

May 2013 ■ RFF DP 14-12

# Measuring the Return on Program-Level Conservation Investments

*Three Case Studies of Capabilities  
and Opportunity*

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# **Measuring the Return on Program-Level Conservation Investments: Three Case Studies of Capabilities and Opportunity**

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## **Abstract**

Conservation investments are increasingly evaluated on the basis of their return on investment (ROI). Conservation ROI analysis quantitatively measures the costs, benefits, and risks of investments so conservancies can rank or prioritize them. This paper includes case studies—of three large-scale conservation projects—designed to assess current ROI capabilities in the field, barriers to ROI analysis, and opportunities to improve conservation ROI. The cases reveal important conservation assessment innovations, but also identify significant gaps in the availability of data and analysis needed to establish many of the basic elements necessary to an ROI analysis.

**Key Words:** conservation, return on investment analysis, payment for ecosystem services

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# Measuring the Return on Program-Level Conservation Investments: Three Case Studies of Capabilities and Opportunity

James W. Boyd\*

## Introduction

Ecological protection, restoration, and management are critical interventions to help society deal with depleted or damaged resources, lost ecosystem goods and services, and community wealth threatened by degraded natural systems. Conservation organizations need to get the most out of these interventions and make the case for greater investment in them. What are the most important problems? What works? What should we do? What should we do first? These questions can only be answered by efforts designed to answer them.

Researchers at Resources for the Future (RFF) are working in partnership with The Nature Conservancy (TNC)<sup>1</sup> to develop tools for analysis of “conservation ROI” (return on investment), in an effort to help inform decisionmakers choosing about how best to allocate conservation funds. Three case studies—the Atlantic Forest in Brazil, Great Bear Rainforest on Canada’s Pacific Coast, and Warm Springs Mountain in Virginia—are presented here as part of this work. The purpose of the case studies was to assess current ROI capabilities, barriers to ROI analysis, and opportunities to improve conservation ROI. More specifically, the cases assess:

- TNC’s ability to quantify factors relevant to ROI analysis, including conservation-related biophysical improvements, baseline conditions, predicted future threats, and economic and social outcomes associated with the projects’ biophysical gains.
- Barriers to practical deployment of ROI, including financial and administrative issues, gaps in data and model capability, and gaps in skills and expertise.
- Motivations for ROI analysis, as perceived by TNC staff, decisionmakers, and other stakeholders.

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<sup>1</sup> See [www.rff.org/conservationROI](http://www.rff.org/conservationROI) for more information.

The specific case studies were selected by TNC based a sense that these projects were likely to have relatively extensive conservation data, modeling, and analysis already in place. This proved to be true in terms of more conventional conservation data and analysis (for example, relating to biodiversity status and needs). However, the cases identify significant gaps in the availability of data and analysis needed to establish many of the basic elements necessary to an ROI analysis. Even for biodiversity outcomes alone, most of the projects lack analysis of future threats or conditions avoided by the conservation activity (the counterfactual baseline). In terms of ecosystem services beyond biodiversity, we found numerous innovations designed to measure the provision of services by the projects. However, today these innovations are in their very beginning stages. Monitoring programs to detect positive water quality outcomes, as an example, are being put in place, but will not yield evidence of ecological benefit for years to come. Finally, and unsurprisingly, the ability to capture economic and other social outcomes is almost entirely absent at present.

An overarching observation is that the quantification of returns associated with specific conservation projects has historically been under-resourced in terms of money and people. At the project level, staff members are extremely motivated to engage in that kind of evaluation, but also note that they are rarely given the resources to do it. New investments in monitoring and evaluation of the Latin American water producer programs are a notable development, but also signify the newness of such investments.

Each of the case studies is organized around (1) a description of the program, (2) the program's conservation interventions and desired outcomes, (3) the way in which the project's location was chosen, (4) ways in which target ecological outcomes are measured, (5) likely, but unmeasured biophysical outcomes, (6) measurement of economic and social outcomes, and (7) cost measures.

## **Sistema Cantareira (Atlantic Forest)**

### ***Setting and Conservation Program Overview***

Brazil's Atlantic Forest is a unique and threatened home to biodiversity that sits in close proximity to Sao Paulo and Rio de Janeiro. The Atlantic Forest and Central Savannas Water Producers' Strategy, the Brazilian TNC Water Fund, is pursuing forest protection and restoration via a payments for ecosystem services (PES) program. The PES program collects payments from companies, municipalities, water funds and other water users to finance land and forest management practices by farmers.

