Final Report (31 Dec 06)

Pilot Study: Improving BAER Calculation of Values-at-Risk
(JFSP 05-01-01-09)

Project Location: Missoula, MT; Moscow, ID

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This final report describes the accomplishments and future outcomes of pilot Project 05-01-01-09, which ended December 2006.

Executive Summary

Without clear demonstration that important resource values are at risk, post-fire response expenditures are not justified. Driven by the need to improve post-fire calculations of values-at-risk (VAR), this pilot study reviewed procedures used for resource valuation and developed potential improvements that could be applied within the constraints of BAER operations. The work was accomplished through direct observations of BAER operations, a survey of BAER/ESR personnel, and review of resource valuation literature. A proposed valuation framework and VAR Calculation Worksheet along with some recommendations are offered for review, testing, and refinement by BAER/ESR personnel.

Field observation visits were conducted to review the BAER work environment, current VAR assessments procedures, and test preliminary ideas for procedural changes. Observations revealed consistent and effective procedures to assess most threats (i.e., mapping burn severity), but uncertainty with VAR assessment procedures. Enumeration of probable VAR during the initial BAER meeting and subsequent refinement of this list was inconsistent among BAER teams. Threat (e.g., noxious weed invasion) was commonly confused with the resource value at risk (e.g., native vegetation). Mapping hardware, software, and personnel were generally available to meet all mapping support needs, including the spatial evaluation of VAR.

The purposes of the survey were to characterize the experience of BAER personnel, review methods and resources currently used for VAR analysis, assess barriers to implementing VAR analysis, and solicit

feedback on preliminary ideas for procedural improvements. Background and resources differ between USFS and DOI BAER personnel. Suggestions to develop VAR training modules and increase GIS use were viewed as most desirable, while suggestions to assign a designated VAR member to each BAER team and to compile academic literature received somewhat less support. Interagency agreement was highest for the suggestion to increase GIS use and lowest for the development of unified interagency tools.

Literature reviews examined current practices for assessing values at risk and published valuation data, especially for resources not easily monetized. The following conclusions were drawn from the literature review:

- The importance of all resources at risk should be described relative to perceived value, threat, and cost and probable effectiveness of mitigation.
- Life and safety should not be directly monetized.
- Resources with clear market values should be monetized using locally obtained replacement cost or market value.
- Loss of use of infrastructure should be calculated where significant through consultation with relevant experts such as regional agency economists.
- Existing non-market valuation studies can identify site specific attribute values. However, these studies are inconsistent across regions and resources and benefit transfer problems limit utility in BAER assessments.
- The valuation method called implied minimum value (IMV) may be most useful technique for valuing the non-market VAR in the BAER environment, where time, money, and expertise for economic studies are very limited. IMV equals the cost of treatment divided by the reduced likelihood of experiencing the negative outcome. A treatment is justified to protect a given non-market resource if, in decision-maker's qualitative judgment, the value protected exceeds the IMV. The IMV does not represent the actual dollar value of the VAR, but rather it identifies the minimum resource value protected that would make the proposed treatment a wise investment of public funds. The use of IMV removes the current FS requirement of valuing non-market resources under the no action and selected alternatives.

The above recommendations were built into a BAER Values at Risk Calculation Tool, a spreadsheet tool that BAER teams can use for determining the values of the resources at risk from post-fire effects. A functional demonstration version (Version 1.0) is included in this final report. The VAR Calculation Tool requires evaluation of 1) the likelihood that potential threats will occur and 2) the probable success of proposed post-fire treatment. A method for using the Erosion Risk Management Tool (ERMiT) to evaluate post-fire erosion, a common threat identified by both DOI and USFS BAER teams, has been developed for use with the VAR Calculation Tool.

Introduction

Wildfire effects include loss of vegetative cover and changes to soil properties which lead to increased runoff, erosion, flooding, and sedimentation and increased vulnerability to invasive weeds. These effects threaten human life and safety, cultural and ecological resources, land use, and existing infrastructure. Under current BAER assessment procedures, identification and valuation of values-at-risk (VAR) from the effects of wildfires is required, but guidelines to estimate the monetary value of these resources is lacking. The USFS Manual, Chapter 2523 (USDA Forest Service 2004a) and the DOI Manual, Part 620n Chapter 3 (US Department of Interior, 2004) call for BAER assessment teams to submit reports and funding requests that establish justification for treatments through a qualitative "cost-risk analysis." In the case of the USFS, a quantitative analysis is currently required which implies dollar values be assigned to all resources, market and non-market alike. The BAER team analysis referred to the "cost-risk analysis worksheet," requires four basic inputs 1) probability of the threat occurring, 2) cost of mitigation treatments, 3) probability that treatments will be successful, and 4) VAR measured in dollar terms. Recent JFSP-funded work has resulted in the development of the Erosion Risk Management Tool (ERMiT) which can predict two of those four inputs in terms of post-fire erosion—the probability of the threat occurring and the probability of treatment success (for some post-fire treatments). The costs of common

post-fire treatments have been estimated and are available in the instruction guide for the "cost-risk analysis worksheet." However, there are no known tools to guide the calculation of monetary value for the VAR identified by the BAER team. A methodical and efficient resource valuation procedure is needed that can provide realistic, reproducible, and defensible cost-value amounts for the identified VAR.

This pilot study examined current practice for post-fire assessment of VAR and sought information and methodologies to standardize and simplify the complex valuation task faced by every BAER team. The needed data were derived from a survey of BAER/ESR personnel, direct observations of BAER operations, and review of resource valuation literature. Three questions focused the evaluation of these data:

1) Can standard yet flexible procedures be developed to guide efficient and realistic valuations of resource VAR?
2) How can such procedures provide defensible valuation estimates?
3) Can easily accessed tools be developed that support these procedures?

A proposed "VAR Calculation Tool," a spreadsheet-based calculator, was developed to reflect the observations and recommendations for VAR calculation. The VAR Calculator Tool integrates the qualitative assessments currently used by DOI with many elements of the quantitative procedures currently required by the USFS. The VAR Calculator Tool emphasizes that BAER justification for post-fire treatments is based on the assessment of resources at risk from post-fire threats, and not vice versa. The probabilities of threats occurring and of treatment success are directly tied to the identified VAR. The tool is expected to improve defensibility of VAR and Benefit/Cost calculations, and data requirements are, in many cases, less burdensome than existing procedures. The spreadsheet tool emphasizes the importance of spatially linking the VAR with the likelihood of the identified threat and provides calculation of benefit cost ratios as well as Implied Minimum Values where appropriate for non-market resources.

Goals and Objectives:

The goal of the proposed pilot project was to:

Review current BAER resource valuation procedures and develop pilot procedures and a decision support tool to guide calculation of values-at-risk downstream of burned areas.

Four objectives were delineated to meet the project goal:

1) Evaluate current BAER and ESR resource valuation procedures through field observations and surveys of BAER and ESR personnel.
2) Evaluate and summarize current literature on commodity and non-commodity resources valuation.
3) Identify and evaluate existing resource valuation databases that could benefit valuation procedures.
4) Develop a framework to calculate values-at-risk that may be used in BAER and ESR assessments.

Accomplishments:

Objective 1: *Evaluate current BAER and ESR resource valuation procedures through field observations and surveys of BAER and ESR personnel.*

Field observations—Three BAER teams were observed to review the BAER work environment and current VAR assessments procedures and test preliminary ideas for procedural changes. An exploratory approach was used where the same observer followed each team from the organizational meeting through the assessment and reporting process. Notes, impressions, and questions were recorded as each incident progressed. Questions were asked of the team leader to clarify procedural logic, especially related VAR assessment and valuation. The first two observations were completed during 2005. A primary objective of

these first two observations was to inform how the survey of BAER personnel would be built. Analysis therefore was limited to review and summary of information. The third observation was completed in 2006 and used primarily to test ideas about how procedures might be improved. All three BAER assessments were led by USFS teams. The omission of a BAER team operating under DOI jurisdiction and procedures, as originally intended, is an acknowledged limit to this portion of the study.

The first observations were completed during July 2005 at the Mason Gulch Fire, located about 35 miles west of Pueblo, Colorado. The final perimeter of this fire covered over 11,000 acres, most of which fell within the jurisdiction of the Pike-San Isabel National Forest. The BAER operations for the School Fire were observed during August 2005. The School fire burned nearly 53,000 acres in southern Washington across private, state and federal jurisdictions, specifically within the Umatilla National Forest. Insights from these two 2005 observations included:

- B/C analysis would be improved if the focus of BAER analysis is shifted from threat analysis to risk-based analysis – from causes to consequences
- Preparation of data (and some pre-processing), especially maps, would "launch the (BAER) analysis more rapidly." An example is preparing preliminary maps before BAER convenes and using these maps to focus VAR evaluation field work similar to the way BARC is used to focus burn severity analysis.
- Preliminary VAR should be identified at the first BAER meeting
- Need for a method to determine the values used for B/C that is faster, more systematic, and consistent.
- Suggestions are needed to improve the BAER report process that better justify proposed costs and provides the basis for monitoring.

Some of these ideas from 2005 observations were tested during the third and final field study of the BAER assessment of the Gash Creek Fire during September of 2006. This 8,200-acre fire burned almost entirely within the jurisdiction of the Bitterroot National Forest in western Montana. Observations from this final field study included:

- Consistent and effective procedures to assess threats (i.e. mapping burn severity, estimating potential erosion and runoff) are being used, but there is little consistency and much uncertainty in the assessment of VAR. Even the initial identification and description of probable VAR was inconsistent. For example, threats (e.g., noxious weed invasion) were commonly confused with the resource values at risk (e.g., native vegetation).
- Use of maps to identify VAR, organize field assessment of VAR, and connect threats of VAR is inconsistent.
- Preparation for BAER assessment was inconsistent and did not take full advantage of GIS tools which could focus VAR assessment.
- Struggle with non-market valuation causes the most difficulty in determining B/C, but linking probability of event occurrence and probability of treatment success to the B/C is also confusing.

Summaries of the three BAER team observations are included in *Appendix A*.

Survey—Based on the field observations, a survey was developed to characterize the experience of BAER personnel, review methods and resources currently used for VAR analysis, assess barriers to implementing VAR analysis, and solicit feedback on preliminary ideas for procedural improvements (*Appendix B1*).

Survey Results—Survey responses from the 214 respondents have been collated and summarized in *Appendix B2*. General survey conclusions are compiled by section below:

- **SECTION 1**: *Background Information*: The mean number of years of public land management experience was 21 and was similar between USFS and DOI responders. Overall, 61% of respondents have led a BAER team, but most leadership was limited to 5 incidents or less. Direct participation in assigning values, relative or dollar, to VAR was high overall and greater among USFS personnel (76% vs. 64%). GIS use during the normal work year

was reported very high overall, with a larger number of DOI respondents reporting "experienced technician" level (21%) as compared to USFS (5%).

- **SECTION 2:** *Methods and resources used in VAR/CR analysis which currently work*: There was significant overlap between the DOI and USFS in the ten most commonly encountered resources at risk, with the exceptions of terrestrial threatened and endangered species being more commonly assessed by DOI teams and trails being more commonly encountered by USFS teams. **Notably, over one-half of the resources encountered by all teams are most appropriately classified as non-market resources**; they cannot be directly replaced or repaired. Current resource valuation is primarily based upon consultation with resource specialists, team judgment and experience, review of past assessment reports, and "educated estimation." In the open response questions, many respondents strongly emphasized the critical importance of relying on local resource specialists outside the BAER/ES teams, reinforcing that post-fire analysis addresses local resources that should be evaluated by local standards. Significant concerns were expressed within both groups about the limits of monetizing resource values, "economic values cheapen the ecological values." Responses differentiated the components of the VAR process, identifying and defining threats to VAR are the easy part – the real difficulty follows in assigning value.

- **SECTION 3:** *Barriers to implementing VAR/CR analysis:* **Limited time for assessments**, training in VAR/CR analysis, and valuation guidelines were reported as the top obstacles to conducting assessments followed by limited availability of data, supporting literature, valuation expertise, and assessment tools. Most additional comments from the open-ended questions re-emphasized limited time, lack of training and experience in VAR/CR analysis, and lack of consistent approaches and guidelines. Notably, the concern about lack of valuation approaches and guidelines was limited to USFS responses. Many responses, also limited to the USFS group, questioned the need for or the validity of the process. Many respondents from both groups expressed concerns over the difficulty with and subjective nature of non-market or non-commodity resources valuation.

- **SECTION 4:** *Feedback on some preliminary ideas for improvement to VAR/CR analysis:* All ideas were supported by the majority of both groups. Highest support was given for increased use of GIS overall and at the first meeting to support spatially explicit VAR assessments.

The survey results strongly suggest that teams find it difficult, and even controversial, to apply direct dollar values to non-market resources at risk, and over half of the VAR encountered by post-fire assessment teams fall into this category. Although the current DOI process does not require the cost-risk analysis currently required by USFS, there was general agreement between the two groups for process improvements. These areas of agreement show promise for future inter-agency collaboration on the improving BAER/ES information, expertise, procedures, and support tools.

Objective 2: *Evaluate and summarize current literature on commodity and non-commodity resources valuation.*

Literature reviews sought current knowledge for assessing VAR and published valuation data, especially for resources not easily monetized. We recommend that values at risk be separated into market values (those things that are typically bought or sold and have well established prices such as grazing allotments, timber, roads, developed recreation facilities, and buildings) and non-market values (those values where no markets exist and are typically enjoyed by the public such as non-developed recreation opportunities, wildlife habitat, native vegetation, and watershed health). Life and safety are often identified as post-fire VAR; however, they should not be directly monetized; BAER generally describe the specific threat to life and safety, the likely effectiveness of mitigation efforts and warning systems, and the costs of these programs.

An extensive literature review was conducted to identify research on non-market values typically encountered by BAER teams. There exists extensive research into non-market public resource values and numerous studies that identify site-specific dollar values for a variety of resources. However, there are limited studies that address how fire and post-fire erosion events affect these values. Additionally, when resource values typically encountered by BAER teams have been studied, benefit transfer issues (i.e. transferring study results to a different location or resource value) overwhelm the applicability of referencing this research. The closer the affected resource value is to a real market (e.g. many recreation values have close market substitutes while cultural heritage values typically do not), or the more similar the affected resource is to the literature referenced resource in terms of resource type, available substitutes, and geographic and demographic characteristics, the more relevant the literature value.

