools to analyze and visualize indicator data, present current and future data spatially and statistically.

There are multiple versions of the EDT. A version is now available on the ReVA public website, a client version has been placed on a website for local decision-makers in North and South Carolina, and a research version has been placed on a website developed for EPA Region 3. The research version provides data from the Mid-Atlantic region. The public version is for non-scientifically trained public officials and citizens. The client

version describes watersheds and county boundaries. An example demonstrating the use of the client version was presented showing air quality in areas with high and low-density development. A second example demonstrated water quality in areas with high and low percentages of impervious land cover. The research version of the EDT is for EPA regional planners, scientific researchers, and state strategic planning offices. The research version provides a number of interactive tools for using integration methods and tools to display spatial uncertainty associated with data.

Panelists asked questions about the EDT and use of the integration methods. A panelist asked how uncertainty is considered in the analytic hierarchical process. EPA responded that this process can take quantitative data into account and in the future will take judgments into account. EPA is trying to account for uncertainty, translating a spatial map into a single indicator. A panelist asked how the tutorial works in each of the web-based versions of the EDT and why different methods are to be used in each version. EPA responded that the research version will evolve into the EPA regional version to be used by people who have analytical backgrounds. EPA is trying to develop ReVA for different clients.

A panelist commented on the use of trade-offs, priority setting, and the use of “weights” in ReVA. The panelist noted that trade-offs should not be considered in some situations, such as when considering questions regarding endangered species. If trade-offs are used, it is not possible to deal with these kinds of questions. The panelist noted that priority setting involves values, and noted that ReVA does not provide this kind of input. The panelist also questioned how the “weights” used in ReVA will become apparent. The panelist asked whether the current versions of EDT are “illustrative” or final. EPA responded that the public version of ReVA is illustrative. The client version needs additional input and EPA is planning to further develop the research version. The final version of the EDT will depend upon what kind of data is available. EPA is looking for input on how to implement models (for example, should the client create the hierarchy?).

A panelist commented on the clusters in the modeling approach in the EDT, noting that it would be useful to break the approach into two parts: 1) how to predict futures, and 2) how to explain how the system is working. The panelist also noted that priorities must be set based on some interpretation vis-à-vis the actions to take. The meaning of the predicted result must be further explained in order to compare and contrast alternative actions.

The Chair commented on the importance of looking at both the spatial “temporal pulse” of the data. The Chair asked EPA staff how many data sets were available with both temporal and spatial information. EPA responded that not many data sets provided this information. Some of the NAWQA data provide both spatial and temporal information. The Chair stated that this should drive the need to obtain new data.

Panelists commented on the need to apply mechanistic models in ReVA. A panelist noted that in the EDT documentation there is a good discussion of using statistical models, but very little mechanistic modeling has been brought into the EDT. There are

mechanistic models that can be incorporated, and region-wide data are available for use with these models, this kind of information is not provided in the spatially explicit data currently used in ReVA. The panelist also noted that risk characterization (moving from exposure to outcomes) could be incorporated into ReVA. The panelist noted that EPA should work to continue improving ecological predictions, but this cannot be accomplished by relying only on spatial data. The Chair expressed agreement, again noting the importance of using temporal data. EPA staff responded that data are not available to support use of mechanistic models over an entire region. EPA is trying to conduct a coarse assessment to target what is known and to identify the need for further assessment. This is a “broad brush” approach. A panelist noted that a problem with this kind of approach is that it can consistently provide the wrong answers. For example, nitrogen and phosphorus are used to develop total maximum daily loads, but there are other factors that should be considered to improve biotic integrity measures. EPA staff responded that some factors, such as nitrogen and phosphorus are used because there are legal requirements for their use.

Another panelist commented that there is currently a preponderance of Geographic Information System modeling being conducted at the expense of understanding the dynamics of the ecosystem over time. The panelist noted that much research that has been conducted on how ecosystems work and this should be applied. The panelist noted that there is a need to move beyond the use of only colored maps. Another panelist agreed but noted that the maps are useful. Maps provide important baseline data, but there is a need to apply mechanistic models (e.g. fate, transport, and bioaccumulation) to set appropriate thresholds.

Another panelist noted that spatial models are useful, but expressed the opinion that the approaches used have swung too far toward the use of mathematical algorithms. The panelist noted that in Europe, dynamic models are being used and that EPA has also used suites of models. A panelist stated that maps are a clean way of presenting information, but behind the plots are mechanisms. As ReVA is currently presented, it is not possible to associate mechanisms with the plots. This approach is similar to a human epidemiological approach where it may not be necessary to know mechanisms in order to take actions. A panelist commented that it is difficult to extend a model to an entire region, and this is the objective of ReVA.

