DISCUSSION PAPER

# Feasibility of Quantifying Returns from Forest Service Research and Development Programs

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**Executive Summary**

Acres managed, miles of riparian habitat restored, gallons of fresh water provided, populations of wildlife conserved – all are important metrics of natural resources management and will continue to be important measures defining programmatic impact. However, it is becoming increasingly necessary, during constrained budgetary times, staffing declines, and demands for science increasing to understand and communicate the value of research and development if a case is to be made to retain (or even expand) research and development budgets. It is the purpose of this research to briefly explore the opportunities to measure project outcomes across multiple avenues and discuss selected approaches that have been successfully applied elsewhere. The research also examines the feasibility of evaluating Forest Service R&D projects, bearing in mind that doing so requires that the outcome metrics need to be quantifiable, meaningful, and accessible.

The purpose is not to force implementation of some method of measuring returns and benefits. Instead, the purpose of this project is to determine if measuring returns and benefits is practical and feasible, the extent that they can be measured (some projects may never be feasibly quantified), and how quantification efforts can be developed and conducted. Gaining a greater understanding of the breadth of research topics/areas to be considered is an important next step. We need to explore the following:

- What types of projects will need to be evaluated (topics, scale)?
- In what ways can these projects be quantified monetarily?
- Who is the audience to which the figures will be presented, and in what terms would they be interested in seeing projects compared?
- What criterion can be logically required of field personnel to amend to current project output to best inform a potential tool to evaluate projects?

This paper discusses the evolving needs for quantifying, measuring, and reporting the economic value provided by selected wildlife, fish, and related aquatic research performed by Forest Service Research and Development (R&D). This effort will explore varying approaches for measuring returns to research and development in general and applications of such approaches in natural resources areas and fish and wildlife management. The purpose of this paper is to provide a basis for further discussions with Forest Service R&D personnel on the feasibility and proper approaches for measuring and reporting the value of research and development.

Applications of economic valuation and financial metrics can be both forward- and backward-looking. They can be applied ex-post to evaluate impacts of research. This is the case for many studies presented here. They can also be applied ex-ante in research proposals to estimate potential future benefits associated with the proposed research relative to investments. The broader the base of ex-post analysis the better the ex-ante estimates become.

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## Introduction

Acres managed, miles of riparian habitat restored, gallons of fresh water provided, populations of wildlife conserved – all are important metrics of natural resources management and will continue to be important measures defining programmatic impact. However, it is becoming increasingly necessary, during constrained budgetary times, staffing declines, and demands for science increasing to understand and communicate the value of research and development if a case is to be made to retain (or even expand) research and development budgets. It is the purpose of this research to briefly explore the opportunities to measure project outcomes across multiple avenues and discuss selected approaches that have been successfully applied elsewhere. The research also examines the feasibility of evaluating Forest Service R&D projects, bearing in mind that doing so requires that the outcome metrics need to be quantifiable, meaningful, and accessible.

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## Evolving Needs for Measuring and Reporting Project-based Outcomes

Economic relevance of research & development has long been a decisive factor in the project selection process within the business world. Limited by funding budgets, the goal is to efficiently allocate resources to a selected group of projects. The question is: What factors influence the selection process? Among for-profit companies, three metrics have consistently been important in the decision making process: financial returns, alignment with business strategies, and projected value of current research and development projects (Schwartz et al. 2011). These types of metrics have not historically been a key factor influencing the allocation of public funds across proposed research and development projects. Often the focus of either anticipated or realized outcome metrics has been guided by an agency's recent focus towards restoration and has included both qualitative and quantitative measures focusing on biological and ecological impacts (Pendleton 2010).

Amidst budget deficits and greater levels of fiscal constraint, agencies and organizations are being asked to augment their current metrics beyond just environmental impacts to include both social and economic impacts. Speaking to the principles and standards for water and related resources studies to be implemented, the White House Council on Environmental Quality cites the need to "protect and restore natural ecosystems and the environment while encouraging sustainable economic development" as the foremost planning standard (CEQ 2009 p. 5).

Recommendations from a Blue Ribbon Panel for Estuary Economics support that position. Pendleton, synthesizing their findings argues that:

> Finding ways to determine the economic effects of restoration activities is a critical first step in showing how restoration can improve the economic wellbeing of the nation. It can help determine the appropriate level of funding for restoration, choose the best restoration projects, and could be used to design better restoration projects that include economic as well as ecological goals. The appropriate and optimal level of funding for habitat restoration depends in part on the economic value of restoration." (Pendleton 2010 p. 2)

Established in 1990, Land & Water Australia (LWA) is a research and development organization within Australia's Agriculture, Fisheries, and Forestry agency. Its mission is to "invest in knowledge, partnerships, innovation, and adoption to underpin sustainable natural resource management" and at least part of its financial support comes from the Australian government (Chudleigh et al. 2006 p. 38). Over roughly the last twenty years, LWA has explored ways to evaluate its research and development strategy with environmental, social, and economic metrics in an effort to communicate research impact in a meaningful way to all investors, including the Australian government.