There are several systems of value estimation for non-commodity resources covered in the literature. Valuation methods included in this literature summary are the: 1) contingent valuation, 2) travel cost, 3) hedonic pricing, 4) ecosystem services, 5) production possibility analysis, and 6) benefit transfer. These methods have been summarized because they were the most commonly used methodologies for natural resource valuation and are each referenced as "method used" in cited studies compiled and linked to the VAR Calculation Framework Tool (Accomplishments, Objective 4). Another method, the 7) implied minimum value, is included in the literature summary because it has been adapted for use in the BAER assessment process and incorporated into the VAR Calculation Framework Tool. A cursory description of each method is included below; however, these seven methods are described in more detail with comments concerning their use and limitations in *Appendix C*.

Contingent valuation (CV)—Valuation is based on consumer willingness to pay for, or willingness to accept compensation for, a defined part of a public good (in this case, a non-market resource).

Travel cost (TCM)—Valuation is based on the travel costs and times from a number of people and locations as the price of consuming a non-market resource.

Hedonic Pricing (HPM)—Valuation is based on a comparison of the market values of properties having different degrees of a specific (non-market) attribute and extracting the implicit value of the attribute from the variation in property values.

Ecosystem services (ES)—Valuation is based on assigning an economic value to the services natural systems provide to support human welfare, such as water and air purification, flood control, and climate moderation.

Production possibility analysis (PPA)—Valuation is based on developing the potential for a given piece of land to produce desired resource outputs. By mapping out the feasible output levels under different management scenarios, the opportunity cost of providing one level of resource in terms of another is identified.

Benefit transfer (BT)—Valuation is based on the adaptation of economic information from a specific site and/or resource to another site with similar resources and conditions.

Implied minimum value (IMV)—Valuation is based on the amount that is spent to avoid a negative outcome (i.e., BAER treatment) and the amount of risk reduction received for the money spent.

The implied minimum value (IMV) method may be most useful for non-market value calculations in the BAER assessment environment. The concept of IMV can be used to provide face validity for non-market values. If managers determine that a treatment is justified to protect a given non-market resource, then the manager has implied that the minimum value of the potential resource value change to society equals the cost of treatment divided by reduced likelihood of experiencing the negative outcome. For example, if a BAER team spends $10,000 to reduce the likelihood from 50 percent to 40 percent of 1 mile of bull trout spawning habitat being severely degraded for 3 years, there exists an implied minimum value of the change in bull trout habitat. This value is not $10,000 but $100,000 ($10,000*1.0 = X*(.5-.4)). This

calculation does not suggest that the true economic value of this resource is $100,000; simply that a $10,000 treatment that modifies an expected outcome by 10 percent is economically justified if the change in outcomes is worth *at least* $100,000 to society. The use of IMV removes the current FS requirement of assigning values to non-market resources under the no action and selected alternatives. The use of IMV supports local decision making by providing a sound economic basis for relating the cost and likelihood of success of proposed mitigation treatments to the specified non-market value at risk.

Objective 3: *Identify and evaluate existing resource valuation databases that could benefit valuation procedures.*

Review of commonly encountered VAR

Nearly 400 BAER reports from the past 25 years were examined to determine the VAR listed and the justification for the requested BAER treatment projects. The two most frequently listed VAR were soil erosion (in our opinion a threat not a risk) and watersheds. Other notable VAR are site productivity, fisheries, and property. Some of the least encountered VAR are wilderness, range, and invasive species (again, in our opinion, a threat not a risk) (Table 1).

Table 1. Resource values at risk as reported in 394 USFS BAER 2500-8 reports during 1980-2005.

RESOURCE VALUES AT RISK	OBSERVATIONS
	Total=394
Soil erosion (landslides)	70
Watershed (municipal supply, control, quality, etc.)	55
Property (livestock, structures, orchards, improvements, etc.)	47
Engineered (roads, fences, trails, utilities, signs, etc.)	46
Ecology (site productivity, soil)	46
Fisheries	43
Human Life	23
T&E species/habitat (grizzly, bulltrout, goshawk, plants)	16
Wildlife (summer & winter range, etc.)	15
Timber (production)	9
Recreation (campgrounds, lakes, etc.)	9
Cultural	5
Range	4
Invasives	4
Wilderness	2

Although values at risk or project justifications were present in most BAER 2500-8 reports, few of the reports contained cost/risk assessments (CRA); therefore, it was not possible to know if a CRA was completed. The cost-risk analysis spreadsheet amendment to the Forest Service handbook is dated 1995, so it is unlikely that USFS BAER teams would have done this type of analysis prior to 1995. DOI BAER teams are not required to put monetary values on the resources at risk, instead the VAR are rated as high, moderate, low, no risk and a narrative is provided to justify the treatment requested.

Literature Reviews of valuing processes of non-market VAR listed in the BAER 2500-8 reporting form

The VAR categories listed in previous USFS BAER 2500-8 report forms were organized in five categories: 1) Life, 2) Property, 3) Water quality, 4) Threatened, endangered, or sensitive species, and 5) Soil productivity. A literature search was done to determine how dollar values have been assigned to non-market resources typically encountered by BAER teams. Few studies provide value estimates of VAR from the same perspective as the BAER assessment, which compares the cost of "no action" to the cost of treatment. Most of the literature related to non-market value estimates, produced only a limited number of studies applicable to resource valuation within the post-fire emergency response environment. Much of the literature related to non-market values of forest resources were estimates of recreation benefits to

humans as opposed to estimates of ecological values. A summary of the literature review for non-market VAR categories found in USFS BAER 2500-8 forms are found in *Appendix D*.

National Resource Databases

Multiple datasets exist and are in the process of being compiled that can support rapid identification of values-at-risk. Sources for these data sets include geospatial data libraries and published literature. Large projects such as LANDFIRE, FPA, and other systems to support fuel reduction, forest restoration, and strategic wildland fire response require nationwide inventories of terrain, vegetation, and resource asset information. While some of these databases may be limited by coarse resolution, they may serve as effective starting points for post-fire VAR analysis. Just as BARC images establish the first-cut at a burn severity map, resource inventories may provide the starting point for mapping VAR, such as water supply intakes and reservoirs, pipelines, HAZMAT locations, parcel and structures layers, critical habitat, and other infrastructure elements such as bridges, campgrounds, and historic sites. Although local data sources and field assessments will be required for final, fine-scale VAR analysis, it would be redundant for BAER teams to collect nationally available data themselves. As new decision support systems are developed for wildfire management, it would be useful to establish consistent information exchange channels between Incident Management Teams (IMT) to BAER.

Objective 4: *Develop a framework to calculate values-at-risk that may be used in BAER and ESR assessments.*

Framework of the VAR Calculation Tool

A proposed assessment framework and a spreadsheet tool were developed to create a VAR valuation process that reflects the observations and recommendations discussed above. The procedure is transformed from threat analysis to risk-based analysis—from causes to consequences—by first delineating VAR in relation to probable threats and then assessing the probabilities of a threat occurring and treatment success. The proposed framework integrates the qualitative assessments currently used by DOI with many elements of the quantitative procedures currently required by the USFS. The structure of the VAR Calculation Tool explicitly and spatially couples assessed threats with potential consequences to identified VAR. This assessment may provide a more defensible treatment (or no treatment) plan. The spatially-explicit analysis may assist the development of the subsequent treatment monitoring program. In addition, the VAR Calculation Tool may provide a starting point for an integrated BAER reporting system.

The conceptual framework of the VAR Calculation Tool is described in Table 2 as a series of steps. It begins with the identification of resources-at-risk and associated threat(s). This iterative first step will focus field assessments and may make them more efficient. For example, high burn severity, as represented by a BARC image, would not necessarily need to be ground-truthed if no VAR are associated with the burn area. Formal resource valuation begins early in the BAER process (Step 2), and direct market values (cost to repair, replace, or restore) for VAR are acquired and as needed for B/C ratio analysis. Monetary values for life and safety and non-market VAR are not evaluated using B/C analysis. Steps 3 through 5 result in a) estimations of the probabilities that identified threats will cause damage to associated VAR and b) identification and estimation of the probable success of potential threat mitigation treatments. Treatment costs are calculated. The final step is calculate the B/C ratio or IMV for non-life and safety VAR. These values are used to justify BAER funding requests.

Table 2**:** Framework of the BAER post-fire VAR Calculation Tool

Step	Process	Leading Questions	Examples
1a	**Identify resources at-risk**	What resources are threatened and where are they relative to burned areas?	life and safety, homes, roads, culverts, cultural artifacts, and critical habitat
1b	with the associated hazards to the VAR	What are the erosion/flood/biological hazards given burn severity, topography, and climate?	high erosion risk at head of very steep drainage with friable soils
2	**Resource valuation**	What is the relative or estimated dollar value of each resource?	cost to replace, repair, or restore
3	Mitigation plan	What treatments might mitigate hazards to threatened resources?	straw mulch, erosion barriers, seeding
4	Treatment costs	What would it cost to implement treatments?	cost per acre to aerial mulch with straw
5	Effectiveness analysis	How much might treatments mitigate hazards and will changes merit implementation?	mulching treatment reduces the probability of damaging erosion by 50%
6	**Benefit/Cost analysis**	Are VAR sufficient to justify cost of proposed treatments in the context of probable success of treatments?	high likelihood that $2K treatments will protect $10K footbridge

In addition to this using these steps, other procedural changes may improve the identification and valuation of VAR efficiency:

- Locate critical local data for more rapid access
- When BAER is anticipated coordinate with GIS personnel and fire IMT to build initial BAER maps before assessment teams convene
- Work with GIS personnel to import or build layers of commonly encountered VAR and terrain layers used for assessment

The VAR Calculation Tool

The VAR Calculation tool will facilitate the implementation of the framework steps. Data requirements are, in many cases, less burdensome than existing procedures. The spreadsheet tool emphasizes the importance of spatially linking the VAR with the identified threat and provides calculation of benefit/cost ratios as well as Implied Minimum Values (IMV) where appropriate for non-market resources.

The tool provides separate worksheets for each “map zone” to facilitate independent evaluation of each connected set of resources, threats, and treatments. Where market values are the only risk identified the tool guides the user through the calculation of the B/C ratio of the proposed treatment. If the only values at risk in a map zone are non-market values, the user is guided through the calculation of the IMV. If both market and non-market values are at risk in a map zone a hybrid approach is used; first calculating the B/C ratio of the market values alone, and then if the B/C ratio is less than 1 (market values alone do not justify proposed treatments), the required dollar value to justify treatments is assigned to the non-market values for the calculation of IMV. Although the use of IMV provides a rational, consistent, and economically-based process for justifying treatments to protect non-market values at risk in the post-fire environment, it is a departure from the current requirements of USFS to use a B/C ratio for all analysis or the DOI ranking system. Future use of the VAR Calculation Tool, with the IMV component, will depend on its acceptance by both the BAER teams and the managers involved in BAER funding approval processes at the DOI and USFS. (Sample pages from the VAR Calculation Tool in *Appendix E*)

Using ERMiT to determine the probability of an erosion threat occurring

Increases in post-wildfire runoff and erosion are the most frequently encountered threats that must be evaluated by USFS BAER teams, and are commonly encountered by DOI BAER teams as well. Treatments that increase the capacity to accommodate runoff and peak flows (e.g., up-sizing culverts, armoring fill slopes) and treatments to mitigate post-fire erosion (e.g., mulching of hillslopes) constitute the bulk of BAER treatment expenditures. To evaluate the threat of post-fire erosion and justify treatment expenditures, BAER teams complete cost-risk analysis. Although the DOI and USFS have different approaches, both agencies require identification of VAR and assessment of the probability that threat(s) will occur and probability of treatment success. Recent JFSP-funded work (JFSP 98-1-4-12 and 01-3-02-08) has resulted in the development of the Erosion Risk Management Tool (ERMiT), which provides probabilistic estimates of single-storm post-fire hillslope erosion by incorporating variability in rainfall characteristics, burn severity, and soil characteristics into each prediction (Robichaud and others, 2006). ERMiT is a web-based application that uses the Water Erosion Prediction Project (WEPP) technology to estimate event erosion rates, in probabilistic terms, on burned and recovering forest, range, and chaparral lands with and without mitigation treatments (http://forest.moscowfsl.wsu.edu/FSWEPP). ERMiT output can be used to determine the probability of an erosion threat occurring and the probability of treatment success—two of the four inputs needed for the cost-risk analysis. To support the VAR Calculation Tool, the methods needed to derive the VAR Worksheet inputs (related to post-fire erosion threats) using the interactive ERMiT output tables have been described and illustrated with two examples (*Appendix F*).

Before erosion prediction is done, BAER team soil scientists use maps and field observation data to group watersheds into types of landscapes based on soil type, pre-fire vegetation, and post-fire management concerns (VAR), etc. Within each landscape type, hillslopes are stratified by significant topographical and burn severity differences. ERMiT runs are completed for a sample of each stratum and results are extrapolated over other hillslopes with the same features (i.e., within the same stratum). In addition, the BAER team must determine the amount of event sediment yield that the VAR can tolerate without sustained damage. For example, if the VAR is an extremely sensitive stream reach with a population of threatened bull trout, the BAER team may determine that any additional sediment will be damaging and, thus set the tolerable limit of event sediment delivery at 0 t ac^{-1}. On the other hand, if the VAR is a less vulnerable stream reach with a reasonable flush rate, the BAER team may determine that a 1 t ac^{-1} event sediment delivery to the stream could be tolerated without sustained damage.

Using the ERMiT output,

- **probability of exceeding** the **tolerable event sediment delivery** with **no treatment** is the likelihood of damage to the VAR occurring without treatment. In USFS BAER report language, that is the probability of failure of the “no action” alternative.

If there is a high probability of erosion damage to the identified VAR, erosion mitigation treatment scenarios are considered. ERMiT output includes five years of sediment yield probabilities with treatments in place--mulching (4 rates), erosion barriers (size and spacing adjusted by the user), and seeding. Thus, using the same interactive ERMiT output table,

- **probability of exceeding** the **tolerable event sediment delivery** with **a given treatment** in place is the probability of failure with treatment.

The probability of treatment success is 100 percent minus the probability of failure. These data are inputs for the current USFS BAER cost-risk analysis worksheet (USDA, FSH 2509.13; Amendment No. 2509.13-95-9) and the newly developed VAR Calculation Tool.

Key Findings

1 By refocusing post-fire BAER assessment from causes to consequences, the BAER team would first determine the values at risk and then the extent and probabilities of the threats. Refinement of VAR and threat assessments will be iterative and focus on areas where greatest risk of loss exists. VAR identification would move to the front of the process allowing more time for valuation and B/C analysis.