The panel discussed the use of “incomplete” data and forecasting in ReVA. EPA staff noted that the strategy for using incomplete data sets is a research design topic. In ReVA the Agency is applying what is presently known. Panelists acknowledged this, but noted that the use of additional modeling tools could provide more confidence in the results. A panelist noted that the ReVA EDT builds expectations that may not be met with the currently available tools and data. EPA staff noted that futures research is a whole field itself, and that there is much that can be done. EPA staff noted that the Agency wants to be careful about providing the most appropriate tools to users for developing futures scenarios and has not yet made the tools available for general use. A panelist noted that the tools should be tested and coupled with mechanistic models. Calibration is needed.

Following the discussion the Chair recessed the panel for a break and reconvened the meeting at 3:00 p.m.

### Application of ReVA tools and methods to decision-making

The Chair asked EPA for the next scheduled presentation on application of ReVA tools and methods to decision-making. The presentation was provided in three parts. EPA staff provided an overview of how ReVA has been applied in decision-making. Staff from the EPA Region 3 then discussed how the Regional Office has used ReVA. A presentation was provided by staff from the University of North Carolina – Charlotte Urban Institute to indicate how ReVA has been used in counties around Raleigh, North Carolina.

EPA staff noted that ReVA is being developed serve many partners with many interests on many scales. Partners in developing ReVA have included EPA Regions (Region 3, Region 4, and Region 5), States (Maryland and Pennsylvania), and local groups (the Sustainable Environment for Quality of Life). EPA staff described the decisions that ReVA can inform. These include: prioritizing management resources, seeking compromises among different interests, planning conservation efforts, assessing the condition of regional components, estimating the effect of restoration/mitigation, and evaluating the effects of individual stressors. EPA staff noted that ReVA can apply multiple data layers to evaluate stressors and determine how management of resources could be prioritized. EPA staff demonstrated how the effects of stressors such as agriculture along streams and steep slopes, forest fragmentation, and invasion of exotic species could be evaluated in the Mid-Atlantic region. EPA staff demonstrated how ReVA could be used to seek compromises among different interest groups (e.g. fishing, hiking/bird watching, and planning) to evaluate and priorities. Examples of the use of ReVA to evaluate development in Region 3 and to evaluate regional growth and sustainable development in North Carolina were presented. EPA staff noted that the next steps in applying ReVA will involve continued work in EPA Region 3 and new work in EPA Regions 4 and 5. This work will focus on evaluating alternative smart growth strategies, assessing impacts of alternative incentives for pollution prevention, and investigate solutions for cross-boundary issues associated with air and water quality, such as cross-media trading.

The Chair thanked EPA for the presentation and asked for the next scheduled presentation on how ReVA has been used in EPA Region 3. Staff from EPA Region 3 described how ReVA is being used to make strategic decisions. EPA Region 3 is committed to: assessing the ecological condition of the Region's land and water, assessing human health condition, assessing the vulnerable ecosystems and human health populations in the Region, building an ecological corridor map, mapping the major stressors, displaying this information with maps and story boards, parsing the information (by state, congressional districts, watersheds, and ecoregions), and collaborating with states. EPA Region 3 has found that ReVA will be of great benefit in accomplishing these objectives. ReVA will help provide appropriate data, indicators, tools, and maps that reflect the condition of ecosystems. ReVA will help provide the means to

strategically prioritize, direct and measure the results of collective efforts, and ReVA will help provide the methods for determining where and how to integrate information into existing policy making and implementation processes.

The Chair thanked EPA Region 3 staff for the presentation and asked staff from the University of North Carolina Charlotte Urban Institute for their presentation on how ReVA is being applied in the Sustainable Environment for Quality of Life (SEQL) Program. Staff stated that ReVA is being applied in the SEQL Program (covers 100 counties and municipalities). The Charlotte metro region is facing some difficult environmental quality of life issues. SEQL is pulling together government, business and community leaders to address quality of life issues. A major issue in the region is non-attainment of air quality. Staff described how the ReVA EDT is being used to understand the questions that must be addressed to improve air quality and manage growth.

Panelists asked a number of questions concerning the application of ReVA. A panelist asked whether ReVA is being used as a tool to compare alternatives or look at overall vulnerability. EPA staff responded that it is being used for both purposes. It is being used to understand relationships between urban land cover and impervious surfaces, and to understand and compare potential solutions to air and water quality improvement issues. EPA Region 3 staff noted that the capability of integrating data to develop vulnerability estimates is very important.

A panelist noted that one of the goals presented in the discussion was achieving regulatory compliance. The panelist noted that regulatory compliance may not be the best response to be measured. EPA staff agreed that even if regulatory compliance is achieved, the desired environmental result may not be achieved.

A panelist asked the EPA Region what level of watershed was to be used in the near future for these kinds of assessments. EPA staff responded that discussions have indicated that it will be useful to apply ReVA on a stream segment, or as fine a scale as possible. In the short term, ReVA may not satisfy that need.

A panelist noted that it may not be appropriate to provide certain models and methods to decision-makers without guidance on use of the models. The panelist noted that planning decisions are political and models can be misused, or one group can pick models for others to use. EPA staff agreed that elected officers should not choose models for staff. Another panelist noted that most planning decisions are made at state and local levels, and that EPA would not be the end user of ReVA in these cases. The panelist asked EPA to comment on which level of decision maker would be most likely to use ReVA. EPA staff responded that decisions are made at all levels. ReVA is being developed for multiple decision makers at multiple scales.