This case study focuses on the Atlantic Forest's most quantitatively documented water producer program: the "Extrema" program, the first PES program in Brazil. The highly degraded Posses micro-watershed is located in Extrema Municipality and in the larger Sistema Cantareira—a 551,000-acre water supply system that provides water to roughly 48 percent of São Paulo's 9 million people.

### ***Program Interventions and Desired Outcomes***

The project has several goals: First, to target forest protection and restoration toward riparian lands thought to have a particularly significant effect on water quality and flows. Note that the water quality and flow-related improvements create the motivation and funds for the PES program. Second, to improve and protect biodiversity via forest protection and restoration. The third goal of the project is to sequester carbon.

Specific conservation and restoration interventions, via agreements with landowners, include:

- Incentives to conserve natural land cover
- Reforestation via planting
- Assisted natural reforestation, including installation of fire barriers and fencing to prevent tree damage from livestock and fire
- Riparian fencing to prevent livestock from entering surface waters and to protect areas under restoration and conservation

To date<sup>2</sup>, 51 landowners have enrolled in the Extrema PES program in the 3000 acre Posses micro-watershed. About 200 acres are being restored and 461 acres have been placed under protection by the agreements. The total area of the properties under agreement is 2446 acres. This larger area includes areas that remain in agricultural production. Current land cover within the project boundary includes a range of types, including pasture where no forest regeneration occur and highly degraded forest fragments where some natural regeneration occurs.

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<sup>2</sup> May, 2011.

### ***How Was the Project's Location Chosen?***

TNC's activities in the Atlantic Forest as a whole are motivated by a combination of its remaining biodiversity, substantial forest loss (only 12 percent of the original forest remains), and proximity to ongoing development pressure from major metropolitan areas. Additionally, 70 percent of the Brazilian population lives in the Atlantic Forest and the forest plays a vital role in providing drinking water to that population.

The Sistema Cantareira was chosen as a regional focus for two reasons: the system's role as a water source for São Paulo and the existence of an institutional framework to facilitate payments for ecosystem services. The institutional framework includes a "Watershed Committee" composed of federal, state, and municipal government representatives, NGOs, and water users (including water companies and industrial users). The committee is empowered by law to resolve conflicts, design and collect water user fees, and apply them to conservation and reforestation projects within the watershed system.

Within the Sistema, the Extrema municipality pioneered experimentation with payments for ecosystem services via a municipal regulation that generated dedicated funding, starting in 2006. Between 2007-2010 this program directed \$296,500 in payments to 72 farmers in two sub-watersheds. The Posses microwatershed is one of these. The Posses was chosen due to its relatively degraded state and relatively low-income landowner population (a population thought to likely to benefit from the PES program). Riparian and steep-sloped parcels were also targeted, as were parcels contributing to forest connectivity. Also, a regional study of erosion potential targeted the Posses, due mainly to the presence of rural roads.

### ***Measurement of Improved Biophysical Outcomes***

Currently, the Posses PES program measures three biophysical outcomes associated with its reforestation interventions: land use, water quality, and water flows.

#### **Land Use**

The project has developed baseline land use and land cover data using satellite imagery that will be periodically calibrated with field assessments. The creation of baseline data is a significant accomplishment, since no such data existed prior to the project. Satellite imagery allows rough assessment of land cover & vegetation monitoring (e.g. forest vs. pasture). More detailed (species-specific) evaluation is not possible with the imagery.

Also, on a monthly basis properties enrolled in the PES program are visited to check on the progress of restoration and compliance with the contracts. These site visits allow more detailed evaluation of vegetation types and status.

A comparison of land between 2004 and 2009 has been conducted, showing initial increases of 42.6 ha of initial secondary stage vegetation and 1.2 ha of median to advanced secondary stage vegetation.

### **Water Quality**

A water quality monitoring program is in place for the Posses. Six times a year, in partnership with the National Water Agency the program measures dissolved oxygen, biochemical oxygen demand, temperature, pH, and turbidity. Going forward, TNC has created a partnership with the University of São Paulo to conduct a larger monitoring effort. Beginning in 2011, this monitoring effort will monitor water quality at several locations on a monthly basis. The partnership will eventually lead to a monitoring protocol designed to detect the effects of the program's payments on water quality and to be used across all water producer projects. In addition, fish biodiversity monitoring in the Extrema project will commence in 2011.

### **Water Flows**

By slowing or retaining water, riparian reforestation can beneficially change the timing and amount of surface water flows. A motivation for the PES program, in fact, is to avoid seasonal drought conditions and flooding that can damage property and agriculture. Precipitation and river flow are being monitored daily in the Posses micro-watershed.

Additional measurement efforts are occurring in other parts of the Cantareira System, though not as yet in the Posses micro-watershed. In particular, detailed vegetation monitoring for certification of carbon offset credits and sediment load reduction modeling.