2 After field observations of the BAER valuation processes and review of the literature on non-market values at risk in the post-fire environment, we recommend that resource values at risk should be categorized and evaluated as follows:
   a) Life and safety. Life and safety should not be monetized; the specific threat and associated issues should be described.
   b) Non-market values (e.g. cultural resources, non-developed recreation opportunities, wildlife habitat, and native vegetation). The existing non-market value literature is insufficient to use as a basis of valuation within the BAER environment. However, the implied minimum value (IMV) of a treatment can be established by examining the cost of mitigation efforts divided by the reduced likelihood of experiencing the negative outcome. The use of IMV removes the current FS requirement of valuing non-market resources under the no action and selected alternatives.
   c) Market values (e.g. bridges, structures, roads, and culverts). Monetary values for these resources should be identified using local sources. The benefit to cost ratio may be established by calculating the value of the resource to be protected times the reduced likelihood of experiencing the negative outcome with treatment, divided by the cost of mitigation treatment.
   d) Loss of use. In some instances the loss of infrastructure may substantially affect local resource based economies. In these instances consultation with an expert such as the Forest Service regional economist may be most appropriate. If consultation is not possible the implied minimum value concept developed for non-market values may be used.

3 A demonstration version of the BAER VAR Calculation Tool has been developed to calculate the Benefit/Cost ratio of BAER treatments when used to protect market values at risk and to calculate the Implied Minimum Value of protecting non-market values at risk. These calculations require input of the probabilities of the threat occurring and of treatment success. For the threat of soil erosion, these probabilities can be determined by using The Erosion Risk Management Tool (ERMiT).

4 Analysis of VAR is a spatial problem and would benefit from the use of mapping and spatial analysis tools. Use of mapping to identify and connect threat and risk locations would likely focus, and perhaps reduce, the necessary field work. Based on the results of the survey and the field visits, it is apparent that mapping hardware, software, and personnel were generally available to meet all mapping support needs, including VAR.

Deliverables

Proposed	Delivered	Status
Review of Field Results	**Appendix A**: BAER Team Field Observations **Appendices B1 and B2**: Survey of BAER personnel to augment field observations and inform the development of the spreadsheet tool.	Done Done
Progress Summary	Submitted on time—Feb. **2006**	Done
Conference or Meeting	National BAER Meeting, San Diego, CA, 1-3 February **2006**: Presented study overview; interviewed multiple attendees about current VAR processes and needs	Done
Conference or Meeting	R1/R6 BAER Refresher Meeting, La Grande, OR, 6-7 June **2006**: Presented preliminary findings of survey of BAER personnel	Done
Conference or Meeting	2nd Fire Behavior and Fuels Conference, Destin, FL. Will present key findings of this study	Planned for 26-30 March **2007**

Literature Review: Valuation of Forest Soils and Water Resources	**Appendix C:** Literature reviews of non-market valuation methods **Appendix D:** Literature review of valuation of non-market VAR categories in the USFS-BAER 2500-8 forms	Done Done
Research Note	A **General Technical Report** is being prepared that will provide instructions for use of the VAR Calculation Tool for risk assessment and treatment justification in post-fire assessments.	In progress; expected submission June **2007**
Spreadsheet Tool: summarizing valuation literature and data	**Enclosed CD**: An expanded version of the proposed spreadsheet tool has been developed. The demonstration version of the **VAR Calculation Tool** (Version 1.0) includes a summary of valuation literature and data; however, it also provides a defensible method for valuation of both market and non-market values at risk. (Example pages from the VAR Calculation Tool in **Appendix E**). **Appendix F:** Method for using ERMiT to assess post-fire erosion threat (obtain probabilities of threat occurring and treatment success) as input data for the VAR Calculation Tool. Further refinements will be complete by June 2007 for inclusion in the GTR.	Done Done
Final Report		Done
Peer-reviewed paper	A peer reviewed paper will be submitted to the *Journal of Forestry*	In progress; expected submission by June **2007**.

Acknowledgements

Without the generous cooperation of hundreds of DOI and USFS personnel this study would not have been possible. Thank you to everyone who completed the survey and to leadership at all levels who supported us throughout this study. We extend special appreciation to the teams who allowed us in to observe their processes, for their patience with our questions, and for trusting us to test ideas within the strenuous pressures of the BAER environment. We recognize that team members typically have no training and very little experience with resource economics and they understand that the current environment of identifying and valuing resources at risk is difficult at best. As we reviewed the valuation processes and present the findings we do so with utmost respect for the extraordinary work accomplished under very challenging circumstances. We have attempted to make this study useful across agencies and hope these work products benefit everyone involved in the work of burned area evaluation.

Appendix A

BAER Team Field Observations

Mason Gulch Fire, Colorado

The primary values at risk from the Mason Gulch Fire on federal lands were forest soils, native vegetation cover, and forest roads; on private lands, life and safety, structures, roads, and bridges. Although the team leader had previous BAER experience, this was his first team leader assignment. Overall, threat analysis was generally thorough; however, the team struggled with assessment of VAR. Two factors appeared to contribute to the difficulties—problems discriminating between threats and resource values and inconsistent use of maps. Specifically time was lost verbally clarifying spatial relationships that could more quickly have been described using maps. Specific resources at risk were mentioned only briefly during the initial meeting and not substantially discussed until day 2 after the first field reconnaissance. After day 2, the team refined VAR each morning during the daily planning meeting. The need to determine dollar valuation for specific VAR was identified early in the week, but not followed-up on until the end of the process. The team encountered problems assessing values for aquatic T&E habitat and openly expressed difficulty in determining how to assign value and what an appropriate basis for valuation might be.

When questioned, local GIS specialists expressed interest in what resource-related data, if pre-assembled, might have benefited the team. They stated that relevant, BAER-specific data could have been transferred from IMT if it had been requested and that relevant maps could have been ready for the initial BAER meeting. They also stated that some pre-processing of terrain and infrastructure data could be completed pre-fire season and that this work would probably benefit other planning operations. The Forest Supervisor when asked what improvements he would like to see to BAER operations, said, “anything that can help the team launch the analysis more rapidly.” The Mason Gulch Cost/Risk Assessment reported treatments costs and probability of treatment success and used a qualitative ranking for all VAR including property.

School Fire, Washington

Primary VAR on federal jurisdiction included life and safety, critical salmon habitat, natural forage on wildlife habitat and grazing allotments, roads and trails, and campgrounds and historic structures. Private assets downstream from federal lands that were potentially threatened by the watershed response from federal lands included life and safety, critical salmon habitat, residential and commercial structures, a state-owned learning center, and highway infrastructure. The team leader had experience with multiple BAER events and had worked closely with most everyone on the BAER team. The School Fire BAER team, composed of local resources specialists, showed thorough command of threat assessment but struggled through self-acknowledged difficulties with assessment of resources at risk. The assessment was also complicated by impacts of a national computer virus attack that limited network access and communications, a limitation partially overcome through close cooperation with the Incident Management GIS that was still in the active fire camp.

A comment by a local manager during the initial BAER meeting directly acknowledged uncertainty about conducting cost/benefit (C/B) analysis. The team leader added that while C/B analysis is commonly left to the end of the process, VAR should be considered immediately. This would focus field time, directing groundwork to most critical areas only. Discussion of VAR during the first meeting remained very general and maps posted on the walls were not explicitly used. Identification of potential VAR became somewhat more specific during pre-field discussions on Day 2. The task item to begin a list of probable VAR along with possible treatment costs was noted on Day 4 and the preliminary list of VAR was reported at a managers briefing the following day. One document provided itemized “Resources Values and Risk” by resource category with brief entries for resource description, issue/concern, relative risk rating, and treatment priority. A separate document itemizes resources and estimated value (Table A1). Note: Given the limited timeframe and the data available, only value estimates were provided for some, not all, VAR; estimates for timber prod. (sic) and the non-market resources, such as water quality and fish habitat, were not provided. Notation of probability of success and threat to life are omitted. Per current

operating procedures, no map was provided associating resources and sources of threat and therefore relationships cannot be independently assessed. The draft hydrology report does indicate that watershed analysis and modeling was prioritized based on the proximity of severely burned area to identified values at risk.

Table A1: "Property or Resource Risk cost" provided with School Fire 2500-8 report as compiled within the initial timeframe of the BAER assessment.

Property or Resource at Risk	Probability of Success	Threat to Life	Benefit/Value (Cost of No Action)	Cost of Preferred Alternative
Private Residences:				
Tucannon			$2,182,500	
Pataha			$318,487	
Last Resort			$150,000	
State:				
Camp Wooten			$1,750,000	
Wildlife Station			$75,500	
Ponds			$60,000	
Campgrounds			$35,000	
USFS:				
Roads and Bridges			$2,850,000	
Tucannon Campground			$350,000	
Tucannon Guard Station			$125,000	
Fish habitat				
Wildlife habitat prod.—all			$177,000	
Timber prod.				
Water quality				
Weed treatment			$63,000	
TOTAL			**$8,136,500**	**$535,367**

Gash Creek Fire, Montana

The effects of the Gash Creek Fire presented multiple threats to life and safety on a heavily used trail, rare native plant and fish populations, and several road crossings and segments of road surface. With the permission of the BAER Team leader, several processes for determining the value of resources at risk were introduced and implemented by the research assistant for this project. Existing BAER standards and requirements were followed. Some processes for specifically addressing VAR valuation complimented normal procedures, such as the use of maps to guide the explicit listing of preliminary VAR at the initial meeting. Other suggestions resulted in enhancing familiar steps, such as using GIS to add an explicit link to VAR, onto the mapped threats (burn severity). Trial innovations included: preparing and presenting preliminary VAR assessment maps at the first meeting; using these maps to guide focused identification of preliminary VAR; using preliminary maps to focus BAER field verifications and assessments; VAR review and refinement at subsequent team meetings; use of VAR assessment worksheets to focus VAR assessment relative to the associated threats; building a summary map of that showed the spatial relationship of associated VAR and threats (map zones); and compiling cost/benefit information into a spreadsheet format that demonstrated a new concept for non-market valuation. (The details of the Gash Creek BAER team use of the VAR Calculation Tool were used as the example within the demonstration version of the VAR Calculation Tool included in this final report.)

Overall team members were very receptive to the innovations and indicated that the VAR portions of the process seemed to move more effectively than their prior experiences. Although some of the new procedures were redundant, especially those related to threat analysis, the specific association of probable threats to VAR early in the BAER process was generally perceived as useful.

Appendix B1—Blank Survey

BAER/ES&R – Assessing Values-at-Risk

Survey of BAER/ES&R Personnel

Survey Instructions:
In this survey we ask you to consider procedures used by all personnel involved in BAER/ES&R teams to assess Values-at-Risk (VAR) and to complete Cost/Risk (CR) analyses (hereafter referred to jointly as "**VAR/CR analysis**".

As a framework for discussion we suggest that the full ES&R/BAER analysis may be itemized in the following steps:

1. Identify resources at-risk	What resources are threatened and where are they relative to burned areas?	e.g. homes, roads, culverts, artifacts, habitat
2. Resource valuation	What is the relative or estimated dollar value of each resource?	e.g. cost to replace, degree of rarity
3. Hazard assessment	What are the erosion/flood/biological hazards given burn severity, topography, and climate?	e.g. high severity burn of forest at head of very steep drainage with friable soils…
4. Mitigation plan	What treatments might mitigate hazards to threatened resources?	e.g. straw mulch or waddle, cross-felled logs, seeding
5. Treatment costs	What would it cost to implement treatments?	e.g. cost per acre to seed by air with native seed stock
6. Effectiveness analysis	How much might treatments mitigate hazards and will changes merit implementation?	e.g. 30% chance that seed will stabilize soils before first 10-year storm
7. Cost/Benefit analysis	Are the values-at-risk sufficient to justify cost of proposed treatments in the context of probable success of treatments?	e.g. high likelihood that $2K treatments will protect $10K foot bridge

We recognize and appreciate that there are different interpretations of where and how VAR/CR fits into BAER/ESR analyses. For the purposes of this survey, by VAR/CR analysis we specifically refer to steps 1) Identify resources at-risk, 2) Resource valuation, and 7) Cost/Benefit analysis, reconciling values with success-adjusted costs. This definition of VAR/CR analysis does not explicitly include steps 3 through 6.

Please answer the following questions based upon your direct BAER/ES&R experiences over the **past 5 years**.

You may detach this page from the survey.

If you have any questions about this survey, please call me or one of the principle investigators listed on the cover letter.

Again, thanks!

Kevin Hyde /METI Corp.
Survey Manager
406.329.2137 Fax: 406.543.2663
kdhyde@fs.fed.us

Please return survey to:
Kevin Hyde /METI Corp.
RMRS Forestry Sciences Lab
800 E. Beckwith Ave.
Missoula, MT 59803

BAER/ES&R – Assessing Values-at-Risk
Survey of BAER/ES&R Personnel

Please answer the following questions based upon your direct BAER/ES&R experiences over the past 5 years.

Section 1: Background Information

1. Number of years of public land management experience (include state and federal): _____
2. Number of years of experience on a BAER/ES&R team or prescribing BAER/ES&R treatments: _____
3. Number of BAER/ES&R assignments since 2000: _____
4. Year of most recent BAER/ES&R assignment : _____
5. Agency: ☐ BIA ☐ BLM ☐ BOR ☐ NPS ☐ USFS ☐ USFWS
   ☐ Other _____
6. Your areas of expertise generally called upon during your normal work year: (CHECK ALL THAT APPLY)
   ☐ Archaeology ☐ Botany ☐ Contracting ☐ Ecology ☐ Engineering
   ☐ Fire Mgmt. ☐ Fisheries ☐ Forestry ☐ Geology ☐ Geomorphology
   ☐ GIS ☐ Hydrology ☐ Landscape Arch ☐ Range Management ☐ Research
   ☐ Soils ☐ Wildlife ☐ Other _____
7. Number of times as BAER/ES&R team lead? _____ ☐ None
8. Have you directly participated in assigning values, relative or dollar, to VAR? ☐ Yes ☐ No
9. Have you personally completed a Cost/Risk Worksheet or Assessment form? ☐ Yes ☐ No
10. Rate your level of GIS use during your normal work year:
    I am an experienced GIS technician ☐
    I commonly use GIS to support job tasks ☐
    I use GIS on a limited basis ☐
    I direct others to complete GIS tasks for me ☐
    I do not use or direct use of GIS ☐
11. How frequently has GIS been used during BAER/ES&R assessments where you have participated?
    ☐ Always ☐ Usually ☐ Infrequently ☐ Never

CONTROL NUMBER ☐

Section 2: Methods and resources used in VAR/CR analysis which currently work

Please answer the following questions based upon your <u>direct</u> BAER/ES&R experiences over the past 5 years.