Panelists commented that EPA provided a very good demonstration of how to use the EDT, but that it was not possible to determine which tools were being used to generate results. Additional support validation, and calibration of the methods is needed in order to avoid challenges to decisions. It is important to test whether the input data to ReVA

can provide a valid assessment of ecological condition. A panelist noted that it is important to document how ReVA predicts current conditions, not just future conditions.

At the conclusion of the discussion the Chair thanked the participants for their presentations and reviewed plans for the next day. The Chair stated that on the next day the Panel would discuss each of the charge questions and develop responses. The Chair reviewed the assignments of various Panel members as discussion leaders for the charge questions. The Chair noted that the responses to charge question one would be considered in two subparts, responses to charge question two would be considered in three subparts, the response to charge question three would be considered in one part, and the response to charge question four would be considered in two subparts. The Chair then stated that the panel would reconvene at 8:30 a.m. the following day and recessed the Panel at 5:00 p.m.

#### **WEDNESDAY, OCTOBER 27, 2004**

The Chair reconvened the meeting at 8:30 a.m. and reviewed the agenda for the day. The Chair stated that the Panel would consider each of the charge questions and develop draft responses. The DFO would assist the chair in developing a draft report, which would be circulated to the Panel for review and approval. Before the Panel addressed the first charge question, EPA staff requested an opportunity to provide clarifying information about the ReVA report on integration methods. The Chair asked EPA staff to address the Panel.

EPA staff noted that the integration report should not be viewed as an assessment of the Mid-Atlantic region. The product that is being developed for vulnerability assessment is the EDT. The integration report describes methods that are available to develop statistical models. EPA will take advantage of the models that are available to develop the EDT. EPA staff noted that some mechanistic models are being used.

A panelist responded that statistical models should be validated and that several procedures are in place for validation. EPA staff noted that it is not possible to find data for validation of all of the models. The available data were used to develop the models. The panel discussed approaches for cross validation of the models. Panelists noted that validation of the models is very important. Part of the available data should be used for building models, and part should be used for validation. EPA staff noted that it is important to define what "model" refers to, and whether an integration method should be called a model. A panelist suggested that it might be useful to think of four groups of models that might be used in ReVA: 1) interpolation models, 2) mechanistic models, 3) integration methods, and 4) landscape models. Statistical methods are included in these groups of models. Another panelist noted that validation methods are available for all of these kinds of models and should be used. The Chair asked EPA staff whether they were planning to validate the ReVA integration methods. EPA staff responded that this work is planned.

Discussion of the strengths and weaknesses of ReVA as a tool to provide an overview of current and future regional conditions

The Chair then asked the panel to begin discussion of the first part of charge question one, noting that EPA asked the Panel to comment on the strengths and weaknesses of ReVA as a tool to provide an overview of current and future regional conditions.

One panelist stated that in order to answer this question it is necessary to understand the quality of the input data used in ReVA. The panelist noted that there is no documentation of confidence levels in the data. One can comment on ReVA as an approach, but if asked whether it can be used, one has to look at how good the data are. EPA staff noted that broad sets of data are used in ReVA. Most of the data were obtained from federal agencies and public sources (such as the National Land Cover Data Base and NAWQA). The panelist noted that he was troubled by not knowing how “good” the data are. He noted that the confidence levels (e.g., 10% or 100%) are not available.

Another panelist stated that it was not clear to him what the boundary of ReVA is. It is very difficult to circumscribe what ReVA is. The Chair stated that an even more fundamental problem is that whether the right attributes are being considered in ReVA. If EPA made a judgment of the data needed in ReVA it might be quite different from what is currently available in ReVA. It would be useful to have insight into how the data integration process provides information on data gaps. EPA staff noted that it would be difficult to answer this question.

A panelist stated that, while he applauded EPA for developing the ReVA approach, it is important to identify elements for which metadata are available. It is important to include the metadata so that decision-makers can decide how they want to use the data. Another panelist noted that it would be useful to compile and publish a separate document to identify the types of data and data layers. A statement about the quality of data could be made in this document. A panelist stated that EPA might want an appendix to list the steps that were followed to identify the data and include it in ReVA. Another panelist noted that it would also be useful to provide information on the data that were not included in ReVA. A panelist asked EPA if a list of the data used in ReVA is available. EPA responded that a matrix of all data sets is available and that the Agency is working on compiling the metadata.

The Chair asked the Panel to be cognizant of the fact that the ReVA documentation provided has not been presented as an assessment. It is a framework of an approach that EPA continues to develop.

A panelist noted that in ReVA vulnerability appears to be defined by stressors X resources. An alternative model to be considered is a blend between a social science view and risk assessment practice that is consequences X vulnerability equals hazard.