### **Vegetation & Carbon Sequestration**

Elsewhere in the Cantareira System reforestation achievements are being certified—in accordance with Clean Development Mechanism, Brazilian, and UN Protocols—so that carbon

credits can be sold.<sup>3</sup> TNC is active in the development land cover measures for this certification. The carbon credit protocol will rely on remote sensing of land cover over time to demonstrate creditable changes in forest cover. Carbon assessment will be applied to the Extrema municipality in the near future. (Reforestation is already being measured in the Posses, but not using the certified credit protocol.)

### ***Sediment Load Reductions Estimates***

The Water Producer Program has also begun to apply models designed to predict changes in sediment runoff. Sediment reductions have not been monitored directly. Rather, load reductions are predicted based on the InVEST sedimentation modeling tool developed by the Natural Capital Project. The InVEST tool is based on the Universal Soil Loss Equation (USLE) that takes measurable inputs such as soil type, land cover, slope, and precipitation and projects them into an estimate of sediments delivered to surface waters.

The initial prediction is not based on actual enrollments in the PES program. Instead, the model was applied to a scenario in which all riparian parcels in the Cantareira System were reforested. Under that assumption, the model predicts a 64 percent reduction in sediment loads. Note that only a fraction of riparian lands in a single micro-watershed are currently being restored. Also, InVEST was not applied to the Posses micro-watershed itself, due to lack of data. Data limitations have also prevented the use of the InVEST water quality module.

The Extrema program in the Cantareira Water System is one of several TNC water PES programs in the Atlantic Forest. Additional outcome measures and monitoring plans are being developed at other sites, including monitoring efforts in the Guandu watershed for aquatic and avian species, water quality, and water flows. These various TNC monitoring experiments emphasize different monitoring issues and will over time lead to monitoring improvements for all the water producer programs.

### **Fish Species Occurrence Monitoring (as Indicator of Habitat Quality and Function)**

In the Guandu watershed the National History Museum, with TNC's cooperation, conducted a baseline inventory of fish species occurrence at nine sites throughout the watershed,

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<sup>3</sup>AmbientalPV Ltda., "Reforestation Program Activity Design Document (CPA-DD) version 01, 2011," (May 2011).

[https://s3.amazonaws.com/CCBA/Projects/Watershed\\_Restoration\\_in\\_the\\_Cantareira\\_Water\\_System%3ACarbon\\_Community\\_and\\_Biodiversity\\_Initiative/PDD+CPA+Cantareira+Cachoeira\\_08May11.pdf](https://s3.amazonaws.com/CCBA/Projects/Watershed_Restoration_in_the_Cantareira_Water_System%3ACarbon_Community_and_Biodiversity_Initiative/PDD+CPA+Cantareira+Cachoeira_08May11.pdf)

using a range of sampling techniques. The baseline assessment has been completed and an ongoing monitoring protocol established. The next assessment will occur in 2013 or 2014 (the goal is to sample every 5 years). The same sampling protocol will be applied to the Poses system in 2011. Sampling occurs at ten sites by a team of trained technicians. Sampling techniques include fish traps, dip nets, and monofilament cast nets. Two aquatic indices have been developed and will be applied to the sampling sites in order to relate fish abundance to habitat conditions.

### **Improved Avian Species Abundance**

Also in the Guandu watershed baseline inventories of bird species occurrence were conducted in 2009 and 2010. Sampling occurred at 60 sites. Sampling methods included bird song monitoring, mist nets, and visual surveys. For the baseline, 230 species were observed, including 10 globally threatened species and 29 not previously known to be present in the forest. The avian monitoring protocol has been completed.<sup>4</sup>

### **Water Quality**

A water quality monitoring program is in place, with data collected 3 to 6 times a year across nine sites. Nine water quality measures will be monitored: dissolved oxygen, biochemical oxygen demand (BOD), nitrogen, turbidity, phosphorus, pH, temperature, color, and fecal coliform. Data has been collected since 2009. A USDA stream condition protocol will also be used to assess basic stream conditions such as channel condition, riparian zone features, bank stability, water appearance, and barriers to fish movement. These assessments will begin in 2012.

### **Water Quantity**

Precipitation will be measured daily at three sites. Flow and velocity data are monitored at three sites within the watershed on a monthly basis. Data collection began in 2011.

### **Visual Stream Health Assessment**

In 2011 the program will deploy a visual stream assessment protocol developed by the USDA. The protocol is designed to provide a quick, inexpensive evaluation of stream ecology that can be conducted by staff with relatively little training. The protocol includes measures of river channel condition, riparian zone conditions, bank stability, water appearance, and barriers

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<sup>4</sup> The combined cost of the initial aquatic and avian monitoring efforts in the Guandu watershed was \$94,000.

to fish movement. The tool is used to identify degraded conditions and management actions to improve them.