A more in-depth discussion of LWA's metrics and methods is presented later in this paper. While the approach has shortcomings, it has been instrumental in estimating returns to natural resource management efforts during a period of increasing pressure to "account for investments and…to improve the performance of future investments" (Pearson et al. 2010 p. 2).

## Challenges of Measurement

The challenges to measuring the impact of natural resource management research and development are many. Most scientists are focused on metrics that directly measure the objectives of their research. However, while a field scientist may think that a measure of acres restored is ample information for evaluating a project whose goal is to restore wildlife habitat, those making decisions further up the chain may require a more direct link between acreage and dollars.

Schwartz et al. (2011) addresses this need to provide outcome measures of research and development that are relevant to those who will be using it. The goal is not to move away from science-based decision making but rather to augment decision making through "productive

discussion among different and competing interests" (Szaro and Peterson 2004 p. 10). Where the interests of scientists and those who control the sources of financing intersect, a philosophical shift to value the importance of measuring outcomes from an economic perspective as well as from ecological and societal perspectives might be necessary.

With budgetary constraints, the tendency is to measure the dollar value of research against its costs. Some might argue that this "it's all about money" attitude is what is wrong with corporate science and that it has no place in government-based research. Yet, assigning value to research and development within the Forest Service is not unlike the need to evaluate R&D within a corporation. Schwartz et al (2011) outlined the reasons for evaluation as any combination of (1) justification for the effort within the company (agency), (2) ensuring resources are used efficiently, and (3) to estimate need for future investment in research.

At the heart of this effort is the actual measurement of those ecological services and goods provided by those areas studied and managed. Much has been written about assigning economic values to the ecosystem, either in part or in total, and there is still much to be said on that topic. This is by no means an exhaustive account of that body of research or even a how-to guide. The goal is to briefly touch upon a few key issues.

As Brown et al. (2007) mentions, things are of value to people if those things are found to provide utility. Ecosystem goods and services certainly provide utility and poses both a use and non-use value for individuals. Use values are derived through either direct and indirect consumption of the good or service. Non-use values are typically associated with non-consumptive uses including the value that individuals assign to the system or good based upon the knowledge of its existence.

In the presence of a competitive market, the price of a good or service is reflective of its value to an individual. In the case of ecosystem goods and services, very few markets exist because of the attributes of those goods and services challenge the creation of a market. And, in those when a market does exist, they are often not competitive. Given the nature of the bundle of characteristics associated with ecosystem system services or goods as well as the composition of "utilization" types, a market many not fully reflect the total economic value. In the absence of better or additional data, prices can be thought of as a lower bound of economic value recognizing that there is value to individuals making direct use of the good or service.

There are four methods that Brown et al. (2007) identifies as methods to reveal the value of a good or service. All of these methods make use of pricing information but not in the strict market sense. Those are: 1) revealed preference methods, 2) stated preference methods, 3) production function methods, and 4) replacement cost methods. In its most simplified description, revealed preference models make use of observed behaviors to reveal a willingness to pay or accept an environmental attribute. Stated preference models try to identify economic value based upon an individual's predicted behaviors given a set of scenarios. Production functions can make use of the values of inputs and outputs to estimate economic value of a change in an environmental condition. And, the

replacement cost approach estimates the cost of replacing an ecosystem good or service or the costs avoided if ecosystem preservation is chosen as an option.

Any effort to quantify an economic value of an ecosystem good or service is likely to be met with some challenges. Pearson et al (2010) notes that the lack of "readily available, specific examples of actual benefits" (p.14) was one of the main reason that benefits were not quantified. Much of the literature is lacking an example of attempts to assign monetary value to outcomes derived from natural resources research. Primary data collection can be both cost- and time-prohibitive within the constraints of a project. It is possible through benefit transfer to apply existing knowledge of economic value estimated within one context to a new context. Rosenberger and Loomis (2001) explore this avenue as it relates to outdoor recreational use value. The validity and reliability of economic benefits ascribed within the new context is directly related to the similarity of context characteristics, the methods employed to estimate benefits in the original context, and the quality of information collected and reported.