The panel discussed the difference between the Mid-Atlantic Integrated Assessment (MAIA) and ReVA. A panelist asked EPA whether MAIA incorporated integration tools

or forecasting. EPA staff noted that MAIA did not incorporate integration tools or forecasting. The web tools in ReVA build on the MAIA work. However, if you look at MAIA you do not get an understanding of what ReVA does because MAIA is a partnership that provides a set of monitoring indicators and models, but it does not provide tools to meet user needs.

A panelist noted that in considering the response to the first charge question one could think of ReVA as providing three elements: 1) an extensive set of spatially explicit data in a GIS format with standard evaluation procedures, 2) component mechanistic models for forecasting, and 3) integration methods to meet program mandates of defining vulnerability that can be used for regulatory decision-making. EPA staff noted that ReVA does not specifically address regulatory decision-making.

Another panelist noted that the EDT is the ReVA approach. The panelist noted that in ReVA vulnerability is defined as a gradient and a surface. However, it is important to clarify that ecological condition is multidimensional.

At 10:15 a.m. the Chair stated that the Panel would recess for a fifteen minute break, and that following the break he would ask the charge question leads to focus the Panel discussion on the key points to be included in the responses to the questions.

The Chair reconvened the Panel at 10:30 a.m. and asked Dr. Gilmour to lead the discussion identifying the strengths and weaknesses of ReVA as a tool to provide an overview of current and future regional conditions.

The following key points were identified and discussed in the response to the charge question. Panelists noted that EPA has done a good job assembling drivers of vulnerability in ReVA. However, translating them into future conditions is a problem.

Panelists noted that EPA needs to clarify the elements in ReVA for which good metadata are available. The panel also noted that more attention to mechanistic models is needed in ReVA. A panelist stated that one of ReVA's strengths is plausible scenario evaluation. ReVA is a great visualization tool that can be used by planners. The GIS representation in ReVA has great potential, but people may make decisions without looking at the underlying data.

Panelists noted that the suite of ReVA tools provides an exceptional application opportunity to assist local and regional resource managers assess current and future regional conditions. The use of spatially explicit data coupled into a geographic information system interpretation and display module has a high degree of value to be applied over the range of questions ReVA intends to address.

The panel discussed a number of strengths of ReVA. Panelists noted that ReVA provides new methods to synthesize existing data in a spatial framework and that integration approaches for multivariate data are being developed in ReVA. Panelists also noted that

ReVA offers the power to apply visualization tools for effective communication with the public.

Limitations of ReVA were discussed. Panelists noted that there is a lack of basic documentation of the ReVA framework and process, and also a lack of availability of ecosystem-specific data, and good indicators of ecosystem health. A panelist stated the summary indicator models in ReVA needed calibration, verification, and sensitivity demonstrations.

Panelists offered a number of suggestions to improve ReVA as a tool for providing an overview of regional conditions. It was suggested that overarching conceptual models should be developed for ReVA, and that clear basic documentation on the ReVA process was needed. Panelists also noted that a process to evaluate the performance of indicators used to assess ecosystem health was needed. A panelist stated that increased transparency in providing information on the data sets used in ReVA is also needed.

A panelist stated that the development of ReVA has been a great effort by a highly skilled team, but that much of the knowledge about what constitutes ReVA resides with the developers. A source document is needed to articulate what ReVA is, and what specific procedures to be followed. A panelist noted that ReVA is a process, the strengths of which lie in the standards for assembling the data sets, quality assurance reviews, and methods for interpolating limited data with an eye to understanding and addressing specific regional questions. The panelist noted that SAB should recommend that EPA develop and make available to the public and ReVA clients a concisely written description of the ReVA process, and the tools that have been developed within ReVA.

Another panelist noted that the developers of ReVA must make clear the differences between forecasting and scenario analysis to project future vulnerability. The panelist noted that the SAB might define forecasting as the application of well defined, calibrated and validated mechanistic models.

At the conclusion of the discussion of the chair thanked the panel for their responses and asked Dr. Newman to lead the discussion identifying the strengths and weaknesses of ReVA as a priority setting tool to target areas for more focused risk assessments.

#### Discussion of strengths and weaknesses of ReVA as a priority setting tool to target areas for more focused risk assessment

Panelists noted that the strengths of ReVA for targeting areas for more focused risk assessment are its value as a tool for presentation of complex information and integration of multi-variate data. Panelists also noted that ReVA offers unique and promising integration tools and the ability to conduct exploratory analyses with data layers and weighting factors coupled in the Environmental Decision Toolkit. Panelists discussed these strengths of ReVA but also noted that caution is needed in considering how users will apply the data. A panelist stated that, as presently described, ReVA is not well suited for use as a priority-setting tool to target areas for more focused risk assessment.

The panelist noted that priority setting is difficult because vulnerability encompasses many different dimensions and is related to concepts that are poorly defined in a consensual way. The panel discussed these concepts in more detail, focusing on the need to define stability, resilience, resistance, elasticity, robustness, viability, and ecosystem health in developing conclusions about vulnerability. The panel discussed multiple conflicting objectives associated with prioritizing actions. A panelist noted that the ReVA team cannot be expected to know what the objectives will be, or how decision-makers and stakeholders wish to prioritize them.