### ***Likely, But Unmeasured Biophysical Outcomes***

The Extrema PES program is likely to yield a range of desirable ecosystem service benefits in addition to those being measured. In principle, these outcomes should be measured or predicted in order to capture the program's full benefits. Unmeasured, but potentially important benefits include:

#### **Native Terrestrial Species Protection**

Restored forest habitat may lead to protection and increased abundance of terrestrial fauna typical of the natural habitats of the region. Forests can also have positive effects on surface water quality and temperature and thereby lead to increased abundance of aquatic species.

#### **Groundwater Abundance and Quality**

Forest cover may lead to greater infiltration of precipitation into soils and increased recharge of subsurface aquifers and improvements in their water quality.

#### **Improved Air Quality**

Forests intercept (through deposition of aerosols on leave surfaces) or sequester (through take-up of gases via stomata) many pollutants from the atmosphere, including nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter.

#### **Improved Landscape Aesthetic Value**

Extrema and the Cantareira region are increasingly important recreational areas for the São Paulo population. The region is seeing rapid growth in tourism, hotel visits, and development of second homes, for example. It is possible that forest cover changes may enhance the aesthetic value of the region to these kinds of users.

### ***Measurement of Social Outcomes, Including Economic Benefits***

Social benefits related to the project's biophysical outcomes have not been quantified or analyzed, though there is reason to believe that social benefits could be significant. The Cantareira System provides water to 48 percent of São Paulo's nine million residents. The Extrema and other PES projects generate economic benefits to this population by, for example,

reducing water treatment costs and avoiding costs associated with water rationing during drought conditions.

All of the possible biophysical outcomes associated with the project have the potential to create measurable social benefits. Sediment load reductions and turbidity reduction, for example, will reduce dam operation costs by increasing dam storage capacity (i.e., reducing dredging needs and extending reservoirs' useful lives) and reduce water treatment costs. Air quality improvements, contributions to native species, and groundwater improvements all have economic value that can, in principle, be estimated and used to convey the project's benefits or "returns."

Payments to farmers under the project may be interpreted as a social benefit. From an economic standpoint, though, these payments are project costs, not benefits. To be sure, payments benefit participating farmers and their communities. Redistribution of income from municipal to rural communities may have social value (payments may improve health and educational outcomes, for example). But these benefits arise only because of the financial transfer from water users to the farmers (and imply a corresponding cost borne by water users). Our test of a program benefit is that it arises directly from an improvement in a biophysical outcome. The project has sponsored a "social assessment" of the communities in the micro-watershed. This assessment is not an assessment of conservation or ecosystem service-related benefits, however. Instead, it is a demographic summary of the communities' incomes and employment status and was used to set the program's payment levels.

### ***Program Costs***

The Extrema program keeps detailed records of payments, restoration and management costs, and ongoing monitoring and management expenses. One set of budget documents describes the program's "establishment costs," including pre-implementation planning, implementation expenses including line items for management, forest restoration, soil conservation, fencing, landowner payments, and project mapping. Specifically for the Posses project implementation(1200ha):

#### Pre-implementation

Planning and management = \$347,000 (all in US dollars)

#### Implementation phase

Management = \$105,000

Landowner payments = \$304,000

Forest restoration = \$413,000

Mapping = \$44,000

Fencing and enclosures = \$171,000

Soil conservation = \$182,000

#### Post implementation

Monitoring = \$93,000

Several of these cost categories will be recurring, including landowner payments, monitoring costs, and program management. Landowner payments are fixed at an annual rate of \$94 per hectare. (Future Water Producer program payments will be assessed on more complicated formulas.) The monitoring costs reported above are for 2007 only.

The program also collects particularly detailed cost estimates for specific forest restoration and management practices. For example, for specific vegetation, land use, and soil types (e.g., degraded pasture with compacted soil, degraded young secondary forest) the costs of specific interventions are available: including the costs of fire lines, fencing, seedling plantings, mechanical and chemical grass control, and stimulated seed bank germination.

#### ***Summary and Implications for ROI analysis***

The Posses PES project features several innovations relevant to ROI analysis. The development of previously non-existent baseline vegetation mapping and regular participant field surveys will enable the Posses project to measure increased forest vegetation over time. This is necessary both for future evaluations of carbon sequestration and species evaluations based on habitat assessment. Elsewhere in the Cantareira System, land cover assessments motivated by carbon credit certification will create additional vegetation measures. The Water Producer program is also notable for its application of the InVEST module used to predict reduced sediment delivery. A range of new monitoring initiatives is also being developed for the Guandu watershed (not part of the Cantareira, but still part of the Atlantic Forest). Much will be learned from these monitoring protocols, with future relevance to the Cantareira system.