Despite all of these imperfections and challenges, Brown et al. (2007 p. 344) argues that:

> Decisions are commonly made about whether to protect or degrade ecosystem goods and services, and those decisions are more likely to be made in the best interests of the relevant publics if decision makers have comparable information about what is gained and what is lost if a certain policy option is chosen. Monetary estimates of the values of ecosystem goods or services, even if inexact may be far better than complete lack of such estimates, especially if the direction of the error in estimation-whether the value estimate is taken to be a lower bound or an upper bound of actual value, for example-is known.

Just as it is important and challenging to determine and estimate only those benefits directly attributable to the particular project under examination, it is equally important and challenging to isolate costs associated with a particular investment in research. It may be necessary to track investments from many different partner agencies across a number of different projects. In all cases, tracking or accounting systems may not allow this level of detail. Or, scientists' time may not be mutually exclusive across their project loads thereby challenging the allocation of expenses such as salary and overhead to one particular project.

Bringing these two pieces together, economic value or benefit and project-related cost enables the calculation of financial metrics. Listed below are a few metrics measured within the case studies presented in the following section.

## Metrics Utilized in Selected Case Studies

*Present value of benefits (PVB)*

Economic value of the stream of benefits associated with the research or project adjusted for the influence of time to reflect present day values.

*Present value of costs (PVC)*

Economic value of the stream of costs associated with the research or project adjusted for the influence of time to reflect present day values.

*Net present value (NPV)*

The difference between present day benefits and present day costs.

*Benefit:cost ratio*

Ratio of the present value of benefits relative to the present value of costs.

*Internal rate of return (IRR)*

The rate of return required of the research or project that returns a zero net present value or benefit cost ratio of 1.0.

## Case Studies Outside of the Forest Service

Many examples of the returns to research now exist. The approach and goals are determined to be either a one-off analysis or with the intent to aggregate a total return across a number of projects with a central theme. Case studies examined in depth here are selected with an eye towards studies that might provide insights for similar restoration projects implemented as objectives of the fish and wildlife program of the US Forest Service. These cases are very short summaries of the reported case study which in turn is a short summary of research activities associated with each project. The focus here is on process and not the findings of each case study. Additional information associated with each study can be accessed through the full reports cited in the references section.

### Australian Case Studies

*1. Use of incentive payments to conserve remnant vegetation (Schofield et al. 2007)*

The promotion of protecting "biodiversity and native vegetation" on private acres was the target of this case study. Historically, the emphasis has been on preserving and protecting native species and plants on public lands in Australia. The goal of this particular project was to present specific proposals for changes to policy which would encourage both private landowners as well as public landowners to conserve Australia's natural vegetation. The project was funded between 1996 and

1999. Outreach items included several popular press publications as well as one research paper that presented a model toolkit to incorporate those lessons learned into the design of policy.

Policy changes driven by this research were designed to increase the number of landowners and acres enrolled under agreements to conserve native vegetation on private land across the country. A triple bottom line approach identified the following benefits as a result of additional acres enrolled as a result of this research effort:

Economic benefits

- Shelter for livestock from cold and heat stress
- Windbreaks/shadelines for cropping and grass growth
- Erosion reduction and improved crop productivity
- On-farm benefits from ecosystem services

Environmental benefits

- Reduced or slowed transfer of surface water to ground water systems
- Conservation of biodiversity
- Prevention of soil erosion
- Greenhouse gas reduction and maintenance of water quality

Social benefits

- Private use and amenity value contributing to lifestyle and general enjoyment
- Future use options values

Based upon the list of benefits above, preservation and restoration of native vegetation can be measured through contributions to farmland productivity as well as non-localized environmental improvements and public and private enjoyment. Costs associated with private land conservation are incurred by the landowner. For the analysis, these costs are assumed to be equal to the benefits or off-set by enrollment incentives. As a result, the benefits valued are associated with those environmental benefits to society as a result of additional enrollment of private acres into preservation programs.

A baseline measure of landowners and area enrolled and under negotiation was established in 2002, a few years after the initiation of the project. Follow-up analysis was underway in 2007 to evaluate the increase in enrollment. Actual future enrollment associated with this particular research can be measured from this baseline. However, no concrete data was available to measure the actual change in enrollment. Nevertheless, a reasonable estimate is utilized.

To quantify an individual's value of environmental benefits based upon the impact of this research, a benefits transfer approach is taken. Existing willingness to pay estimates are researched and a conservative estimate is determined. This estimate is applied as a function of the estimated percentage change in the acres of land enrolled and aggregated based upon the number of households within the region, which in this case are total households in Australia.

These benefits are compared to investments and a project-specific net present value, benefit/cost ratio, and an internal rate of return are estimated. Given the uncertainty surrounding the two key factors utilized to quantify benefits, the willingness to pay estimates as well as actual enrollment, a

sensitivity analysis is also conducted to evaluate the degree of influence changes to the estimates have on the return measures.