12. Please rate how frequently you encounter each of these resources potentially at-risk during BAER/ES&R assignments.

	Always	Usually	Seldom	Never
a. Agricultural lands	☐	☐	☐	☐
b. Bridges	☐	☐	☐	☐
c. Buildings	☐	☐	☐	☐
d. Cultural/historic artifacts	☐	☐	☐	☐
e. Culverts	☐	☐	☐	☐
f. Forest soils	☐	☐	☐	☐
g. Hazardous material storage	☐	☐	☐	☐
h. Habitat – aquatic	☐	☐	☐	☐
i. Habitat – terrestrial	☐	☐	☐	☐
j. Impoundments	☐	☐	☐	☐
k. Irrigation intakes	☐	☐	☐	☐
l. Native vegetation	☐	☐	☐	☐
m. Public safety	☐	☐	☐	☐
n. Public utilities	☐	☐	☐	☐
o. Public water supply	☐	☐	☐	☐
p. Rangeland	☐	☐	☐	☐
q. Recreation resources	☐	☐	☐	☐
r. Research sites	☐	☐	☐	☐
s. Roads	☐	☐	☐	☐
t. T&E species – aquatic	☐	☐	☐	☐
u. T&E species – terrestrial	☐	☐	☐	☐
v. Timber	☐	☐	☐	☐
w. Trails	☐	☐	☐	☐
x. Wellheads	☐	☐	☐	☐

13. Please list any other at-risk resources you commonly encounter.

_____

_____

_____

_____

_____

_____

_____

14. Please rate how frequently you have used each of the following methods and resources to assess value of resources at-risk

		Always	Usually	Seldom	Never
a.	Not applicable	☐			
b.	BAER/ES&R team judgment	☐	☐	☐	☐
c.	Consult forest engineer	☐	☐	☐	☐
d.	Consult local authorities	☐	☐	☐	☐
e.	Consult agency economist	☐	☐	☐	☐
f.	Consult federal officials	☐	☐	☐	☐
g.	Consult resource specialist	☐	☐	☐	☐
h.	Consult state officials	☐	☐	☐	☐
i.	Consult utility manager	☐	☐	☐	☐
j.	County property records	☐	☐	☐	☐
k.	Educated estimation	☐	☐	☐	☐
l.	INFRA database	☐	☐	☐	☐
m.	Internet resources	☐	☐	☐	☐
n.	Lessons from past experience	☐	☐	☐	☐
o.	Academic literature	☐	☐	☐	☐
p.	Review previous reports	☐	☐	☐	☐
q.	Scientific wild guess	☐	☐	☐	☐

15. Please provide comments and list any other methods you commonly use to assess VAR.

_____

_____

_____

_____

_____

16. Which methods and resources have you found most useful for assessing VAR?

_____

_____

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_____

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_____

17. If you used Internet resources to assess resource values where did find useful information?

_____

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_____

18. Please comment on your approach for assessing non-market / non-commodity resources, those where dollar values may not be readily assigned.

_____

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_____

Section 3: Barriers to implementing VAR/CR analysis:

19. Please rate how frequently you encounter each of the following possible **barriers** to completing VAR/CR analysis?

a. I have not directly participated in VAR/CR analysis ☐

	Always	Usually	Sometimes	Never
b. Limited access to local resource specialists	☐	☐	☐	☐
c. Limited assessment tools …….	☐	☐	☐	☐
d. Limited valuation guidelines ……..	☐	☐	☐	☐
e. Limited computer availability ……..	☐	☐	☐	☐
f. Limited network access ……	☐	☐	☐	☐
g. Communication hurdles with IC* ……...	☐	☐	☐	☐
h. Limited data availability……	☐	☐	☐	☐
i. Limited valuation expertise on team …….	☐	☐	☐	☐
j. Limited support literature ……...	☐	☐	☐	☐
k. Conflicting priorities with local mngt. ……...	☐	☐	☐	☐
l. Limited time for assessment ……	☐	☐	☐	☐
m. Limited training in VAR/CR analysis ……...	☐	☐	☐	☐
n. Other _____	☐	☐	☐	☐
o. Other _____	☐	☐	☐	☐
p. Other _____	☐	☐	☐	☐

20. Please provide comments and observations about barriers to implementing VAR/CR analysis.

_____

_____

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_____

* IC – Incident Command

Section 4: Your feedback on some preliminary ideas for improvements to VAR/CR analysis:

Please be assured that the following ideas are offered just to stimulate thought and discussion. While we offer these ideas we have no pre-conceived notion of the form that any changes make may ultimately take.

21. Please evaluate the following ideas to improve VAR/CR analysis:

A. Build unified, interagency Values Assessment and Cost-Risk analysis tools.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

_____

_____

B. Initiate specific VAR assessment at first BAER/ES&R meeting moving VAR/CR analysis to one of the first priorities. Initial assessment would include resource locations, basic description, and discussion of valuation strategy – sources for information to determine resource values.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

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C. At the initial BAER/ES&R team meeting assign a designated team member, other than the team leader, to compile data about potential resources at risk. The objective is to shift responsibility to an individual who could be specifically trained in assessment and valuation of resources-at-risk.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

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_____

D. Use GIS at the initial BAER/ES&R team meeting to identify potential values-at-risk. This approach could help prioritize field time, focusing ground verification of burn severity on areas upstream of or proximate to threatened resources.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

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_____

E. Increase overall use of GIS, linking resource data to Incident Command, BARC, terrain, and other watershed data. GIS may be a very effective platform to rapidly consolidate, analyze, summarize, and report multiple sets of resource data.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

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F. Improve coordination of relevant federal, state, local , and private resource database libraries.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

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_____

G. Compile academic literature relevant to valuation of commodity and non-commodity resources under emergency conditions and make readily available for use by BAER/ES&R personnel.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

_____

_____

H. Develop and implement BAER/ES&R training modules specifically addressing procedures to complete VAR/CR analysis.

☐ Already being done ☐ Good idea ☐ Of limited value ☐ Need more information

Comments:_____

_____

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_____

Section 5: Your ideas on how VAR/CR analysis can be improved

22. Please list your ideas about how the VAR/CR assessment may be improved.

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23. Please use this space for any other information or feedback.

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_____

If you would be willing to discuss this project with a member of the research team please provide your name and phone number below. Again, all comments will be held in strict confidence.

Name: (optional) _____

Phone: (optional) _____

Thank you for your time and contributions!

Return completed survey to:

Kevin Hyde /METI kdhyde@fs.fed.us 406.329.2137
RMRS – Forestry Sciences Lab Fax: 406.543.2663
800 E. Beckwith Ave.
Missoula, MT 59803

Appendix B2

Results of Survey of BAER/ESR Personnel

Summary of Responses:

Q. 5: A total of 214 individuals responded to the survey (Table 1) nearly evenly divided between the DOI and USFS. Within the DOI two-thirds of the responses came from the BLM, nearly 20% from the BIA, about 10% from NPS, and about 7% from the FWS.

Table 1: Responses by agency

DOI	**110**	**51.4%**
BIA	*19*	*8.9%*
BLM	*69*	*32.2%*
NPS	*13*	*6.1%*
Other	*1*	*0.5%*
USFWS	*8*	*3.7%*
USFS	**104**	**48.6%**
Combined	**214**	**100.0%**

SECTION 1: Background Information

The following summary of the experience of the respondents to the BAER/ES survey is provided as context for the responses to values-at-risk assessment practices that follow. Differences noted between the two groups (all DOI agencies and USFS) may inform discussions of interagency solutions. Furthermore differences in specialization and experience on BAER/ES teams and with team leadership frame the space in which any program changes must be considered and ultimately implemented.

Q. 1-4: The mean number of years of public land management experience was 21 and was similar between USFS and DOI responders. Number of years of BAER team experience was greater for USFS at 10.6 compared to 6.6 for DOI. The mean was 8.5. Nearly half of all responders last completed a BAER assignment within the past year before the survey was completed. This number was greater for the DOI group, 60% v. 40% for USFS (Tables 2-5).

Table 2: Number of years of public land management experience (state and federal):

	DOI	**USFS**	**Combined**
Mean	19	22	21
Min	0	4	0
Max	37	36	37
s.d.	9.9	8.9	9.5

Table 3: Number of years of experience on a BAER/ES&R team or prescribing BAER/ES&R treatments

	DOI	**USFS**	**Combined**
Mean	6.6	10.6	8.5
Min	0	0	0
Max	30	35	35
s.d.	5.9	8.1	7.3

Table 4: Number of BAER/ES&R assignments since 2000

	DOI	USFS	Combined
Mean	6.6	10.6	8.5
Min	0	0	0
Max	30	35	35
s.d.	5.9	8.1	7.3

Table 5: Year of most recent BAER/ES&R assignment

	DOI		USFS		Combined	
2006	8	7.3%	3	2.9%	11	5.1%
2005	65	59.1%	39	37.5%	104	48.6%
2004	12	10.9%	18	17.3%	30	14.0%
2003	8	7.3%	18	17.3%	26	12.1%
2002	2	1.8%	9	8.7%	11	5.1%
2001	2	1.8%	3	2.9%	5	2.3%
2000	1	0.9%	2	1.9%	3	1.4%

Q. 6: While specialist representation overall was broadly distributed across disciplines (Table 6) the most common were soil scientists (15%), hydrologists (14%), ecologists (11%), and range managers (8%). Specialist representation was much more evenly distributed among the DOI with higher number of ecologists (14%), fire managers (12%), range managers (12%), and GIS specialists (10%). USFS representation was predominately hydrologists (25%) and soil scientists (25%).

Table 6: Areas of expertise generally called upon during your normal work year

	DOI		USFS		OVERALL	
	Count	%	Count	%	Count	%
Archeology	13	5%	0	0.0%	13	2.6%
Botany	22	8%	6	2.5%	28	5.5%
Contracting	11	4%	4	1.7%	15	3.0%
Ecology	37	14%	19	8.0%	56	11.1%
Engineering	4	1%	2	0.8%	6	1.2%
Fire Management	31	12%	3	1.3%	34	6.7%
Fisheries	2	1%	7	3.0%	9	1.8%
Forestry	22	8%	9	3.8%	31	6.1%
Geology	3	1%	16	6.8%	19	3.8%
Geomorphology	2	1%	16	6.8%	18	3.6%
GIS	27	10%	11	4.6%	38	7.5%
Hydrology	10	4%	58	24.5%	68	13.5%
Landscape Arch.	1	0%	0	0.0%	1	0.2%
Range Management	31	12%	7	3.0%	38	7.5%
Research	5	2%	2	0.8%	7	1.4%
Soils	17	6%	58	24.5%	75	14.9%
Wildlife	13	5%	6	2.5%	19	3.8%
Other	17	6%	13	5.5%	30	5.9%

Q. 7-9: Overall, 61% of respondents have led a BAER team (Table 7). However, team leadership was more common among USFS survey responses (68% v. 54%). Most leadership was limited to 5 incidents or less in both groups (43% USFS, 37% DOI) with more experienced persons (> 6 incidents) responding from the USFS (25% compared to 16%). Direct participation in assigning values (Table 8), relative or dollar, to VAR was high overall (70%) and greater among USFS personnel (76% v. 64%). Fewer

individuals, but still a clear majority (61%), have personally completed a Cost/Risk Worksheet or Assessment form (Table 9) with a similar experience factor between agencies (63% USFS, 58% DOI).

Table 7: Number of times as BAER/ES&R team lead

	DOI		USFS		Combined	
	Count	%	Count	%	Count	%
0	51	46%	33	32%	84	39%
1 - 5	41	37%	45	43%	86	40%
6 - 10	7	6%	18	17%	25	12%
11 - 15	6	5%	4	4%	10	5%
16 - 20	2	2%	3	3%	5	2%
21 - 25	2	2%	1	1%	3	1%
26 - 30	1	1%	0	0%	1	1%

Table 8: Have you directly participated in assigning values, relative or dollar, to VAR?

	DOI		USFS		Combined	
	Count	%	Count	%	Count	%
Yes	70	64%	79	76%	149	70%
No	37	34%	21	20%	58	27%
NR	3	3%	4	4%	7	3%

Table 9: Have you personally completed a Cost/Risk Worksheet or Assessment form?

	DOI		USFS		Combined	
	Count	%	Count	%	Count	%
Yes	64	58%	66	63%	130	61%
No	44	40%	32	31%	76	36%
NR	2	2%	6	6%	8	4%

Q. 10-11: GIS use during your normal work year (Table 10) was reported very high overall with a majority either using GIS commonly (38%) or directing others (23%). A larger number of DOI respondents reported “experienced technician” level (21%) as compared to USFS (5%). Conversely, a larger number of USFS responders (30%) reported limited GIS use. Overall GIS was reported as commonly used during BAER assessments (Table 11), “always” at 58% and usually at 26%. In terms of GIS level of regular use throughout the year, DOI teams responded “always” (66%) more than USFS teams (49%).

Table 10: Rate your level of GIS use during your normal work year

	DOI		USFS		Combined	
	Count	%	Count	%	Count	%
Experienced	23	21%	5	5%	28	13%
Commonly Use	42	38%	39	38%	81	38%
Direct Others	24	22%	25	24%	49	23%
Limited	18	16%	31	30%	49	23%
No Use	2	2%	2	2%	4	2%
NR	1	1%	2	2%	3	1%

Table 11: How frequently has GIS been used during BAER/ES&R assessments where you have participated?

	Always	Usually	Infrequent	Never	NR
DOI	73	17	0	1	19
	66%	15%	0%	1%	17%
USFS	51	39	0	5	9
	49%	38%	0%	5%	9%
Combined	124	56	0	6	28
	58%	26%	0%	3%	13%

SECTION 2: Methods and resources used in VAR/CR analysis which currently work

Q. 12: Summary of frequency of encounters with resources potentially at-risk during BAER/ES&R assignments and other resources not listed in survey.

Table 12 summarizes the resources most commonly encountered by BAER/ES teams during assessments. A large number of the resources listed in the survey are more commonly assessed by USFS teams as indicated by the higher frequency values overall for the majority of the resources listed. Though rank order varies, there is significant overlap between the DOI and USFS in the ten most commonly encountered resources, with the exceptions of terrestrial threatened and endangered species being more commonly assessed by DOI teams and trails being more commonly encountered by USFS teams. Notably, over one-half of the resources encountered by all teams are most appropriately classified as non-market resources; they cannot be directly replaced or repaired. In other words, it is difficult, and as made clear by many comments throughout the survey, even controversial, to apply direct dollar values to these resources.