For all of these monitoring and modeling efforts, implementation issues remain. For example, the budget for and regularity of vegetation monitoring remain unclear. At this time, in the Posses micro-watershed, the only vegetation outcome measures available are the number of trees planted or regenerated and land use (a proxy for vegetation). Also, the sediment reduction

estimates produced by InVEST could not be applied to the Posses and do not relate specifically to the program's interventions. Rather, they describe a scenario in which all riparian lands in the Cantareira system are reforested. Program benefit assessment will require analysis based on actual reforestation outcomes.

Also, the program is likely to have a range of biophysical benefits for which there are no baseline data or ongoing monitoring plans. These outcomes include species protections, groundwater, aesthetic, and air quality improvements—all of which could significantly contribute to the program's social returns. (Note, though, that aquatic and avian abundance is being monitored in the Guandu program.) Without additional investment in baseline and time-series monitoring, these benefits are impossible to quantify. Given the program's emphasis on water quality and seasonal flow benefits, it will be particularly important for the Cantareira program to continue development of, and financing for, its water monitoring program.

The Guandu program features a more extensive set of monitoring activities. The baseline aquatic and avian inventories, and the monitoring protocols that are under development, could be replicated in order to quantify program impacts on species abundance. Similarly, Guandu's water flow and quality monitoring activities are illustrative of desirable outcome assessment practices.

The Extrema and Guandu projects have demonstrated a commitment to monitoring and performance assessment. These experiments are essential to ROI and effectiveness analysis. If the experiments are to pay off, sustainable funding for monitoring efforts is crucial.

Finally, we note that no social or economic evaluation of the program's conservation outcomes has been conducted. The program's quantifiable social benefits could in principle take a variety of forms. For example, with additional analysis sediment reductions could be translated into reduced dam and reservoir operation costs. Water quality improvements could be translated into human health improvement or avoided treatment cost estimates. Avoided flood damage or water rationing costs could be related to changes in the timing of surface water flows and storage. Air quality improvements could be related to human health benefits or reduced energy usage (via cooling). None of these benefit estimates are derivable, however, without long run measurement or prediction of the biophysical changes that give rise to them.

Another important source of returns from the Extrema PES program is its role as a first experiment that will be subsequently leveraged into numerous other water produced programs in the Atlantic Forest. In addition to the Guandu project (discussed earlier), the Extrema program has provided the basis for water producer programs in the Pípiripau River watershed (which provides water to 200,000 residents of Brasilia), Feio River watershed (which provides water for

the 80,000 residents of Patrocínio, Minas Gerais), Taquaruçu River watershed (which provides water to 170,000 residents of Palmas, Tocantins), and the Guariroba River Watershed, in Campo Grande, Mato Grosso do Sul.

The Extrema program's development of PES as an institution (including the legal framework and stakeholder process) and monitoring programs will improve and simplify development of these future programs. The program has also been able to create a range of partnerships with universities, NGOs, municipal governments, and private sector water users that will be valuable to subsequent water producer programs.

## **Great Bear Rainforest**

### ***Setting and Conservation Program Overview***

The Great Bear Rainforest (GBR) is an example of large-scale conservation and sustainable economic development. GBR covers a 19 M acre tract of mostly undisturbed, sparsely populated temperate rainforest. Stretching along Canada's Pacific coast from Vancouver Island to Alaska, it is one of the largest such areas in the world. GBR represents a full quarter of the world's remaining temperate rainforest (60 percent of the world's original stock of such rainforest has already been lost to logging or development). The region features old growth forest habitats, includes over 2500 salmon runs, and is home to wolves, humpback whales, eagles, grizzly bears, and hundreds of other species. GBR is also home to over 20 First Nations with interest in preserving spiritual and cultural connections to the land and the development of a conservation-based economy.

A 2006 agreement between the British Columbia provincial and First Nation governments created 5.2 M new acres of protected land where logging, hydropower development, mining, road building and other habitat quality-degrading land uses are strictly prohibited. In addition, millions of acres outside the protected areas will be managed according to strict rules designed to protect focal species habitat and stream ecosystems from the effects of logging. Together, these aspects of the agreement mean that 50 percent of each forest type in the GBR is now protected in, or managed for, old growth conditions. Prior to the agreement, only 1.1M acres had been protected. For the rest, clear-cut timber harvests posed the greatest threat to watersheds and habitat.