*2. Wetland management guidelines (Schofield et al. 2007)*

Three individual projects were investigated within the wetland management framework and their goal was to increase the understanding of a wetland's response to various management and rehabilitation plans in an effort to predict the consequence of changes to current management efforts and policies. Project outreach included four research publications identifying guidelines for wetlands preservation and rehabilitation. Since their publication, these guidelines continue to be widely distributed through print materials and educational seminars.

The goal of all three projects was an on-the-ground application of guidelines developed which would contribute to wetlands restoration and preservation. A triple bottom-line approach identified the following benefits as a result of this research effort:

<u>Economic benefits</u>

- Grazing production
- Tourism, recreation, and hunting

<u>Environmental benefits</u>

- Conservation and rehabilitation of biodiversity of flora and fauna
- Flood mitigation/ groundwater recharge
- Ecosystem service values (carbon sequestration)

<u>Social benefits</u>

- Existence values
- Provides natural beauty to local and regional landscape

The best-practices guidelines developed through this research are most applicable to inland wetlands. The bulk of wetlands fitting this type are found in southeastern Australia and as a result, the benefits measures (whether it be acres managed or monetary benefits realized) reflect only the portion of the total wetlands present in southeastern Australia.

Two sub-region surveys of wetland owners were implemented in order to ascertain benefit values. Roughly half of landowners indicated that their benefits (monetary and non-monetary) from conserved wetlands exceeded their benefit in the absence of a wetland area. Additionally, recreational use values were estimated for duck hunting. And finally, a choice model was used to estimate respondents' willingness to pay for increases in environmental attributes across four different attribute scenarios.

Benefits are scaled to reflect only those additional wetland acres rehabilitated and managed as a result of these guidelines above and beyond existing efforts and regulatory structures. However, tracking and measurement of guideline adoption practices are difficult to ascertain. Nevertheless, a reasonable estimate was employed for the purpose of this analysis. Existing willingness to pay estimates were again applied and aggregated based upon the number of households. Future benefits were also captured within the modeling process and discounted to a present day value.

The estimated benefits were compared to investments across all three projects to develop a collective net present value, benefit/cost ratio, and an internal rate of return. Given the uncertainty surrounding the willingness to pay estimates as well as the level of guideline adoption, a sensitivity analysis was conducted to evaluate the degree of influence changes to the estimates have on the estimated return measures.

**US Case Studies**

*1. An Economic Evaluation of Fusiform Rust Protection Research (Cubbage et al. 2000)*

Vulnerable to fusiform rust, research has shown that families of loblolly and slash pine, within the southern pine forests, have developed a genetic resistance to the disease over time. Identification of those resistant seedlings enables their cultivation and planting in areas which are susceptible. Utilized for timber production, benefits in the form of improved quality and production of timber can be translated into increased economic value.

The research evaluated with and without scenarios comparing plantation growth and productivity on stands without rust-resistant technologies relative to stands exhibiting resistance. It can be assumed that the difference provides an economic value associated with rust resistance. Simulated within models are "the establishment of new plantations, growth to rotation age, harvesting, merchandising into products, and valuation" (Cubbage et al. 2000 p. 78).

More specifically, characteristics determined within the model at the stand level are: growth and yield based upon initial scenarios of site quality and intensity of infection, quality of the harvested timber in the merchandising stream, product prices, and plantation establishment costs. Given the assumptions associated with these characteristics, two financial measures are estimated to quantify the impact of technology: soil expectation value and net present value.

Stand level estimates are then aggregated to reflect the estimated impact of technology across the southern US. To account for regional differences, the following additional regional specifications were added to the model: existing regional stand health relative to rust infection, pine plantation area, rust resistant seedling production, and deployment as well as further gains to resistance expected within the seedling population.

Reported research costs were collected from seedling producers, research cooperatives, and the Forest Service at five year increments between 1970 and 1990. These reported estimates were augmented with data from other unpublished sources. Annual estimates were generated using linear interpolation. Using these cost estimates relative to estimates across all model scenarios, both benefit/cost ratios and net benefits can be computed for the region.

Flexibility of the model facilitates sensitivity analysis based upon factors such as timber supply and its impact on market price as well as rotational age, genetic advancement, and merchandising.

*2. The Economic Returns to US Public Agricultural Research (Alston et al. 2011)*

Agriculture and research have been inextricably linked for many decades. Alston et al. argues that despite impressive estimated returns to research, public investment is facing faltering support. The reason for this is two-fold. First, current federal budgets are constrained and placing pressure on funding for many research programs including those focused towards agriculture. Second, skepticism surrounding returns to research that seem too good to be true also seems to hamper the degree of support.