Table 12: Rank order listing of resources most commonly encountered during BAER assessments. VAR

Resource	VAR Type	Always - Usually	Overall Rank	DOI Freq	DOI Rank	FS Freq	FS Rank
Roads	M	76%	1	64%	4	89%	1
Native vegetation	N-M	76%	2	76%	1	76%	6
Habitat – terrestrial	N-M	73%	3	72%	2	73%	7
Public safety	N-M	72%	4	59%	6	87%	4
Cultural/historic artifacts	N-M	68%	5	65%	3	71%	10
Culverts	M	67%	6	46%	10	89%	2
Forest soils	N-M	66%	7	44%	11	88%	3
Habitat – aquatic	N-M	65%	8	47%	9	84%	5
Recreation resources	M	63%	9	54%	7	73%	8
Rangeland	M	56%	10	60%	5	52%	14
Trails	M	52%	11	32%	14	72%	9
Timber	M	51%	12	41%	12	61%	11
T&E species – terrestrial	N-M	48%	13	48%	8	49%	16
Buildings	M	44%	14	31%	15	59%	12
T&E species – aquatic	N-M	43%	15	31%	16	57%	13
Public utilities	M	41%	16	34%	13	48%	17
Bridges	M	33%	17	16%	20	50%	15
Public water supply	M	32%	18	23%	17	42%	18
Impoundments	M	28%	19	18%	19	39%	19
Irrigation intakes	M	18%	20	9%	23	28%	20
Agricultural lands	M	16%	21	19%	18	13%	21
Wellheads	M	12%	22	16%	21	8%	22
Research sites	N-M	11%	23	14%	22	8%	23
Hazardous material storage	M	4%	24	5%	24	3%	24

Type refers to market (M) v. non-market (N-M) valuation.

Q. 13: Responses to the open-ended request for “any other at-risk resources you commonly encountered” revealed a number of distinct resources not included on the survey list or refinements to listed items: Native American sacred and cultural use sites; gas/oil/mining facilities and infrastructure; fences; Wild and Scenic Rivers; livestock grazing and infrastructure; range soils (distinct from rangeland); fish hatcheries; cadastral survey monuments; wilderness and scenic values; reservoirs (distinct from impoundments); non-T&E wildlife (game, non-game, and endemic); historic and cultural buildings and sites (distinct from artifacts); forage (distinct from habitat). Noxious and invasive weeds were also identified under this category; however, more correctly these represent threats to native vegetation, the value-at-risk.

Q. 14 Frequency of methods and resources used to assess value of resources at-risk and other methods and resources not listed in survey

Table 13 summarizes responses to a list of methods and resources used to assess resources at risk. The reported percentages are the sum of “always” and “usually” survey responses combined and between groups. BAER/ES&R personnel report that resource valuation is primarily based upon consultation with resource specialists, team judgment and experience, review of past assessment reports, and “educated estimation.” Somewhat less commonly teams rely on local, state, and other federal employees, as well as academic literature and internet resources. Reliance upon private utility managers, the corporate INFRA

database, and property records are low. Consultation with agency economists is rarely done. The between group differences are primarily due to the higher number of non-responders within the DOI group, reflecting in part the lower percentage of DOI responders who have directly participated in assigning values to at-risk resources.

Table 13: Rank order listing of methods and resources most commonly used to assess values at risk.

Method or Resource Used	Overall	Rank	DOI Freq	DOI Rank	FS Freq	FS Rank
Consult resource specialist	83%	1	72%	2	96%	1
BAER/ES&R team judgment	80%	3	66%	4	96%	2
Lessons from past experience	81%	2	74%	1	89%	3
Review previous reports	75%	4	67%	3	84%	4
Consult forest engineer	49%	9	22%	12	78%	5
Educated estimation	67%	5	58%	6	77%	6
Consult local authorities	55%	7	45%	8	65%	7
Consult federal officials	62%	6	61%	5	63%	8
Academic literature	54%	8	51%	7	58%	9
Internet resources	44%	10	41%	10	47%	10
Consult state officials	42%	11	42%	9	41%	11
Scientific wild guess	31%	12	24%	11	39%	12
Consult utility manager	20%	13	16%	14	25%	13
INFRA database	16%	15	8%	15	24%	14
County property records	17%	14	21%	13	13%	15
Consult agency economist	3%	16	4%	16	2%	16

Q. 15: Responses to the open-ended request for "comments and (to) list any other methods you commonly use to assess VAR" provided a number of additional resources as well as many concerns about the expectation and process of assessing values-at-risk. Other methods varied from the specific to very general and are presented in no particular order of significance:

- Consultation with Native Americans
- Use of various databases including cultural resources, landslide and soil surveys, a range of GIS databases including noxious weed maps*, federal agency resources including NOAA (rainfall intensity, flood, and climate data), RSAC (BARC maps*), and USFWS and NRCS resources
- Assessment tools including USFS Cost/Risk Worksheet and the BAER Website; GIS applications to assess erosion potential* (FSWEPP)
- Private commercial resources; seed catalogues, vendors and contractors who supply repair, replacement, and rehabilitation materials and services
- Existing resource reports: WFSA reports from the incident requiring BAER/ES assessment; management plans and documents including habitat management and conservation plans, environmental assessments, and land use plans
- Role of field work was strongly emphasized

While cited as resources to assess VAR, the items marked above by an asterisk (*) explicitly apply to threat assessment and do not directly lead to assessing value of resources at risk.

Many important concerns about the valuation process itself emerged from open responses. Thorough valuation of resources at risk requires more information than can be collected within the constraints of the BAER/ES environment. Respondents from both groups expressed comfort with and confidence in the relative rank-order, non-monetary valuation system used by DOI teams. Many respondents strongly emphasized the critical importance of relying on local resource specialists outside the BAER/ES teams,

reinforcing that post-fire analysis addresses local resources that should be evaluated by local standards. Deeply held concerns and beliefs were expressed within both groups about the limits of monetizing resource values, "economic values cheapen the ecological values." One comment stated that that VAR values are sometimes adjusted upwards using the current USFS C/B method (USFS) as a matter of "land ethics to protect remaining resources." The importance of local knowledge and the limited value of academic work were expressed. Even if BEAR teams wanted to use academic findings, the difficulty of accessing the best available science makes use infeasible. Another response differentiated the components of the VAR process, identifying and defining threats to VAR are the easy part – the real difficulty follows in assigning value.

Q. 16: Which methods and resources have you found most useful for assessing VAR?

Overall, highest confidence with resources and methods to assess VAR was placed in reliance on local knowledge and experience along with the judgment of BAER/ES teams. Reliance upon local knowledge was reported to be most useful for assessing VAR (80 responses). This included consultation with resource specialists and other local managers, authorities, and personnel. Following in order of most reported were self-reliance on experience, judgment, educated estimation (60), use of existing documents including local plans and documents, past BAER reports, and fire suppression plans (25), outside resources including academic literature, internet resources, and GIS databases (21), and on the ground evaluation (5). A particularly strong critique of the current USFS was stated in response to this question. "Normally view cost/risk analysis as a meaningless exercise. If we think a BAER treatment is necessary we can usually find a defensible way to make the C/R analysis work out favorably."

Q. 17: If you used Internet resources to assess resource values where did find useful information?

The most commonly cited internet resource used was the BAER website (25 responses). Other resources follow: Commercial vendor and supplier sites (11); academic reference sites (10); USGS and NRCS data sites (9 each), general search engines (7), Fire Effects Information System (FEIS) (5); and a range of other federal, state, and county sites (51) including state GIS clearinghouses and county land and parcel records.

Q. 18: Please comment on your approach for assessing non-market / non-commodity resources, those where dollar values may not be readily assigned.

General responses to the request for approaches to assess non-market/no-commodity resources included, in order of most common occurrence; qualitative, descriptive approach including rank order evaluation; local knowledge of use and relative value from resource specialist or advisor; best estimation or guess (this response was most common among USFS responders); other resource plans and reports specific to the area; and academic literature and other publications. Other more specific resources and solutions were reported: calculate impacts to archeological sites using cost of data recovery; assess loss of traditional and subsistence uses; assess cultural or ecological value through criteria defined by National Register, ESA, or records of sacred or religious importance; use published estimates of hunter/recreation users days; calculate cost to repair, replace, or restore lost or damaged habitat or population; use economic studies developed for different resources and adapted to burn conditions; calculate cost to buy and haul in topsoil; use the standard figures shared among BAER specialists in AZ; use state F&W information on value of fish; use analyses in the NPS 19JJ system.

SECTION 3: BARRIERS TO IMPLEMENTING VAR/CR ANALYSIS:

Q. 19: Limited time for assessments, training in VAR/CR analysis, and valuation guidelines were reported as the top obstacles to conducting assessments (Table 14) followed by limited availability of data, supporting literature, valuation expertise, and assessment tools. Access to information from outside resources and to computing systems poses the least significant barriers. The rank order of concern between the DOI and USFS is essentially the same; however, there are several notable group differences in this assessment of barriers. USFS reported greater concern about limited training, valuation guidelines,

and assessment data. DOI responders were more concerned about communication with incident command and limited access to local specialists than their counterparts.

Table 14: Summary of barriers to implementing VAR/CR analysis ranked by frequency of response overall and between groups

Barrier	Overall	Rank	DOI Freq	DOI Rank	FS Freq	FS Rank
Limited time for assessment	58%	1	59%	1	57%	3
Limited training in VAR/CR analysis	54%	2	47%	2	62%	1
Limited valuation guidelines	47%	3	32%	4	61%	2
Limited data availability	46%	4	38%	3	54%	5
Limited support literature	43%	5	31%	5	56%	4
Limited valuation expertise on team	36%	6	27%	6	44%	6
Limited assessment tools	32%	7	22%	7	42%	7
Conflicting priorities with local mngt.	18%	8	21%	8	14%	8
Communication hurdles with IC*	14%	9	18%	9	11%	9
Limited access to local resource specialists	9%	10	9%	11	9%	10
Limited network access	9%	11	10%	10	8%	11
Limited computer availability	1%	12	1%	12	1%	12

Q. 20: Most additional comments emphasized limited time, lack of training and experience in VAR/CR analysis, and lack of consistent approaches and guidelines. Notably, the concern about lack of valuation approaches and guidelines was limited to USFS responses. Many responses, also limited to the USFS group, questioned the need for or the validity of the process. Many respondents from both groups expressed concerns over the difficulty with and subjective nature of non-market or non-commodity resources valuation.

SECTION 4: FEEDBACK ON SOME PRELIMINARY IDEAS FOR IMPROVEMENTS TO VAR/CR ANALYSIS

Q. 21: Responses were compiled (Table 15) assuming “already being done” or “good idea” indicated acceptance of the idea, “of limited value” indicated resistance, and the combination of “need more info” and no responses indicates uncertainty. All ideas were supported by the majority of both groups. Highest support was given for increased use of GIS overall and at the first meeting to support spatially explicit VAR assessments. Thereafter development of training modules, improvement of database libraries and coordination, and compilation of academic literature were deemed most important. Emphasis on VAR assessment during the first meeting, development of unified interagency tools and assigning a team member to coordinate VAR assessments received the least support overall. Comparing perception of current status (already being done) with approval of the suggestion as a “good idea” reveals within-idea differences. Large gaps exist between current practice and identified need for change regarding training modules, database improvement, and building literature resources.

Table 15: Summary of responses to ideas to improve assessment of values at risk ranked by order of acceptance.

Improvement Idea	Responses: Already Being Done	Good Idea	Of Limited Value	Need More Info	Blank	Interpretation: Accept	Resist	Uncertain
1 Increase GIS Use								
Combined	41%	37%	5%	7%	11%	78%	5%	18%
DOI	38%	35%	5%	7%	14%	73%	5%	22%
USFS	44%	38%	4%	7%	7%	83%	4%	13%
2 Use GIS First Meeting								
Combined	41%	34%	5%	7%	13%	76%	5%	19%
DOI	42%	33%	5%	6%	14%	76%	5%	20%
USFS	40%	36%	6%	7%	12%	76%	6%	18%
3 Develop Training Modules								
Combined	5%	71%	7%	7%	10%	76%	7%	17%
DOI	5%	66%	9%	8%	12%	71%	9%	20%
USFS	5%	77%	4%	7%	8%	82%	4%	14%
4 Improve Database Libraries								
Combined	10%	62%	8%	9%	11%	72%	8%	20%
DOI	9%	65%	7%	5%	14%	74%	7%	19%
USFS	11%	60%	10%	13%	8%	70%	10%	20%
5 Compile Academic Literature								
Combined	5%	66%	15%	5%	10%	70%	15%	15%
DOI	5%	62%	13%	6%	14%	68%	13%	20%
USFS	4%	69%	17%	3%	7%	73%	17%	10%
6 VAR Assessment 1st Meeting								
Combined	29%	39%	10%	13%	10%	67%	10%	22%
DOI	23%	41%	9%	14%	14%	63%	9%	28%
USFS	36%	37%	12%	12%	5%	72%	12%	16%
7 Unified Interagency Tools								
Combined	3%	59%	13%	13%	13%	62%	13%	26%
DOI	4%	48%	16%	14%	18%	51%	16%	32%
USFS	3%	70%	9%	11%	8%	73%	9%	18%
8 Assign Designated Member								
Combined	10%	43%	25%	10%	12%	53%	25%	22%
DOI	13%	41%	20%	11%	16%	53%	20%	27%
USFS	8%	45%	30%	10%	8%	53%	30%	17%

Feedback on individual suggestions – Listed in order of Table 15:

Increase GIS Use: Respondents reported multiple benefits from intensive GIS use. Coordinated GIS use was reported as a process common to National DOI BAER teams that could help regional and local teams. However, the process is not documented and needs refinement. GIS was recognized as a tool to integrate information transfer from Incident Management Teams to BAER teams. Current lack of coordination and cooperation with IMT hinders this process. Overall, respondents support more use of GIS provided expertise, equipment, and data are available. The reasonable caveat was expressed that GIS

is not a substitute for field work, however preparing with GIS makes field time more efficient. A GIS refresher based on BAER was recommended.

Use GIS First Meeting: This is another area of inconsistent application. It was reported as standard operating procedure, especially with National and DOI teams, that sped up the entire process, especially VAR/CR analysis. Some users are highly skilled and have well-developed pre-assembled, regionally standardized data libraries (USFS Region 5), GPS dictionaries, and standing procedures within normal management functions to build critical maps for the initial meeting. Limits to broader application include data availability, lack of pre-season planning, and recognition that some critical values are simply not recorded within GIS systems.