Central to the agreement are the Coast Opportunity Funds, \$C 60 M in funding raised by TNC, other conservation organizations, and philanthropies, and then matched by the British Columbia and Canadian governments, for a total of \$120 million. Half of the funds are in an

endowment that will be used by First Nation communities to engage in and strengthen natural resources management, and half are in a spend-down fund to diversify local First Nation economies and create sustainable economic development. Funds were not used to purchase land, since the lands in question were already in public ownership by First Nations, national, or provincial governments. This case study focuses on the GBR agreement and TNC's role as its facilitator and investor.

### ***Program Interventions and Desired Outcomes***

The agreement can be thought of as a land use and forest practices plan negotiated between First Nations and the provincial government with conservation financing to support the well being and economic development of First Nation communities. The essential elements of the plan are (1) a geographically delineated set of protected areas—the conservancies and the strategic landscape reserves; (2) specified ecological outcomes to be achieved from forestry plans that apply to the majority of acres not subject to outright protection; 3) financing to diversify First Nations economic development; and 4) financing to strengthen the capacity of First Nations to undertake shared resource management with the province.

The agreement identifies several desired ecological outcomes. First is the old growth preservation goal: protection of 70 percent of each specific forest type in GBR (the current outcome is 50 percent of each forest type, with the 70 percent goal to be achieved by 2014). The goal is based on the best available science, which indicates that 70 percent protection of each forest type is necessary for the persistence of ecological processes and species currently dependent on the forest. Second, is the protection of 100 percent of class 1 and 50 percent of class 2 grizzly bear habitat. Third, is 70 percent protection of critical habitat for five focal species: northern goshawk, tailed frogs, marbled murrelets, mountain goats, and black-tailed deer. Fourth, is protection off freshwater ecosystems from changes in flows and water quality via protection of riparian forest, and prohibitions on hydropower, mining, logging, and road building.<sup>5</sup>

Delivery of ecosystem services (beyond biodiversity) is not a stated goal of the agreement. However, the protection of resources for the cultural, recreational, and economic use of indigenous communities is an important aspect of the agreement.

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<sup>5</sup> In addition, but technically separate from the agreement, a program has been established to certify and sell carbon sequestration credits based on the agreement's forest protections.

To achieve these goals the agreement establishes:

- Eighteen parks administered by the provincial government;
- A new class of provincial parks, called “conservancies,” which allow for traditional land uses and protect both ecological and cultural values. The 111 conservancies are jointly managed by the province and First Nations;
- 21 “biodiversity, mining, and tourism areas” where logging and hydropower are prohibited;
- 1.3M acres of “Grizzly Bear Management Area.” Specific land and resource management plans within these areas remain under development;
- Strategic management reserves designed to meet the 70 percent old growth goals, to be finalized by December 2011; and
- Ecosystem-based management (EBM) rules for logging that protect streams and focal species.

The EBM rules, as an example, give a detailed sense of the agreement’s goals. In 2009, as a result of the EBM agreements, new regulations were created that govern commercial logging on lands outside the network of protected areas. These regulations set aggregate goals for old growth forest preservation for the entire GBR, as well as within specific watersheds and eco-regions. The regulations also require protection of riparian forest buffers, grizzly habitat, watersheds important to fisheries, rare and threatened plant communities, special aquatic features such as wetlands and floodplains, and “traditional heritage features” important to First Nations communities.<sup>6</sup> Many of these areas have already been mapped or defined with enough specificity to affect specific logging operations.

The GBR agreements primarily protect existing, high quality ecological conditions – in contrast to conservation projects that restore or manage resources to improve ecological conditions. However, where logging has occurred in the recent past (primarily in the southern areas of GBR) reforestation and management toward old growth conditions will take place.

TNC itself is not responsible for, nor does it have authority to conduct, specific conservation or management actions in the GBR. Principle authority for conservation, land, and

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<sup>6</sup> Background and Intent Document for the South Central Coast and Central and North Coast Land Use Objectives Orders, April 18, 2008. <http://archive.ilmb.gov.bc.ca/slrp/lrmp/nanaimo/cencoast/plan/objectives/LUO.pdf>.

water management resides with First Nations and the provincial government, specifically the BC Ministry of Environment for conservancies, the Ministry of Forestry for forest management, and the federal government Department of Fisheries and Oceans for marine and salmon management. TNC took the lead role in fundraising for the Coast Opportunity Funds, which made the agreement possible. With respect to the GBR agreement itself, TNC's direct involvement in resource management, planning, monitoring, and enforcement is limited. However, as noted earlier TNC actively supports the development of programs, subsequent to the agreement, that strengthen the capacity of local organizations and First Nations to ensure sustainable management of the resources in this region.