This research "reports the main results from a long-running project…to obtain new and improved estimates of the returns to US public agriculture research and development, to evaluate the role of modeling choices versus fundamental factors in influencing the findings and thus to provide a clearer understanding of the confidence that can be placed in the estimates" (Alston et al. 2011 p. 1257).

At the core of this work is a data set built across more than one hundred years of research investments and more than fifty years of agricultural productivity for the 48 continental states in the US. The hypothesis is that multifactor productivity is a function of investment in both public agriculture and extension. Investments across these two avenues defined a knowledge skill set within a particular state. To account for the unbounded flow of knowledge around the nation, research investments outside of the state are incorporated into the model with a lagged weighting structure. One additional variable, an index of pasture and rangeland condition, is included to account for the influence of environmental factors on agricultural productivity.

The multifactor productivity model, estimated in log form, reveals the marginal benefits associated with a change in research investments. Gross annual research benefits are the product of the change in multifactor productivity and the real value of in-state agricultural production. All research benefits are adjusted for the effects of time and brought to present day values. The dollar value of costs and investments are also adjusted to present day values. Using these two values, a benefit/cost ratio and an internal rate of return are calculated. These financial metrics can then be compared to other existing estimates of the returns to investments in agriculture-based research. Strengths and weaknesses of all models can be revealed and used to temper or support reported findings.

**Lessons Learned About "How to"**

Over the last few years, Land & Water Australia has devoted a great deal of time and effort to evaluating returns to investments in research and development from the perspective of a triple bottom line (ecological, social, and economic). Historically, it is possible that the focus has not been on economic monitoring perhaps, in part, because of the fear that the return would be less than

flattering. Nevertheless, this approach is gaining momentum in the US based upon evidence put forth by Pendleton (2010).

The goal is a holistic approach towards defining the impact of restoration projects by measuring benefits and costs across the "triple bottom line." Econometric approaches should not necessarily be the primary focus, thereby minimizing the importance of social or ecological measures. But, at the same time, they should not be ignored.

A message of "begin now" and "learn-by-doing" is emerging from all interested parties. In an attempt to share lessons learned, each group put forth a list of best practices or guiding principles when undertaking an effort to quantify project benefits, costs, and returns.

*Land & Water Australia's guiding principles, Chudleigh et al. (2007)*

1) Describe the restoration effort or project
2) Identify investment costs, tracking separately all costs associated with each contributing partner across a selected time frame
3) Identify and describe output, findings, or outcomes
4) Describe outcomes such as behavior changed, adoption of improved practices, changes in policies or strategies linked to research
5) Identify and select benefits for valuation
6) Develop the with and without argument
7) Quantify benefits by consistently and conservatively measuring benefits including discounted future benefits (Benefits are valued as cost reductions, changes in income, or other monetary impacts. Environmental or social benefits are monetized using benefit transfer from previous WTP/WTA studies.)
8) Estimate identified investment measures (present value of benefits and costs, net present value, benefit/cost ratio, and internal rate of return)
9) Present sensitivity analysis by adjusting critical assumptions
10) Apply confidence ratings

*Pendleton's guiding principles (synthesized from a Blue Ribbon Panel for Estuary Economics), Pendleton (2010)*

1) Choose a theme if there are multiple projects or project groups and focus on those likely to have obvious effects on economic activity or value (larger projects, those directly impacting use or important species/habitats).
2) Choose a geographical region where many events are likely to occur. Within this region, some target areas will be impacted by restoration or other efforts and some areas will not be impacted. These will serve as natural treatment and control areas.
3) Choose sites for data collection. These sites will serve as places to collect both pre- and post-effect data and may be impacted by the prevalence of historical data.
4) Identify the metrics and data to be collected. In the interest of efficiency, these metrics might also look towards available data for its integrity and applicability. In this effort, input from a specialized team or working group might be sought to identify the plan for primary data

collection including the necessary data to measure valuation as well as other social and environmental measures.

5) Start collecting data systematically including site-specific data to supplement economic and ecological information.
6) Manage data and analysis over both the short- and long-term either through internal processes or through partnerships with other appropriate agencies or research units.

Outside of the lists of guiding principles, two messages are also very clear.

Making it meaningful

The project values need to be meaningful to whom they will be reported (e.g., Forest Service leadership and management staff, Congress's appropriations committees), and this audience needs to be considered when creating these values.

The scale at which a project is measured needs to be determined by the scale of its immediate and quantifiable impacts. A trout habitat restoration project can be quantified by fly-fishing days (and thus dollars spent). If all projects are expected to be projected as amount of carbon sequestered, this effort can quickly blow itself out of proportion with expansive, seemingly meaningless numbers.