Develop Training Modules: Opinions varied about level of detail required and how training should be implemented. All personnel should be exposed to general VAR and benefit/cost analysis and a few individuals should get detailed training. Some expected on-line access to be sufficient while others stated that dedicated training sessions would be most effective. Many expressed that training in benefit/cost analysis is essential. Concerns were expressed about whether there was sufficient time in already cramped schedules to use training resources, how the training should be scaled, and if traditional resource specialists would also benefit.

Improve Database Libraries: This was generally perceived as an important idea with little resistance. Existing programs could be built upon and national mapping project data made available via high-speed links. Value of comprehensive parcel and structures databases, especially near WUI, was recognized. While many agreed that data conformance between agencies is a good idea, there are issues of firewalls, access, and interagency trust. Concerns were expressed about cost to build and update these databases given that preparedness dollars are not part of the current BAER program. Better ways to interact with other BAER personnel, e.g. e-mail lists, could increase sharing and awareness of current data, tools, and practices.

Compile Academic Literature: Results from this idea generated the most ambivalence. While some recognize the value of compiled reference libraries others express skepticism that it would be sufficiently representative and maintained over time. To be useful within the time-constraints of most BAER operations, literature needs to be well summarized, categorized, and rapidly accessible. Other reactions ranged from “love to see it” to concern about how users would interpret conflicting findings to outright sarcasm.

VAR Assessment at First Meeting: Responses revealed much inconsistency in current practices. Many agree that in some manner teams currently start with VAR ID, but that the process is often informal and should be formalized. Many insist that this is and should be standard procedure, at least for large fires. Others insist that this is the job of specialists. Others believe that severity assessment should be completed first and that no VAR assessment should be completed before the team goes to the field and assesses resource damage. One suggestion was to create a brief, one-page bulleted list of possible VAR to trigger discussion and improve team focus at the initial team meeting.

Unified Interagency Tools: Comments provide strong reinforcement that consistency is important and would likely yield more defensible treatment plans. Many expressed concerns that any system must be flexible and account for local values. A common warning was that, “one size does not fit all.” Feasibility of an integrated system was questioned based upon differences between agency missions, processes, funding regulations, and values.

Assign Designated Member: This idea generated the most controversial results. Many strongly believed that this is the job of each specialist and the entire team. Many others thought it was a good idea or reported it as standard operating procedure, especially on large fires (this response was more frequently reported with DOI teams than with USFS teams). Others thought it a good idea only if an additional trained staff member is provided to each team; perhaps this person could be a resource economist. Some perceive it as the current team leader role but see value in assigning one individual to focus on the VAR

valuation process—to collect and compile information from specialists, assemble a VAR report, research required valuation information, and complete the final benefit/cost analysis.

SECTION 5: YOUR IDEAS ON HOW VAR/CR ANALYSIS CAN BE IMPROVED

Q. 22: Please list your ideas about how the VAR/CR assessment may be improved. Responses to this question included:

- Any changes must be simple and easy to use, adjustable to local conditions, and supported by data, templates and training. A complicated, quantitative system is DOA.
- Increase level of advanced information sharing before BAER team arrives.
- Well designed training systems are essential.
- Develop agreement between DOI and USFS to evaluate VAR beyond watershed issues.
- Any improvements should truly benefit resource management objectives and not simply upper level calls for greater accountability.
- Assure that results from any tools can be easily printed.
- Move to use of standard BAER teams with thoroughly trained people.
- Reinforce why valuation and benefit/cost analysis are important.
- Improve understanding of probability and risk-based assessment.
- Provide examples of quality VAR assessments.
- Implement more formal and consistent monitoring and follow-up procedures.
- Develop general flowcharts and checklists to guide procedures.

Q. 23: Please use this space for any other information or feedback. Responses to this question included:

- Reassess the entire BAER training program to assure consistent knowledge of intent and process
- It is imperative that any changes not be perceived to be driven by one agency or academia.
- A formal process is needed that tracks and transfers IC data and assessments directly to BAER teams.
- Improve means to predict and quantify fire effects or value assessments will be meaningless.
- A lot of the suggestions in the survey are already being implemented to some degree by national BAER teams. Improvements are necessary, especially additional guidance on CR assessment.

Appendix C

Literature reviews of non-market valuation methods

Introduction

The economic concept of value underlies the processes used to assign a dollar value to goods and services. Basic economic theory states that when traditional markets are clearly identified and defined, commodity values usually are easily monetized. Buyers and sellers collectively determine an equilibrium price of a good or service based on economic principals that maximize benefits to society[1]. However, the value of natural amenities and ecosystems are not so easily monetized and have been subject to rigorous academic debate. Ecosystem functions and the associated outputs of those functions (i.e. goods and services) are often referred to as having non-market characteristics. That is, there is no clear definition of existing markets, no buyers and/or sellers, and therefore no equilibrium prices or dollar values assignable to those ecosystem functions. Further, when traditional markets do not exist an inefficient distribution of resources is likely without government intervention.

This literature summary will focus exclusively on the non-market valuation methods and the potential application to the BAER/ESR valuation process. Property values are characterized by markets and when encountered as values at risk, are valued by the dollar amounts required to replace the properties (e.g. rebuild a lost structure, fence, bridge, etc.). This information is generally available through county tax records, insurance appraisals, or engineering specifications. Although literature does exist that quantify the value of human life and morbidity, life and safety are not be monetized in the BAER/ESR valuation process. The prevailing methods for assigning dollar values to non-market goods and services will be discussed. Following we will examine resources and values at risk commonly encountered during the BAER/ESR process.

Contingent valuation method

A prevalent estimation method for non-market values covered extensively in the literature and employed often over the last several decades is the method of contingent valuation (CV). CV is a stated preference method executed through a survey instrument of those utilizing a resource which may have both market and non-market values, except that the survey design focuses on the non-market portion of the resource. CV elicits a consumer's stated willingness to pay (WTP) for, or willingness to accept (WTA) compensation for, the maximum increment or decrement of a public good[2]. In economic theory, this increment or decrement is reflected by the change in an individual's consumer surplus[3]. CV surveys are neither simple nor inexpensive to implement (Carson and others 2000) and rely on responses regarding a "hypothetical market" (Cameron 1992). Several limitations and assumptions occurring with the use of CV have been identified in the literature and these primarily relate to the design and/or execution of the survey instrument. An extensive list of CV issues, limitations, and potential sources of bias is available at www.ecosystemvaluation.org, including:

- Humans have practice making choices with market goods and CV assumes that people understand the good in question
- The expressed answers to a WTP question in a CV format may be biased because the respondent is actually answering a different question than the surveyor had intended. Rather than expressing value

[1]In economic theory this is the sum of consumer and producer surpluses.

[2] Public goods are goods or services that can be consumed simultaneously by everyone, from which one's consumption does not diminish another's ability to consume the good or service, and from which no one can be excluded. A public good is a good that is hard or even impossible to produce for private profit. Through taxes, governments usually supply public goods such as roads and national defense.

[3] In economic theory this is the area below the demand curve and above the price level. It is the difference between the maximum amount a person is willing to pay and a good or services current price.

for the good, respondents might actually be expressing personal feelings about the resource or the valuation exercise itself
- Respondents may make associations among environmental goods that the researcher had not intended
- There may be a fundamental difference in the way people make hypothetical decisions relative to the way they make actual decisions
- In theory, WTP and WTA should be very close; however, when the two formats have been compared WTA has shown to be significantly higher than WTP
- Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome
- A single respondent may give different WTP depending on the specific payment vehicle chosen, i.e. taxes, contributions, or donations
- Non-response bias may occur since individuals who do not respond are likely to have, on average, different values than individuals who do respond
- Estimates of non-market values are difficult to validate externally.

In addition to some of the issues and limitations listed above, areas of uncertainty arise with the application of CV. There exists difficulty of obtaining valid monetary estimates for non-market values (Roach and Wade 2006). Hanemann and Kristom (1995) suggested that if CV respondents truly knew the value of the resource in question, an open-ended survey[4] format is best used; however, uncertainty in the respondent's valuation of the non-market resource in question may arise. Shaikh and others (2006) state that uncertainty arises in a number of ways: Respondents may be uncertain about what they are being asked to value, values respondents assign to a non-market good may be influenced by prices of substitutes and complements[5], respondents may have difficulty making trade-offs between the amenity in question and a monetary good, and confusion about the contingency in question can all lead to uncertainty, a source of error in the CV estimation method.

Also, large differences between WTP and WTA have been observed for valuation of the same good. Bromley (1995) states that while WTP estimates result in increases in welfare, and WTA estimates result in decreases in welfare, often times each approach is misapplied. For example, Ward and Duffield (1992) describe several instances where the differences between WTP and WTA are sizeable. This is because individuals value possible gains much differently than they do possible loses (Bromley 1995, Knetsch 1990). Also, Roach and Wade (2006) cite two examples from the National Oceanic and Atmospheric Administration (NOAA) whereby an expert panel explored the reliability of CV. This panel concluded that CV estimates could "provide useful information in the determination of damages so long as the survey met certain scientific standards. The panel concluded that contingent valuation estimates tended to overstate actual losses and subsequent NOAA guidelines suggest that contingent valuation estimates be scaled downward by a factor of 2 in the absence of more reliable scaling information."

Notwithstanding the above noted issues and/or limitations, CV has been a popular and widely used method for valuation of goods when markets fail to do so. The fundamental utility of the CV method has been upheld (Ajzen and others 1996) and its flexibility facilitates valuation of a wide variety of non-market goods enabling researchers to assess their total value (Carson and others 2001).

Travel cost method

Another non-market valuation method often employed by economists to estimate the value of non-market resources, has been with the travel cost method (TCM). TCM strives to interpret travel costs and times from a number of people and locations as the price of consuming a non-market resource (Rosenthal and others 1984). TCM shows how the cost of travel to a site is one important component of the full cost of a

[4] This is a survey instrument that allows for a spontaneous response.
[5] In economic theory substitutes are goods or services that can serve as replacements for one another. As the price of one increases, demand for the substitute increases. Complements are goods that go together, a decrease in the price of one good or service results in an increase in demand for the other, and vice-versa.

visit to that site (Freeman 1992). Essentially, TCM interprets variation of travel costs to a specific site where a non-market good is consumed as equivalent to a per trip entrance fee to the same site (Cameron 1992). The TCM approach relies on actual observed economic behavior, or consumer's revealed preferences, rather than consumer's stated preferences derived from CV (Carson and others 2000). An advantage of TCM's revealed preference method is that actual expenditures made for some level of non-market resource consumption are measured. That is, TCM is based on actual, measurable behavior, as opposed to verbal responses to hypothetical situations put forth with CV (Ulibari and Wellman 1997). Measurements necessary for the TCM are typically travel costs to get to the resource as well as opportunity costs[6] associated with choosing the resource. Benefits derived from travel itself must not be included in the TCM.

It is important to note what is usually observed with TCM is the selection of a good or service that is linked to an environmental service, and not the environmental service itself (Bingham and others 1995). A consumer may participate in many activities at one location and TCM values are estimates of the entire trip to that location, not individual activities. When a trip is for multiple purposes, travel costs should be distributed among the joint production of the many goods, and it may become difficult or impossible to assign only a portion of the trip costs to a specific activity (Rosenthal and others 1984). Additionally, when there are multiple substitutes for a recreational trip, for example, the TCM approach may not be appropriate, and the analyst may want to consider alternative models.

Additionally, CV and TCM studies are very site specific and resource oriented. Analysts looking to the existing non-market valuation literature for benefit estimates of a local resource will rarely have studies to refer to for that specific resource and geographic location. When this occurs the application of another form of valuation is required. This method, called benefit transfer, allows the application of a particular valuation study, namely CV or TCM, from one location to a location with similar resource characteristics. The benefit transfer method is discussed in detail below.

Hedonic pricing method

The hedonic pricing method (HPM) has been most widely applied in valuation of real estate, damages associated with occupational health and safety, and personal injury awards. HPM is based on the concept that the price of a good is a function of the sum of its individual characteristics. HPM uses statistical techniques to determine, from the prices of goods with similar yet different measurable characteristics, prices associated with those characteristics. As stated by Ulibari and Wellman (1997), HPM:

> "is used mostly to estimate the willingness to pay for variations in property values due to the presence or absence of specific environmental attributes, such as air quality, noise, and panoramic vistas. By comparing the market value of two properties having different degrees of a specific attribute, analysts extract the implicit value of the attribute to property buyers and sellers. By correcting for other factors that might have influenced the value of the property, the analyst can isolate the implicit price of an amenity or bundle of amenities that have changed over time."

As with any non-market valuation method, HPM is not without limitations. Several of these are listed at www.ecosystemvaluation.org and among them are:

- The scopes of environmental benefits that can be measured are limited to things that are related to housing prices.
- The method will only capture people's willingness to pay for perceived differences in environmental attributes, and their direct consequences.

[6] Opportunity cost is what is given up when a choice is made (e.g. income from work); Cesario (1976) suggests the opportunity cost of travel time is one-quarter to one-half the wage rate.

- The method is relatively complex to implement and interpret, requiring a high degree of statistical expertise.
- The results depend heavily on model specification, large amounts of data must be gathered and manipulated, and the time and expense to carry out an application depends on the availability and accessibility of data.

Ecosystem services models

Ecosystem services models attempt to estimate how natural systems support human welfare and assign economic value to these services such as water and air purification, flood regulation, soil development, and climate control. Most non-market valuation techniques derive value from either stated or revealed preferences based on the dollar value respondents place on the opportunity to use or lose the resource being modeled. Costanza and others (1997) cite examples of moral arguments that are made for and against ecosystem valuation and state that doing so makes the problem of ecosystem valuation more difficult and less explicit. Spash and Vatn (2006) raise questions regarding the meaning of monetary estimates found in the ecosystem service literature. We do not enter the moral debate regarding ecosystem valuation, but prefer to simply report efforts that have been made to do so.

The Gund Institute for Ecological Economics at the University of Vermont hosts the Ecosystem Services Database (http://esd.uvm.edu/) where hundreds of peer-reviewed studies are located. Other notable database sources are listed by McComb and others (2006), including Environmental Valuation Reference Inventory (EVRI) and Envalue.