The Panel discussed potential enhancement supporting the use of ReVA to target areas for more focused risk assessment. A panelist stated that ReVA is presently structured to be applied in assessments of larger scope. A good, future application of ReVA would be to evaluate low probability or rapid changes with highly adverse consequences. Examples might include: a sudden shift in agricultural practice to widespread use of genetically engineered crops with repercussions in heavy pesticide applications, sudden releases of potentially acutely toxic chemicals, and changes in policy with respect to timber harvesting.

Panelists noted that ReVA is designed to focus on moderate to high probability stressors that gradually change over time. ReVA overlooks evaluation of important regional differences in ecological qualities such as keystone habitat that is important beyond physical size to determining biodiversity in an area.

The panel discussed how ReVA would be used as the scale of application decreases. A panelist noted that as the focus of vulnerability assessment changes to smaller scales, different groups of people will be involved in risk assessments. Local professionals address different sets of concerns. Use of professional or best judgment is central in many places throughout ReVA. In the absence of guidance, the application of ReVA by diverse groups may result in discord.

The chair thanked the panel for the discussion of charge question one, and asked Dr Mitsch to lead the discussion of the effectiveness of the ReVA Decision Environmental Decision Toolkit (EDT) in communicating ecological condition and vulnerability to decision-makers.

#### Discussion of the effectiveness of the ReVA Environmental Decision Toolkit in communicating ecological condition and vulnerability to decision-makers

Panelists discussed the three different versions of the web-based EDT that were reviewed (the public, client, and research versions). Panelists noted that the data sets used in these versions provide excellent examples of ReVA applications for specific regions representing different spatial scales. Panelists noted that ReVA uses color maps effectively, and that vulnerability is well described, but ecological condition is not as well described.

The panel discussed a number of concerns about the effectiveness of the EDT, most of the concerns focused on uncertainty and the lack of available documentation for the EDT.

The panel noted that it is difficult to understand from currently available information what the toolbox is, what the tools are in the toolbox, and where the toolbox is located. A panelist asked whether EPA has defined the tools as maps, indices, or the techniques used to generate maps and indices.

The Panel noted that it is difficult to understand what decisions the EDT was developed to influence. A panelist was concerned that the models and tools appear to be presented without a major justification that they are needed. The panelist noted that it would be very useful to provide this information to users of ReVA.

Lack of quantification was also noted as a problem with some components of the EDT. The Panel discussed the concern that some of the models applied in the EDT were not available to the Panel, and that conceptual models were not presented. Panelists stated that it is not possible to evaluate the underlying science supporting the EDT. It was noted that this is a problem of transparency.

The Panel discussed in detail the strengths and limitations of elements in the EDT. The elements discussed included, the spatially explicit data formulated for a GIS-based map system, mechanistic models that can be applied to the base, spatial data to project future conditions or trends and the data integration methods in ReVA.

The Chair thanked the Panel for their responses to the charge question and asked Dr. Patil to lead the discussion of the level of analytical capability needed in the ReVA for intended audiences.

#### Discussion of the level of analytical capability needed in the ReVA EDT for intended audiences

Panelists discussed the issue of analytical capability needed in ReVA. It was noted that analytical capability is a multidimensional issue. Different audiences require different capabilities. The science audience and decision-makers require transparency, simplicity and transferability, the public requires a user-friendly tool. The Panel identified a number of analytical capability needs. These included definitions and descriptions, statistical soundness, and capability for independently reproducing calculations. Panelists discussed the need for a clear description of basic concepts and definitions and information on clarity and accuracy.

The Panel discussed the capabilities of the integration methods in ReVA. The Panel noted that the methods in ReVA offer great promise for further development and future use. Concerns related to some of the methods were discussed. These included: statements in the Simple Sum method concerning skewness, possible inaccuracies related to combining methods, difficulties in the calculation concerning watersheds close to the most vulnerable watersheds, problems associated with triangular and rectangular

distributions, instability of cluster methods, distinction between change and difference analysis, issues related to watershed incomparability, need to assign differential weights to indicators.

Panelists recommended that a methodology document and users manual be prepared as an integral part of the EDT to address the issues discussed. It was recommended that the metadata for the entire ReVA process be included. Panelists also noted that the ReVA program should collaborate with other ongoing projects.

The Panel discussed the differences in analytical capabilities needed (on websites) for different target audiences. It was noted that the analytical capabilities on the public website should be coarse, but that other target audiences need greater capabilities. More information is needed to describe how to use the statistical tools. The Panel noted that audiences need to know the assumptions associated with the tools in order to use them wisely.

The panel discussed the SAB Ecological Processes and Effects Committee document, *Framework for Assessing and Reporting on Ecological Condition* and how it could be used in further development of ReVA. Panelists noted that the ReVA Program should consider the hierarchical structure recommended in this document for reporting on ecological condition.