Providing access

Assigning meaningful, quantifiable values to research needs to be an accessible process. Such an effort cannot add undue amounts of time and resources to simply evaluate the project – thus reducing its return on investment in order to evaluate its return on investment. Requiring reporting measures from the field that are straight-forward and easily obtained would allow the process to move as smoothly as possible.

Developing a tool to aid in the evaluation process is another way to aid in the evaluation process. Automating generalized lines of input by using a database to convert, for example, trout fishing days into a dollar value would cut out some of the time spent on evaluation. Henrikson and Palocsay (2008) created a tool that integrated decision criteria and pre-determined weights into an evaluation tool for decisions to be made. Alston et al. (2011) had a more complex modeling approach to the tool they developed.

**Forest Service Case Studies**

Presented below are three short summary case studies of analysis undertaken by the Forest Service that identify research and development projects that have estimated or can provide measures of benefits or returns to investment. Similar to the case studies presented above, the focus is on process rather than reporting empirical results or findings.

*1. The Marginal Economic Value of Streamflow from National Forests (Brown 2004)*

Amidst the complex environment of existing ownership of and markets for water in the western United States, Brown (2004) estimates the marginal economic value of streamflow from National Forests. More specifically, "rough estimates of the marginal value of stream flow are computed for each of the 18 water resource regions in the contiguous 48 states" (Brown 2004 p. 42).

A multitude of factors play into estimating an economic value for water in this case. The author argues that "(t)he aggregate marginal value of streamflow from a National Forest is equal to the sum of the marginal values in the different instream and offstream uses to which the water is put during its journey to the sea in the one or more rivers that leave the forest" (Brown 2004, p. 5). Instrumental to valuing the stream flow is determining the users, whether they are affected by a change in stream flow, and what the change in flow is worth to each particular user or user group.

In order to associate an economic value with a particular user or user group, the analysis pulls from a number of different resources. The first resource utilizes water prices associated with market transactions across fourteen years reported by the Water Strategist and the Water Intelligence Monthly. In recent years, the West has experienced population growth within the region as well as economic growth. Both factors have placed increased demand on the available water in the region. This growing demand for an essential resource created conditions that brought buyers and sellers together for the purpose of selling rights to defined quantities of water, thereby generating a market for the exchange of water. The market relies on the fact that property rights to water can be identified and a system exists for the transfer of those rights. Since water need is often place-based, it is critical that water must also be physically transferable. And, finally, the cost of transactions must not be prohibitive. Given that, under purely competitive market conditions, the market will adjust to reveal the marginal value of water. A purely competitive water market does not exist. Yet, the author argues that even in the light of market as well as data imperfections, the available information allows for a "rudimentary analysis of the factors influencing water market prices" and as a result an estimate of the marginal value of streamflow (Brown 2004, p. 20). From the transaction data, Brown is able to investigate the types of buyers and sellers, the reason for the water purchase, whether water rights were purchased or leased, and the water source, as well as the value associated with the transaction.

In the case of hydroelectric power, the value associated with changes to water flow equate to aggregate cost savings when hydroelectric plants support power usage during peak power loads or augment base power usage in place of power normally provided by coal-fired plants. Factors such as the number of plants downstream from National Forests as well as the proportion of streamflow available to each plant was factored into estimated aggregate cost savings.

Also contributing to the model is evidence from literature. With respect to recreation, a number of studies were examined for their relevance to this application. These studies approached the value issue from many different non-market avenues: contingent valuation, travel cost method, or willingness to pay. Many of these studies, however, were site-specific, challenging a benefit transfer approach to this much larger regional analysis. Brown turns to a cross-sectional analysis and applies estimates that are considered reasonably reflective of those that might exist in the West.

Lastly, information from a meta-analysis of "US water value studies…across eight water uses" (Brown 2004 p. 40) was used to further develop the dataset and aid with model estimation.

This analysis is able to estimate the value or benefit of streamflow to its end users using market and nonmarket valuation information. Marginal values vary widely based upon region and use (offstream, hydroelectric, and instream). Total values, which are the sum of the three use types, vary widely across the nation. This marginal economic benefit can complement additional knowledge to inform land management decisions, both within and outside of the Forest Service, which impact stream flow. This analysis can also provide insight into the benefits associated with restoration research and efforts which impact streamflow. And, in cases where the costs associated with management and restoration efforts are present and measurable, it might be possible to determine performance measures discussed above.