The majority of non-market valuation estimates available from the literature are from persons who are willing to state or reveal the dollar value they might place on the opportunity to use or lose the resource, most often for recreational purposes. And, recreation values vary substantially by recreation type, vegetation type and region (Englin and others 2006; Loomis 2005; Rosenberger and Loomis 2001). An important aspect of our research was locating estimates of the value of the resources themselves as they relate to the whole ecosystem. However, this has proved a difficult task. Bockstael and others (2000) note that ecosystem services are intrinsically connected and conventional valuation methods might produce piecemeal or incomplete benefit estimates. They further state that:

> "Values estimated at one scale cannot be expanded by a convenient physical index of area to another scale; nor can two separate value estimates, derived under different contexts, simply be added together. When we estimate a compensation measure for one element of an ecosystem, we assume that other aspects of the world that influence human well-being are unchanged."

Shogren and others (1999) state that even low value resources are linked to high value resources through ecosystem interaction. Bingham and others (1995) note that it is extremely difficult to fully measure the functions and processes of an ecological system or to predict the ecological impacts of disturbances to those complex systems. Furthermore, information is lacking about the physical changes to ecosystems and the socio-economic consequences that might result from alternative courses of action. In this regard, much is lacking in the economic valuation research. Only recently have tangible efforts been made to look beyond human placement of value upon ecosystem functions through development and application of compensatory research restoration and habitat equivalency analysis (Roach and Wade 2006). While these approaches do not entirely eliminate the reliance upon people to derive estimates of an ecosystem service, there is much more consideration given to the function of the resource in the ecosystem. And while some progress has been made in valuing certain aspects of ecosystems as commodities, much work remains before satisfactory methods for valuing all the services and attributes of ecosystems will be available.

Production Possibility Analysis

Another method for evaluating the value of non-market resource values is to develop economic production frontiers that compare the tradeoffs between competing resource values (Stevens and Montgomery, 2002 and Montgomery, 2003). Production frontiers, or production possibility curves[7], map all feasible combinations of outputs (desired resource values) possible from a given set of inputs (study landscape). By mapping out the production relationship, the opportunity cost of providing one level of resource output in terms of another can be displayed. By selecting a given alternative the opportunity cost of reaching a specified level of resource output can be explicitly defined in terms of reduction in the competing resource, and when the competing resource is a well defined market value the implied dollar value of the decision can be identified.

Montgomery (1995) and Montgomery et al. (1994) developed the production relationship between the likelihood of the northern spotted owl (*strix occidentalis*) survival over an l00 year horizon and the foregone timber revenue associated with alternative preservation strategies. Marshall et al. (2000) examined cost effective management of endangered species to achieve established safety margins for the survival of the Kirtland's warbler (*Dendroica kirtlandii*). This was accomplished by mapping the opportunity cost in terms of foregone timber revenue associated with reducing timber rotation age below the optimal economic rotation to provide additional young forest stands for increased habitat. Rohweder et al. (2000) examined the production tradeoffs among multiple resource values including timber harvest value, elk hiding cover, woodpecker and songbird habitat, and insect and fire risk of alternative timber management programs in the Blue Mountains of Oregon. Calkin et al. 2002 used heuristic optimization techniques to maximize timber harvest revenue while meeting established habitat goals for the northern flying squirrel (*Glaucomys sabrinus*), a primary prey of the spotted owl, in the Willamette National Forest, Oregon. Calkin et al. (2005) and Hummel and Calkin (2005) explored tradeoffs between fire threat reduction, spotted owl habitat, and fuel treatment costs of alternative treatment scenarios for a late seral reserve in the Gifford Pinchot National Forest, Washington state.

These studies describe how the implied value associated with a forest management decision or policy may be revealed by explicitly identifying the necessary reduction of another forest resource outputs (typically forgone timber revenue) to achieve the desired resource output or goal. A direct analogy may be made with BAER treatment options to reduce the post fire risk to identified resource values. A BAER team's decision to conduct a mitigation treatment to reduce the likelihood of experiencing a negative outcome to an identified non-market resource value implies that the value of the resource to be protected is at least as valuable as the cost of the treatment divided by the reduced likelihood of experiencing the negative outcome compared with the no treatment option.

Benefit transfer method

As described in Rosenberger and Loomis (2001), benefit transfer (BT) is a term that refers to the application of existing information and knowledge to new contexts. That is, BT is the adaptation of economic information from a specific site and/or resource to another site with similar resources and conditions. BT allows a practical way to produce resource valuation estimates when comprehensive research for the site or resource in question is unavailable. This method is often used by public agencies when cost and time constraints preclude more detailed valuation techniques. It is important to note, however, that BT can only be as accurate as the primary research; therefore it is critical that careful consideration be given to the quality of the primary research to be used.

Two forms of BT exist: transfer of average site values previously estimated to the study site ("direct benefit transfer"), and transfer of the function previously estimated to the study site ("benefit function transfer"). With benefit function transfer, the function coefficients are used together with the new study site variables, thus providing a reasonable estimate of both the use and benefits at the new site (Loomis 1992). Others have also found that benefit function transfer provides more robust estimates than that of

[7] In economic theory this depicts the trade-off between any two items produced. It indicates the opportunity cost of increasing one good or services' production in terms of foregoing production of another.

direct benefit transfer (Kirchhoff and others 1994; Brouwer, 2000; Chattopadhyay, 2003). However, in many situations, application of either benefit transfer method must be augmented with additional data, such as demographic and environmental data. Population distribution around the study site has also been found to affect reported benefits (Dwyer and others 1977) and analysts should be careful to choose appropriate sites for the use of benefit transfer. Both sites should be similar with respect to activities, quality of the activities, and the availability of substitutes (Kirchhoff and others 1997).

The BT method should be applied with caution, and it is up to the researcher to decide if this is an appropriate method of non-market valuation. Other notable limitations apply as well, as indicated by Rosenberger and Loomis (2001):

- Most primary research is not designed for benefit transfer purposes
- Some recreation activities have a limited number of studies investigating their economic value, thus restricting the pool of estimates and studies from which to draw information
- Documentation of data collected and reported may be limited increasing the difficulty of demand estimation and benefit transfer
- Different research methods may have been used across study sites
- Different statistical methods for estimating models can lead to large differences in estimations
- Model misspecification and choice of functional form can influence results
- Substitution in recreation demand; there is often a lack of data collection and or reporting on the availability of substitutes

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Appendix D

Literature review of valuation of non-market VAR categories in the USFS-BAER 2500-8 forms

Water quality—Value estimates of water-based ecosystem services present some general challenges that are typical to many non-market VAR. The "services" (uses) of the resource are difficult to determine and it is easy to leave out important services or be so inclusive that a value can not be assigned. In examining the literature valuing freshwater ecosystems over the last several decades, Wilson and Carpenter (1999) found that most studies focused on a specific indicator of water quality. Holmes and others (2004) noted that while these studies have demonstrated "that freshwater ecosystems have economic value, particularly non-market value, they only provide partial benefit estimates because they are based on an incomplete list of potentially valuable services." Conversely, estimates on grand scales exist (Costanza and others 1997). Generally, estimates of watershed ecosystem services and values have been selective to a particular function, service, and locality.

Soil productivity—Most soil valuation is centered on agriculture and describes the cost of soil erosion in terms of lost future productivity (Gunatilake and Vieth 2000). For the purposes of this project, a broader concept of valuing the ecosystem functions of soil was used, such as that described by Knowler (2004): 1) supporting cropping and grazing, 2) buffering and moderating the hydrologic cycle, 3) decomposition and recycling, and 4) regulation of atmospheric gases and elemental cycles. Like water resources, soil productivity (or ecosystem service) is difficult to define let alone value. Grand scale estimates of soil value have also been produced (Barbier and Bishop 1995; Pimentel and others 1995). Also, valuation of lost soil productivity (or other ecosystem service) may not adequately confront irreversible ecosystem modifications that could have serious long-term economic repercussions (Bingham and others 1995). It is difficult to identify and isolate the values at risk from the total value of the resource.

Threatened, endangered, or sensitive species—Many attempts have been made the past few decades to derive monetary estimates of the value of wildlife, especially T&E species. Krutilla (1967) introduced the notion of existence value, and states that "the supply of natural phenomenon is virtually inelastic," and "there are significant limitations on reproducing it in the future should we fail to preserve it." Existence value comprises a portion of total non-market value and describes how persons can value something simply by knowing it exists, usually in its natural state, regardless of whether or not they might physically utilize the resource. Shogren and others (1999) argue that economics are important to T&E species protection because: 1) human behavior and economic parameters determine the degree of risk to a species, 2) scarce resources dictate that the opportunity cost of species protection must be taken into account in decision-making, and 3) economic incentives are critical to shaping human behavior and the recovery of a species. There is a growing body of literature that uses production possibility analysis to explore the tradeoffs between endangered species preservation and foregone commodity production (see Montgomery 2003). Despite the available literature describing the monetary values of US threatened or endangered species; wildlife existence is a public good and is not easily or uniformly monetized.

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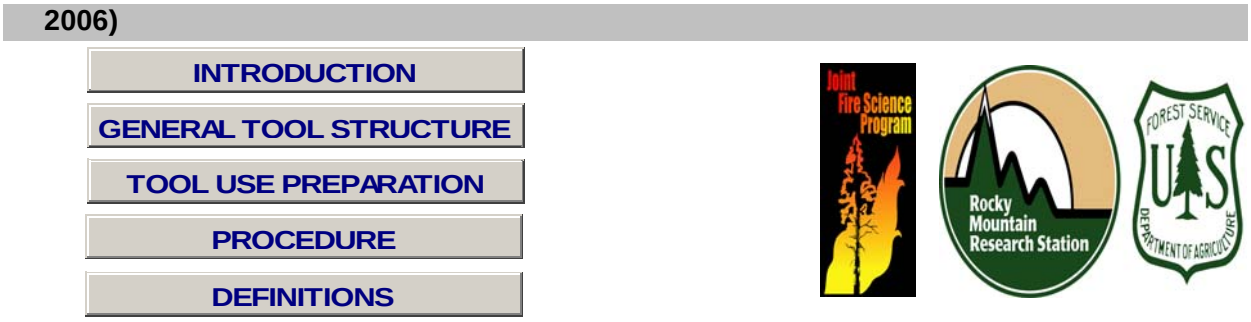
Appendix E

VAR Calculation Tool—sample pages



Welcome Page from VAR Calculation Tool.

EACH MAP ZONE REPRESENTS A SYSTEM OF LINKED TREATMENTS AND ASSOCIATED VALUES AT RISK					
MAP ZONE D VALUES AT RISK					
Life and Safety	**Map link #**	**Description**			
PLEASE NOTE: IF PUBLIC SAFETY IS A FACTOR, B/C RATIO SHOULD NOT BE RELEVANT AND SHOULD STRICTLY BE AN ACCOUNTING EXERCISE					
Non-Market: Cultural Values	**Map link #**	**Description**			
Non-Market: Ecological	**Map link #**	**Description**			
Westslope cutthroat trout	D	Isolated population of WCT, species of concern			
Market Values	**Map link #**	**Value Source**	**# Units**	**Resource Value**	**Total**
Culverts	D	Replacement Cost	5	$ 4,000	$ 20,000
Road surface	D	Replacement Cost	1	$ 40,000	$ 40,000
					$ -
Loss-of-Use	**Map link #**	**Description**		**Resource Value**	
					$ -
					$ -
				What is the likelihood of experiencing the loss with *no* treatment	0.5
				Source:	
				Market Resource Value	**$ 60,000**
TREATMENT DESCRIPTION					
Required treatment		**Map link #**	**# Units**	**Unit Cost**	**Total**
Upgrade culverts		D	5	$ 8,000	$ 40,000
					$ -
				What is the likelihood of experiencing loss if treatment occurs	0.1
				Source: **Other**	
				Total Treatment Cost	**$ 40,000**
RESULTS					
REDUCTION IN LIKELIHOOD OF LOSS					**0.4**
EXPECTED BENEFIT OF TREATMENT					**$ 24,000**
Exp B/C ratio of treatment for market resources only (economically justified if > 1.0)					**0.6**
IMPLIED MINIMUM VALUE OF PROTECTING NON-MONETIZED RESOURCE VALUES					**$ 40,000**

Non-Market Values Literature View Literature

Map Zone D page with example calculations from the VAR Calculation Tool

Map Zone	Map Link	Value Type	Value at Risk	Implied Value and/or Benefit Cost
A	A	Life and Safety	Yes	
A	A	Non-Market: Cultural Values	No	
A	A	Non-Market: Ecological Values	No	
A	A	Market Values	No	$ -
A	A	Loss of Use	Yes	$ -
A	A	*Market Resource Value*		$ -
A	A	*Required Treatment*		$ 8,000
		Expected Benefit of Treatment		$ -
		Exp B/C Ratio of Treatment for Market Resources Only		0.0
MAP ZONE A		**Implied Minimum Value of Protecting Non-Monetized Resource Values**		**$ 10,000**
B	B	Life and Safety	No	
B	B	Non-Market: Cultural Values	Yes	
B	B	Non-Market: Ecological Values	No	
B	B	Market Values	No	$ -
B	B	Loss of Use	No	$ -
B	B	*Market Resource Value*		$ -
		Expected Benefit of Treatment		$ -
B	B	*Treatment Cost*		$ 5,000
		Exp B/C Ratio of Treatment for Market Resources Only		0.0
MAP ZONE B		**Implied Minimum Value of Protecting Non-Monetized Resource Values**		**$ 16,667**
C	C	Life and Safety	No	
C	C	Non-Market: Cultural Values	No	
C	C	Non-Market: Ecological Values	No	
C	C	Market Values	Yes	$ 28,000
C	C	Loss of Use	No	$ -
C	C	*Market Resource Value*		$ 28,000
		Expected Benefit of Treatment		$ 16,800
C	C	*Treatment cost*		$ 16,000
		Exp B/C Ratio of Treatment for Market Resources Only		1.1
MAP ZONE C		**Implied Minimum Value of Protecting Non-Monetized Resource Values**		**Justified**
D	D	Life and Safety	No	
D	D	Non-Market: Cultural Values	No	
D	D	Non-Market: Ecological Values	Yes	
D	D	Market Values	Yes	$ 60,000
D	D	Loss of Use	No	$ -
D	D	*Market Resource Value*		$ 60,000
		Expected Benefit of Treatment		$ 24,000
D	D	*Treatment cost*		$ 40,000
		Exp B/C Ratio of Treatment for Market Resources Only		$ 0.6
MAP ZONE D		**Implied Minimum Value of Protecting Non-Monetized Resource Values**		**$ 40,000**

Summary Page with example values from the VAR Calculation Tool

Appendix F

Using ERMiT output to derive probabilities of success associated with treatment and "No Action" scenarios—two examples

General post-fire scenario

After a wildfire in the Bitterroot Mts. of Montana, the BAER team decided that increased erosion from hillslopes burned at high severity was a potential threat to water quality and aquatic habitat (values at risk) in two streams (A and B). Stream A is larger with a steeper course than Stream B. Although both streams support sport fish populations, Stream B supports a small population of a threatened bull trout species.