The Chair thanked the Panel for their comments and asked Dr Rabeni to lead the discussion of approaches for presenting available information and uncertainty in the EDT.

#### Discussion of approaches for presenting available information and uncertainty in the EDT

Panelists discussed approaches for presenting available information and uncertainty in the EDT. The Panel noted that there is a need to define who the audiences are for multiple toolkits. A strategy is needed to determine whether the EDT website stands on its own, or whether other educational products could be part of the website. Panelist again noted that a more extensive user's manual would be useful to fully understand the adequacy of the approach used to present data in the EDT and the ability of the EDT to present uncertainty

The Panel noted that it is difficult to judge the adequacy of the presentation of information and uncertainty without more specific details describing the implementation of ReVA. The Panel discussed the kinds of additional information needed. The Panel noted that it is not clear how one would weigh or prioritize effects and vulnerabilities using the ReVA approach. It is also not clear what process or rules one would use. Information does not presently appear to be available to provide an in-depth understanding of the methods.

The Panel also noted that it is difficult to know how much uncertainty is associated with the EDT presentation of system vulnerability. The current presentation of vulnerability in ReVA does not include all of the essential aspects of the generally accepted definition of ecosystem vulnerability.

Panel members asked EPA staff whether example maps in ReVA are available for different regions and states. Panelists also noted that a tutorial should be an important part of how information is presented in ReVA. Panelist noted that some examples in the interactive parts of the public website are simplified. More realistic “close to home” examples would be useful.

Panelists noted that the public website would benefit from a discussion of resources and stressors chosen. It is important to make the website easier to use. A panelist commented that presenting fuzzy data is a useful way of addressing uncertainty, but the ReVA Program should consider how this information can be explained to the public. Developing different guides for different users may be a useful approach. The ReVA Program should also consider how to convey uncertainty in futures; the use of “popups” inside the tool kit is one way this could be addressed. The Panel also discussed the issue of how much uncertainty comes from natural variability. Panelists noted that natural sites show more variability than modified sites.

The Chair thanked the Panel for the discussion and stated that the Panel would break for a working lunch from 12:00 p.m. to 1:00 p.m. to continue discussion of charge question 3.

Discussion of the usefulness of ReVA to decision-makers in allowing them to see the consequences of future development, and mitigation, conservation, and restoration activities

The Panel discussed charge question 3 during a working lunch. The Panel discussed the usefulness of ReVA to decision-makers in allowing them to see the consequences of future development and mitigation, conservation, and restoration activities.

Panelists noted that the concepts and features being developed in ReVA will be very useful to decision makers in evaluating the overall consequences of future development, mitigation, conservation, and restoration activities. Panelists strongly endorsed the continued development of ReVA. It was noted that the emphasis in ReVA on critical or vulnerable habitat evaluations is very important.

Panelists discussed a number of ways in which the utility of ReVA can be improved. These included: explicitly acknowledging the differences between forecasting and scenario analyses, continuing efforts to improve or enhance an ecological conditions database, validation or improvement of ecological condition integration methods, incorporation of commercially available decision assisting software, and recognition within ReVA that ecological vulnerability decisions must also consider equity, efficiency, and effectiveness, including social justice issues.

Panelists also noted that although the SEQL provides a good opportunity to show how ReVA will be used, additional examples would be helpful.

The Chair thanked the Panel for their comments, and at the end of the working lunch at 1:00 p.m. asked Dr. Stoms to lead the discussion on issues that are encountered as the information and approaches in ReVA are used at finer scales.

#### Discussion of issues encountered as information and approaches in ReVA are used at finer scales

The Panel discussed scale issues encountered in the use of ReVA approaches. The Panel discussed two issues in applying ReVA at finer scales than the Mid-Atlantic. The first issue is that at finer scales, the number of stakeholders involved in the analysis frequently increases. The implication of this is that ReVA must be developed for users with a significantly lower level of scientific and technical expertise. The Panel noted that the tool must balance scientific rigor with clarity and simplicity of concepts and application. The Panel noted that ReVA's role as an educational tool, as opposed to its original multicriteria decision-making role, should increase at finer scales.

The second issue discussed is that the choice of indicators to be used changes at finer scales. Panelists noted that in ReVA the choice of condition and resource indicators is left to the discretion of users. The Panel expressed concern that users may select indicators myopically, overlooking processes operating at scales above that of the area of concern. The Panel discussed the point that users may overlook exports of stressors to adjoining areas. The export of agricultural nutrients from the Midwest to the Gulf of Mexico was discussed as an example.

Panelists noted that policy options change at different scales. Panelists noted that at finer scales, mechanistic models must be used. Mountaintop removal was discussed as an example in which questions about local phenomena such as flood risk in streams are addressed. Panelists noted that mechanistic models must be used to think about local phenomena. Panelists noted that EPA should document and explain issues related to the choice of indicators in ReVA. Panelists also recommended that EPA consider tracking exports to adjoining areas and making this information available to decision-makers.