*2. State and National Economic Effects of Fishing, Hunting, and Wildlife-Related Recreation on US Forest Service-Managed Lands (ASA 2007)*

In an era of declining acres of private lands available for outdoor enthusiast to hunt, fish, or view wildlife, public lands offer a consistent resource for these activities. The analysis estimates the economic contribution of spending by recreationists using Forest Service lands to the state and national economy. Surveys were conducted by the National Visitor Use Monitoring (NVUM) Program, which collects data across a sample of individual forest units about visitors, motivation for visit, and expenditures for sub-set of visitors to Forest Service-managed lands. The goal is to estimate the level of recreation across the National Forest and, given the additional data, also estimate the total amount of spending associated with that recreation.

The effects of individuals' spending can be measured and referred to in a number of different ways. The focus in this analysis was the economic contribution of spending, which estimates total economic activity spurred from all expenditures by both residents and non-residents associated with the activity under study. "Economic contributions explain the total effects of people's expenditures such as jobs supported, paychecks and business profits generated and more" (ASA, p. 11). The contribution of spending is felt within the economy in three different ways. At first is the direct effect associated with the initial purchase of the good or service. A portion of that amount spent stays within the local economy and contributes to an indirect effect. Lastly, an induced effect results from wages and salaries paid to employees within the directly and indirectly affected industries. The sum of these three effects is the total economic effect.

As previously mentioned, participation is estimated via the NVUM survey. For the purposes of this analysis, participation is reflective of only the estimated visits whose primary purpose was fishing, hunting, or wildlife viewing. Two spending measures were estimated. First, total visitor spending associated with trip-related purchases within 50 miles of the forest is estimated using the reported data collected through the NVUM surveys. Excluded from this spending were equipment-related purchases. Second, total visitor spending associated with both trip- and equipment-related items, regardless of where the purchase was made, was estimated.

The economic contribution of this spending was estimated within the IMPLAN statistical software package. However, specific efforts were made to incorporate multipliers which capture the rounds of economic effects that would most accurately reflect the states where National Forest lands are present as well as the contribution across the nation. Available through this report are state level and national estimates of the economic contribution of spending by hunters, anglers, and wildlife-viewers both individually and collectively based upon just trip-related expenditures made within an immediate 50 mile radius of the forest lands visited as well as both trip and equipment related expenditures. This analysis can also provide insight into the benefits associated with restoration research and efforts which impact utilization of National Forest lands. And, in cases where the costs associated with restoration efforts are present and measurable, it might be possible to determine performance measures discussed above.

*3. The Role of the Forest Service in Aquatic Invasive Species Research (Adams et al. 2009)*

Adams and colleagues (2009) issue a call to action for the Forest Service Research & Development scientists and identify a number of areas where they can lead the charge in the management of native and non-native aquatic and riparian species. In waters and waterways across the US, invasive species are challenging the success of native species through "competition, predation, hybridization, and habitat alteration" (Adams et al. p. 55). The paper highlights several notable regional examples where invasive species have had a significant impact on water quality and quantity as well as the health of existing native species. For example, in the Great Lakes Basin, by their estimation, more than 200 established invasive aquatic species can be found. The introduction and spread of well-known species such as sea lampreys and zebra mussels as well as other lesser-known species can be associated with significant economic losses.

Lands managed by the Forest Service are no exception and Adams charges that they are legally mandated to "sustainably manage aquatic habitat and native species on National Forest System lands" (Adams et al. p. 55). It is argued that the Forest Service Research & Development scientists are both highly regarded and well-positioned because of the expertise the group could offer following necessary changes in the areas of research emphasis and funding levels. Outreach efforts for this type of research could stretch out to include federal, state, local, and tribal governments to landowners, recreationalists, and other community members. In fact, Adams argues that "many existing aquatic invasive species issues stem from conflicting goals and values within and among agencies and the public" (Adams et al. p. 60). Research can provide knowledge to resolve these conflicting goals and facilitate an informed decision-making process.

The time horizon for research is long-term and in fact might represent a potential opportunity for the Forest Service to implement ideas put forth by Pendleton (2010) to develop a longitudinal dataset including information pertaining to pre- and post-treatment efforts. The authors do speak of the need to both build and maintain a state-of-the art centralized repository for data (Adams et al. p. 63). Coupled with capturing and managing data, it is argued that research efforts should be focused towards predictive modeling, ecological risk management, and species impact on both habitat as well as on other species. Beyond those metrics which would support the ecological or environmental

benefits realized or cost savings enjoyed as a result of management or mitigation, the authors speak directly to the need to "(e)nhance the rolls of social science and **economics** in aquatic invasive species research. Accounting for the full costs of species invasions will be instrumental for information the public and policymakers of potential societal effects from nonnative species and, thus, for adopting effective prevention and control strategies" (Adams et al. p. 63).