Example ERMiT runs to support USDA-FS BEAR treatment decisions and cost-risk analysis

Process	Example A	Example B
Determine an event sediment yield that can be tolerated by the value(s) at risk (VAR) downstream of the modeled hillslope(s).	The BAER team determined that the maximum tolerable event sediment yield from the hillslopes above Stream A was **1 t/ac**. Although this short-term sediment input would be a short-term detriment to stream water quality, it was not likely to cause sustained damage.	Because Stream B is currently 303d listed for sediment, the BAER team determined that no additional sediment could be tolerated without sustained damage occurring. Thus, the maximum tolerable event sediment yield from the hillslopes above Stream B was **0 t/ac**.
Run ERMiT	ERMiT was run for the high burn severity hillslopes above Stream A (Fig. C1A).	ERMiT was run for the high burn severity hillslopes above Stream B (Fig. C1B).

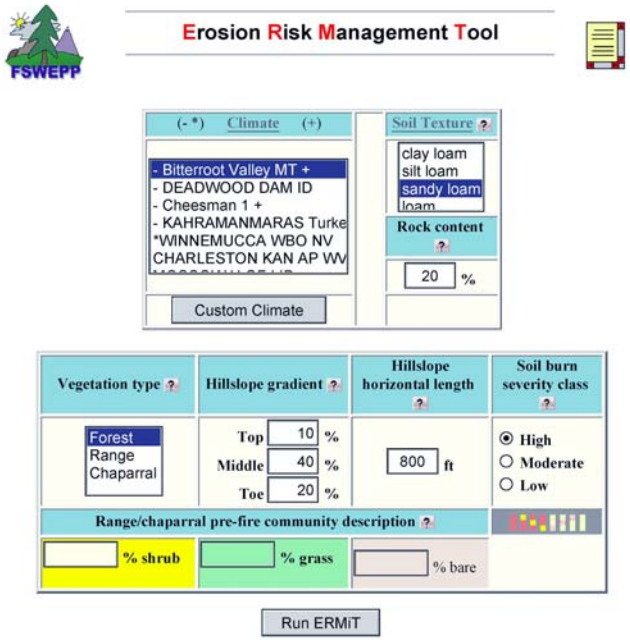


Figure C1A. ERMiT input screen capture for modeling the hillslope associated with **Stream A**.

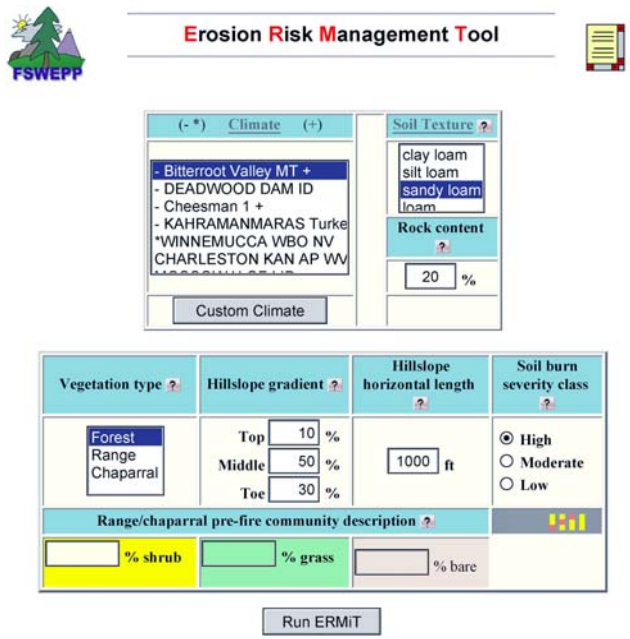


Figure C1B. ERMiT input screen capture for modeling the hillslope associated with **Stream B**.

Use ERMiT output to determine the probability that "No Action" will fail.	In the interactive "Mitigation Treatment Comparisons" output table, the number in the "probability that sediment yield will be exceeded" box was increased until the first year predicted sediment yield with no treatment exceeded 1 t/ac (Fig. C2A). [The probability that 1 t/ac will be exceeded is the "probability that the 'No Action' alternative will fail").] p(S)=100 – p(F) where p(S)=probability of success and p(F)= probability of failure Untreated p(F)=50% p(S)=50%	In the interactive "Mitigation Treatment Comparisons" output table, the number in the "probability that sediment yield will be exceeded" box was increased until the first year predicted sediment yield with no treatment exceeded 0 t/ac (Fig. C2B). [The probability that 0 t/ac will be exceeded is the "probability that the 'No Action' alternative will fail".] p(S)=100 – p(F) where p(S)=probability of success and p(F)= probability of failure Untreated p(F)=68% p(S)=32%

Mitigation Treatment Comparisons

Probability that sediment yield will be exceeded 49.8 % go	Event sediment delivery (ton ac^{-1}) Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.01	0.45	0	0	0
Seeding	1.01	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter 0.15 ft Spacing 50 ft go ?					
Logs & Wattles	0	0	0	0	0

Return to input screen

Figure C2A. ERMiT output screen capture showing the "Probability that sediment yield will be exceeded" that corresponds to more than **1 t/ac** for the untreated hillslope associated with **Stream A**.

Mitigation Treatment Comparisons

Probability that sediment yield will be exceeded 67.6 % go	Event sediment delivery (ton ac^{-1}) Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.05	0	0	0	0
Seeding	0.05	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter 0.15 ft Spacing 50 ft go ?					
Logs & Wattles	0	0	0	0	0

Return to input screen

Figure C2B. ERMiT output screen capture showing the "Probability that sediment yield will be exceeded" that corresponds to more than **0 t/ac** for the untreated hillslope associated with **Stream B**.

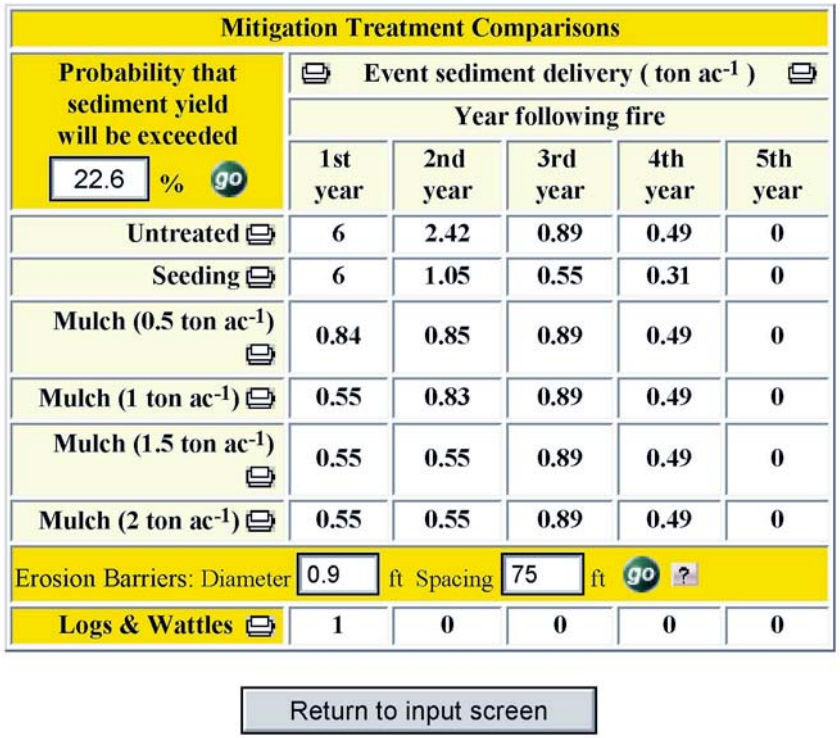
Using the same ERMiT run output and manipulating the value in the "probability that sediment yield will be exceeded" box (as above), list the probability of treatment success (100 percent –the probability of exceeding the tolerable event erosion rate) for a variety of treatment scenarios for Years 1, 3 and 5. [Erosion barrier treatments (contour-felled logs (CFL) or straw wattles (SW)) require additional user inputs related to the installation parameters for the barriers.]

Probability of Treatment Success

Treatment	**Year 1**
Seeding	p(S)=50%
Mulching—	
0.5 t/ac mulch	p(S)=80%
1.0 t/ac mulch	p(S)=86%
1.5 t/ac mulch	p(S)=89%
2.0 t/ac mulch	p(S)=89%
Erosion barriers—	
CFL (0.9 ft dia., 75 ft spacing)	p(S)=77% (Fig. C3A)
SW (0.75 ft dia., 75 ft spacing)	p(S)=73%

Probability of Treatment Success

Treatment	**Year 1**
Seeding	p(S)=32%
Mulching—	
0.5 t/ac mulch	p(S)=66%
1.0 t/ac mulch	p(S)=70% (Fig. C3B)
1.5 t/ac mulch	p(S)=70%
2.0 t/ac mulch	p(S)=70%
Erosion barriers—	
CFL (0.9 ft dia., 75 ft spacing)	p(S)=60%
SW (0.75 ft dia., 75 ft spacing)	p(S)=59%

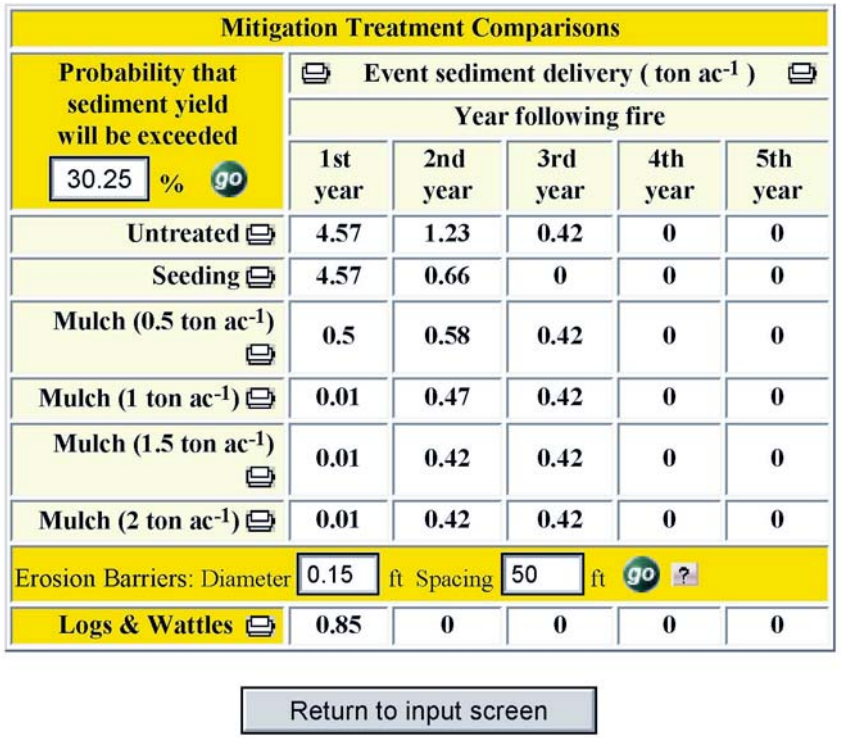


Mitigation Treatment Comparisons

Probability that sediment yield will be exceeded: 22.6 % go	Event sediment delivery (ton ac^{-1}) — Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	6	2.42	0.89	0.49	0
Seeding	6	1.05	0.55	0.31	0
Mulch (0.5 ton ac^{-1})	0.84	0.85	0.89	0.49	0
Mulch (1 ton ac^{-1})	0.55	0.83	0.89	0.49	0
Mulch (1.5 ton ac^{-1})	0.55	0.55	0.89	0.49	0
Mulch (2 ton ac^{-1})	0.55	0.55	0.89	0.49	0
Erosion Barriers: Diameter 0.9 ft Spacing 75 ft go ?					
Logs & Wattles	1	0	0	0	0

Return to input screen

Figure C3A. One ERMiT output screen capture from the modeled hillslope associated with Stream A. This screen shows the "Probability that sediment yield will be exceeded" for **1 t/ac** in the first year with erosion barrier treatment (contour-felled logs with average 0.9 ft diameter and 75 ft. hillslope tier spacing).



Mitigation Treatment Comparisons

Probability that sediment yield will be exceeded: 30.25 % go	Event sediment delivery (ton ac^{-1}) — Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	4.57	1.23	0.42	0	0
Seeding	4.57	0.66	0	0	0
Mulch (0.5 ton ac^{-1})	0.5	0.58	0.42	0	0
Mulch (1 ton ac^{-1})	0.01	0.47	0.42	0	0
Mulch (1.5 ton ac^{-1})	0.01	0.42	0.42	0	0
Mulch (2 ton ac^{-1})	0.01	0.42	0.42	0	0
Erosion Barriers: Diameter 0.15 ft Spacing 50 ft go ?					
Logs & Wattles	0.85	0	0	0	0

Return to input screen

Figure C3B. One ERMiT output screen capture from the modeled hillslope associated with Stream B. This screen shows the "Probability that sediment yield will be exceeded" for **0 t/ac** in the first year with mulching at 1 t/ac rate.

Determine which treatments to further analyze using cost-risk analysis	Cost-risk analysis will be done on two mulching treatments—1 t/ac straw mulch and 1.5 t/ac straw mulch for the first post-fire year.	Cost-risk analysis will be done on 1 t/ac straw mulch straw mulch treatment for the first post-fire year. Although this treatment reduces the probability of the threat occurring by 38%, there is a 30% probability that this treatment will fail and additional sediment from hillslope erosion will go into Stream B during the first postfire year.

ERMiT as support of DOI BAER analysis of Risk of Resource Value Loss or Damage and treatment decisions

The DOI BAER process requires that "Risk of Resource Value Loss or Damage" be assessed and rated as None, Low, Mid, and High. Seven resource values are listed that must be assessed, and these include "Unacceptable Loss of Topsoil," and "Off-site Sediment Damage to Private Property." The threat of erosion is directly related to loss of value of these two VAR and could be assessed with ERMiT. The numerical probabilities that are produced by ERMiT could be correlated to the rating classes required on the DOI BAER form. In addition, the DOI BAER form requires the BAER team to provide the "Probability of Rehabilitation Treatments Successfully Meeting EFR [Emergency Fire Rehabilitation] Plan Objectives." Although most of the treatments listed in the DOI BAER form are not currently modeled by ERMiT, the prediction of aerial and broadcast seeding success can be generated by the current version.