The Chair thanked the panelists for their comments and asked Dr. Hawkins to lead the discussion research priorities and alternative applications of ReVA methods for decision-making at multiple scales.

#### Discussion of research priorities and alternative applications of ReVA methods for decision-making at multiple scales

The Panel discussed the issue of research priorities and alternative applications of ReVA at multiple scales. Panelists noted that the methods and applications in ReVA can provide the kind of information sought by a wide range of organizations, including conservation groups and other nongovernmental organizations. Panelists noted that these

organizations often work in areas that are data-poor and that ReVA can provide them with important and useful information.

The Panel discussed the following points:

Because many organizations work in regions that are data-poor, research is needed to provide further information about the minimal amount of data needed for advice and guidance in decision-making. It is important to examine how much certainty is lost as the amount of available information is reduced, and also whether there is a core set of metrics that will always be needed by decision-makers.

ReVA currently provides information about the vulnerability of geographic areas. An alternative and useful application of ReVA would be to provide information that would enable the identification of geographic areas of “highest value.”

Alternative applications of ReVA will require validation and additional data input files are needed to understand uncertainty. Clearly, integration methods must be validated. Validation of ReVA methods is an important research issue.

It will be important to determine whether ReVA is providing data that describe the critical parameters for assessing vulnerability. If major data sets are not useful to users they should drop out of ReVA. In addition, the “core measures” in ReVA should be identified. The philosophy of using a single index should not be embedded within ReVA.

It would be useful to provide data sets describing simpler scenarios. This would enable the users of ReVA to more easily understand and identify problems that span resource issues. An example scenario of high mountain lakes in California was discussed.

The Panel noted that research is needed to develop a roadmap for validation of ReVA futures tools. The Panel discussed the point that some of the variables in ReVA are computed from others (e.g., phosphorus computed from sediment). The Panel noted that ReVA will be subject to criticism if validation of the futures data layers is not undertaken.

The Panel also noted that: 1) users should be provided information about confidence in data used for projections, 2) some of the maps in ReVA have incorrect labels and should be corrected, 3) EPA must be careful in explaining to users what scenarios mean, and 4) spatial problems (scale effects) associated with ReVA map presentation should be resolved.

### Summary and next steps

The Chair thanked the Panel for the discussion. He noted that he would work with the Panelists who had lead responsibility for discussion of the charge questions to develop a draft report reflecting comments made at the meeting. A panelist asked the Chair for an estimate of the expected length of the draft report. The Chair responded that the length of

the draft report was expected to be approximately 15 pages, but the length would depend upon the amount of material submitted. Mr. Thompson, Dr. Patil, and Dr. Stoms indicated that they would provide parts of the draft responses to charge questions 1, 2, and 3 to the DFO. The Chair then adjourned the meeting at 2:00 p.m.

Respectfully Submitted:

Certified as True:

*/Signed/*

*/Signed/*

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Thomas M. Armitage, Ph.D.  
Designated Federal Officer

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Kenneth Cummins, Ph.D.  
Panel Chair

## Appendix A – Roster of the Regional Vulnerability Assessment Advisory Panel

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### U.S. Environmental Protection Agency Science Advisory Board Regional Vulnerability Assessment Advisory Panel

#### CHAIR

**Dr. Kenneth Cummins**, Co-Director, Institute for River Ecosystems, Humboldt State University, Arcata, CA

#### MEMBERS

**Dr. Cynthia Gilmour**, Senior Scientist and Principal Investigator, Smithsonian Environmental Research Center, Edgewater, MD

**Dr. Charles Hawkins**, Professor, Department of Aquatic, watershed, and Earth Resources; Director, Western Center for Monitoring and Assessment of Freshwater Ecosystems, Utah State University, Logan, UT

**Dr. Orie Loucks**, President, ICValue, Inc., Oxford, OH

**Dr. William Mitsch**, Professor, Olentangy River Wetland Research Park, The Ohio State University, Columbus, OH

**Dr. Michael C. Newman**, Professor of Marine Science, School of Marine Sciences, Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, VA

**Dr. Ganapati Patil**, Director, Center for Statistical Ecology and Environmental Statistics, The Pennsylvania State University, University Park, PA

**Dr. Charles Rabeni**, Leader, Missouri Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, Columbia, MO

**Dr. Mark Ridgley**, Professor and Chair, Department of Geography, University of Hawaii at Manoa, Honolulu, HI

**Dr. James Sanders**, Director, Skidaway Institute of Oceanography, Savannah, GA

**Dr. David Stoms**, Associate Research Scientist, Institute for Computational Earth Systems Science, University of California at Santa Barbara, Santa Barbara, CA

**Mr. Timothy Thompson**, Senior Environmental Scientist, Science, Engineering, and the Environment, LLC, Seattle, WA

**SCIENCE ADVISORY BOARD STAFF**

**Dr. Thomas Armitage**, Designated Federal Officer, U.S. Environmental Protection Agency, Washington, D.C.

## Appendix B – Meeting Agenda

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**U.S. EPA SCIENCE ADVISORY BOARD  
Regional Vulnerability Assessment Advisory Panel  
SAB Conference Center  
1025 F Street., N.W., Suite 3705, Washington, D.C. 20004  
October 26-27, Public**