### ***How Was the Project's Location Chosen?***

It is difficult to document how GBR was chosen as a focus for conservation by TNC. It is likely that GBR's conservation benefits were considered to be fairly self-evident. And clearly, the ability to leverage a network of partner organizations, governments, and commercial interests around a large-scale agreement was appealing.

A wide range of analyses of the region took place in the decade preceding the agreement. For example, in 2001 the province and Turning Point Coastal First Nations (a regional body representing a large number of First Nations) reached an agreement in principle to manage the area using EBM approaches. They also agreed to establish the Coastal Information Team (CIT), an independent analytical unit charged with collecting information and developing analyses of ecosystem-based forestry management in the GBR. CIT operated between 2002 and 2004 on a \$C3.3M budget. CIT analyses provided the scientific basis and actual recommendations for the eventual EBM forestry rules.

Also, in 2003 TNC and partners produced a Conservation Area Design (CAD) analysis for Southeast Alaska and the coast of British Columbia. The analysis used portfolio choice tools (i.e. MARXAN) and a variety of biophysical data to identify Conservation priority areas and specific targets for a range of species and systems. It is clear from analyses such as the CAD that GBR's overall conservation value was already well established—with, for example, already-identified species and ecosystems of concern.

Within GBR, the delineation of locations for protected areas versus EBM regulated forestry lands was determined largely via negotiation between industry, First Nations, environmental groups, and the BC government. These negotiations were informed by the aforementioned CIT and TNC analyses and by land use plans and agreements developed over a period of nearly a decade. For example, in 2003 Central and North Coast Land and Coastal

Resource Management Planning efforts (CCLCRMP and NCLCRMP, respectively) identified specific protected land goals and desired outcomes for EBM forestry. These formed the basis for the Province's negotiating position with First Nations. First Nations developed their own, corresponding land use plans and negotiated around them. Subsequently, First Nations and the province negotiated Strategic Land Use Plan Agreements (SLUPAs) that identified their territories and protected areas within them.<sup>7</sup>

The CIT also produced a series of "Economic Gain Spatial Analyses" to support subsequent land use planning. These studies were intended to identify spatial portfolios of lands to be allocated to economic development. For example, the CIT produced an analysis of forestry-related economic outcomes associated with different forestry EBM scenarios.<sup>8</sup> The analysis modeled harvests, jobs, and forestry revenue changes associated with EBM-type management. Similar studies were conducted for fisheries, non-timber forest resources and tourism to identify spatial locations for future development of economic activity.

To conclude, no single quantitative analysis determined the boundaries of parks, conservancies, and EBM forest lands. Rather, locations were determined by negotiations, informed in part by a variety of quantitative analyses. Going forward, the aforementioned strategic management reserves will be based on quantitative analysis of risks to old growth forest that remain under the agreement. The analysis is being conducted by the Land and Resources Forum Technical Liaison Committee—a group that includes representatives from the First Nations, environmental NGOs, the provincial government, and the forest industry.<sup>9</sup>

The analysis involves modeling efforts (SELES and MARXAN) to identify preliminary reserve locations. The output of the effort will serve as the initial proposal for First Nations review. Reserve locations are to be finalized by December 2011, followed by annual reviews that can adaptively change the location of the strategic reserves.

Perhaps the most difficult form of quantitative analysis—relating to both the benefits of protection and the choice of sites to be protected—is evaluation of future threats avoided. Several analyses of future threats were conducted for GBR. A 2004 ecosystem trends analysis

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<sup>7</sup> Personal communication with Audrey Roburn, Rainforest Solutions Project, April 5, 2011.

<sup>8</sup> Coast Information Team Economic, "Economic Gain Spatial Analysis—Timber for the CIT Region" (August 2004). <http://www.citbc.org/c-egsa-timb-26Aug04.pdf> (accessed May 12, 2014).

<sup>9</sup> [http://ilmbwww.gov.bc.ca/slrp/lrmp/nanaimo/central\\_north\\_coast/plan/forums.html](http://ilmbwww.gov.bc.ca/slrp/lrmp/nanaimo/central_north_coast/plan/forums.html).

done by CIT explored logging-related threats to particular forest types (clear cut logging was the primary threat to the forest prior to the agreement).<sup>10</sup> It is unclear if, or how, the analysis affected land use planning associated with the GBR agreement. However, it explored differences in forest composition between “inoperable” (un-log-able) and “operable” (log-able) lands. Several understandable simplifications were adopted by the analysis. For example, it held fixed into the future current harvest rates and harvest practices (clear cutting). Other land use or land conversion threats, such as from mining, were not included in the analysis.