## Next Steps

Applications of economic valuation and financial metrics can be both forward- and backward-looking. They can be applied ex-post to evaluate impacts of research. This is the case for many studies presented here. They can also be applied ex-ante in research proposals to estimate potential future benefits associated with the proposed research relative to investments. The broader the base of ex-post analysis the better the ex-ante estimates become.

In closing, thoughts from Pendleton (2010) are poignant to this effort.

> "Finding ways to determine the economic effects of restoration activities is a critical first step in showing how restoration can improve the economic wellbeing of the nation. It can help determine the appropriate level of funding for restoration, choose the best restoration projects, and could be used to design better restoration projects that include economic, as well as ecological goals. The appropriate and optimal level of funding for habitat restoration depends in part on the economic value of restoration" (Pendleton 2010 p. 2).

**References**


Adams, Sarah B., Kelly M. Burnett, Peter Bisson, Bret Harvey, Keith H. Nislow, Bruce E. Rieman, and John Rinne. 2009. *The Role of the Forest Service in Aquatic Invasive Species Research*. Available: http://www.fs.fed.us/rm/pubs_other/gtr_wo79_83_055_066.pdf

Alston, Julian M., Matthew A. Anderson, Jennifer S. James, and Philip G. Pardey. 2011. The Economic Returns to U.S Public Agricultural Research. *American Journal of Agricultural Economics*. Vol. 93:5. 1257-1277.

Brown, Thomas C. 2004. *The Marginal Economic Value of Streamflow from National Forests*. U.S. Forest Service Discussion Paper. DP-04-1, RMRS-4851.

Brown, Thomas C., John C. Bergstrom, and John B. Loomis. 2007. Defining, Valuing, and Providing Ecosystem Goods and Services. *Natural Resources Journal*. Vol 47: Spring. 329-376.

Chudleigh, Peter, Sarah Simpson, and Nick Schofield. 2006. Economic evaluation of R&D investment and natural resource management. *Evaluation Journal of Australasia*. Vol. 6:2. 37-48.

Chudleigh, Peter, Sarah Simpson, and Nick Schofield. 2007. A methodology for evaluating return investment from natural resource management research and development. Land and Water Australia Canberra.

Cubbage, Frederick W., John M. Pyre, Thomas P. Holmes and John E. Wagner. 2000. An Economic Evaluation of Fusiform Rust Protection Research. *Journal of Applied Forestry*. Vol. 24:2. 77-85.

Henriksen, Anne D. and Susan W. Palocsay. 2008. An Excel-based Decision Support System for Scoring and Ranking Proposed R&D Projects. *International Journal of Information Technology and Decision Making*. Vol. 7:3. 529-546.

Pearson, Stuart, Peter Chudleigh, Sarah Simpson, and Nick Schofield. 2010. *Measuring return on 20 years of investment in natural resource management research and development*. Land and Water Australia Canberra.

Pendleton, Linwood, Ed. *Measuring and Monitoring the Economic Effects of Habitat Restoration: A Summary of a NOAA Blue Ribbon Panel*. 2010. Available: http://nicholasinstitute.duke.edu/oceans/estuaries/measuring-and-monitoring-the-economic-effects-of-habitat-restoration-a-summary-of-a-noaa-blue-ribbon-panel

Rosenberger, Randall S. and John B. Loomis. 2001. *Benefit Transfer of Outdoor Recreation Use Values: A Technical Document Supporting the Forest Service Strategic Plan (2000 Revision*). USDA Forest Service General Technical Report. RMRS-GTR-72.

Schofield, Nick, Peter Chudleigh, Sarah Simpson, and Stuart Pearson. 2007. *Land and Water Australia's portfolio return on investment and evaluation case studies*. Land & Water Australia, Canberra.

Schwartz, Lawrence, Roger Miller, Daniel Plummer, and Alan R. Fusfeld. 2011. *Research Technology Management*. Sept-Oct. Edition. 29-36

*State and National Economic Effects of Fishing, Hunting, and Wildlife-Related Recreation on U.S. Forest Service-Managed Lands*. 2007. Prepared by American Sportfishing Association. http://www.fs.fed.us/biology/resources/pubs/wildlife/usfs_wildlife_based_recreation_economic_contributions_1_03_07.pdf

Szaro, Robert C. and Charles R. Peterson. 2004. Evolving approaches toward science-based forest management. *Forest, Snow and Landscape Research*. 78, ½: 9-20.

White House Council on Environmental Quality. *Proposed National Objectives, Principles, and Standards for Water and Related Resources Implementation Studies*. 2009. Available: http://www.whitehouse.gov/sites/default/files/microsites/091203-ceq-revised-principles-guidelines-water-resources.pdf

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