### AGENDA

#### Tuesday, October 26, 2004

- 9:00 - 9:10 a.m.      **Meeting Convened by the Designated Federal Officer**  
Dr. Thomas Armitage
- 9:10 - 9:15 a.m.      **Welcome and Introductory Remarks**  
Dr. Anthony Maciorowski, Associate Director for Science  
EPA Science Advisory Board Staff Office
- 9:15 - 9:25 a.m.      **Purpose of the Meeting and Review of the Agenda**  
Dr. Kenneth Cummins, Chair
- 9:25 - 9:35 a.m.      **ReVA Program Within the EPA Office of Research and  
Development**  
Dr. Bruce Jones, Science Lead for Spatial Analysis  
EPA Office of Research and Development
- 9:35 - 10:15 a.m.      **ReVA Overview**  
Dr. Elizabeth Smith, ReVA Director  
National Exposure Research Laboratory  
EPA Office of Research and Development
- 10:15 - 10:30 a.m.      BREAK
- 10:30 - 11:15 a.m.      **Spatial Data and Landscape Models in ReVA**  
Dr. Megan Mehaffey, ReVA Deputy Director  
National Exposure Research Laboratory  
EPA Office of Research and Development

- 11:15 - 12:00 p.m.    **Integration Methods in ReVA**  
Dr. Elizabeth Smith, ReVA Director  
National Exposure Research Laboratory  
EPA Office of Research and Development
- 12:00 - 1:15 p.m.    LUNCH
- 1:15 - 2:00 p.m.    **Future Vulnerability Estimates**  
Mr. Timothy Wade, ReVA  
National Exposure Research Laboratory  
EPA Office of Research and Development
- 2:00 - 2:45 p.m.    **ReVA Integration Toolkit for Communicating Risk and  
Uncertainty to Users and Clients**  
Ms. Valeria Orozco, Waratah Corporation
- 2:45 - 3:00 p.m.    BREAK
- 3:00 - 4:00 p.m.    **Application of ReVA Tools and Methods to Decision-Making**  
**Dr. Paul Wagner, ReVA**  
**National Exposure Research Laboratory**  
**EPA Office of Research and Development**
- Mr. William Jenkins, EPA Region 3**
- Ms. Vicki Bowman, Director, Land Use and Environmental  
Planning Division, University of North Carolina – Charlotte  
Urban Institute**
- 4:00 - 4:10 p.m.    **Public Comments**
- 4:10 - 5:00 p.m.    **Discussion of Charge Questions to the Panel, Summary of Day  
One Discussion, and Expectations for Next Day**  
Dr. Kenneth Cummins and Panel
- 5:00 p.m.            **RECESS FOR THE DAY**

**Wednesday, October 27, 2004**

- 8:30 - 8:40 a.m.      **Review of Agenda**  
Dr. Kenneth Cummins, Chair
- 8:40 - 10:15 a.m.      **Discussion of Charge Question 1 – Strengths and Limitations of ReVA Approach**  
Dr. Kenneth Cummins and Panel
- Question 1.  
ReVA is intended to provide an overview of regional conditions. ReVA may also serve as a priority setting tool to target areas for more focused risk assessments of specific problems. Please comment on the strengths and limitations of the ReVA approach as it applies to these uses.
- 10:15 - 10:30 a.m.      BREAK
- 10:30 - 12:00 p.m.      **Discussion of Charge Question 2 – The Effectiveness of the Web-Based ReVA Environmental Decision Toolkit (EDT)**  
Dr. Kenneth Cummins and Panel
- Question 2.  
Please comment on the effectiveness of the web-based ReVA Environmental Decision Toolkit (EDT) in communicating ecological condition and vulnerability to decision-makers at regional to local scales. Please provide input as to the level of analytical capability needed in ReVA for intended audiences as well as approaches to presenting available information and uncertainty.
- 12:00 - 1:00 p.m.      WORKING LUNCH
- 1:00 - 2:00 p.m.      **Discussion of Charge Question 3 – Usefulness of ReVA Approach to Decision-Makers**  
Dr. Kenneth Cummins and Panel
- Question 3.  
Please comment on the usefulness of the ReVA approach to decision makers in allowing them to see the overall consequences of future development, and mitigation, conservation, and restoration activities.
- 2:00 - 3:15 p.m.      **Discussion of Charge Question 4 – Issues Associated With Scale and Future Research Priorities**  
Dr. Kenneth Cummins and Panel

Question 4.

Please provide input on issues encountered as the information and approaches in ReVA are used at finer scales. Please also provide input on future ReVA research priorities and alternative applications of ReVA methods for decision-making at multiple scales.

3:15 - 3:30 p.m.

**Summary of Day Two Discussion**  
Dr. Kenneth Cummins and Panel

3:30 p.m.

ADJOURN MEETING