Another particularly relevant analysis was the CIT’s “Cultural Spatial Analysis.” The study consulted First Nations about natural resource features with particular significance to the community, mapped the density of such sites, and ranked them on the basis of their current condition and future threats. The explicit focus on threats to the resource makes the study noteworthy. The study was able to calculate that 14 percent of the culturally important features were in locations likely to yield positive timber harvesting returns and 13 percent were located outside protected areas. As with all the CIT studies, it is difficult to determine how the 2004 analyses correspond to the eventual land use agreements. It is likely, though, that the cultural analysis played a role in identification of no-harvest lands under the subsequent EBM agreement.

Finally, the GBR agreement has been certified as a generator of carbon credits, with the first credit payments being made in summer 2011. Certification of carbon credits for sale requires analysis of baseline (counterfactual) forest cover and composition.

### ***Measurement of Improved Biophysical Outcomes***

Baseline assessment of land cover, forest types has been completed for the entirety of GBR. Currently underway is a baseline habitat analysis for focal species, conducted as part of a conservation GAP analysis by environmental NGOs. Programs to monitor compliance with the agreement and the effectiveness of natural resource management program, including EBM forestry are at various stages of development.

Due to the GBR agreement’s scale and collaborative nature, a coordinated monitoring framework was created, involving multiple institutions. TNC’s role is to facilitate development and implementation of the monitoring framework via support for the Rainforest Solutions

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<sup>10</sup> Coast Information Team, “Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case” (March 2004). <http://www.citbc.org/c-cencst-cf-base-31Mar04.pdf> (accessed May 12, 2014).

Project, a consortium of environmental NGOs responsible for oversight of GBR monitoring programs.

Compliance monitoring is largely the responsibility of the BC government. Verification that timber harvest plans and activities at the site level comply with the agreement's provisions is the responsibility of the BC Ministry of Forestry, which is in turn audited by an independent Forest Practices Board. Another layer of oversight is provided by BC's inter-ministerial Forest Range and Evaluation Program (FREP). These provincial programs and their monitoring missions predate the GBR agreement. As a result, compliance monitoring for the GBR is well underway.

For the conservancies, compliance and effectiveness monitoring is largely the responsibility of BC Parks, in conjunction with co-development of management plans with First Nations. Conservancy monitoring plans have been slow to develop, in part because of inadequate funding to support the involvement by both First Nations and BC Parks in the co-planning process. Even where management plans have already been developed, they often lack a level of detail necessary to develop monitoring protocols.

From the standpoint of ROI analysis, the monitoring activities of greatest relevance are those designed to measure the agreement's effectiveness—its ability to change ecological and social outcomes for the better. Effectiveness monitoring for the entire agreement is to be overseen by the Adaptive Management Working Group, which includes representatives from First Nations, the BC government, environmental NGOs, and industry. This group's mission is to identify indicators of human wellbeing and ensure their measurement over time; conduct ongoing evaluation of the ecological effectiveness of the agreement; and conduct research to evaluate the ecosystem-based management guidelines included in the agreement.

The adaptive management working group has formed and met a few times; however, progress on agreements over what should be monitored and how has been slow. Participating organizations are working toward figuring out how best to resolve this situation.

In addition to the institutionalized monitoring of the Great Bear agreement (described above) is the indigenous ranger program, Coastal Guardian Watchmen. The Watchmen program is not technically a part of the GBR agreement. However, Watchmen programs receive significant funding from Coast Opportunity Funds established by the agreement and are designed to promote the goals of the agreement, in particular sustainable resource management by First Nations. The Watchmen monitor specific biophysical and human use indicators in their Territories and provide training programs in natural resource management. In the past two years,

communities with Watchmen programs have begun collaboration on a Regional Monitoring Strategy to ensure data collection useful to First Nations' evaluation of conditions in their territories. A goal of the strategy is to collect consistent types of data, using the same, scientifically robust monitoring protocols so that First Nations' can coordinate their activities and evaluate resource management at the coastal scale. Data collected as part of the community Watchmen programs and the Regional Monitoring Strategy are the property of the individual First Nations; these data are accessible to others only with the signing of a protocol agreement. Based on data through 2010, approximately \$530K of \$3.7M awarded from the Conservation Fund has been allocated to Watchmen programs.<sup>11</sup>

### ***Likely, But Unmeasured Biophysical Outcomes***

As noted above, monitoring of biophysical outcomes is either in a development phase or under the authority of specific First Nations. In both cases, it is difficult for us to describe and assess any specific monitoring protocols or data. Thus, for the purposes of this case study, "unmeasured biophysical outcomes" comprise an extremely wide range of potential measures. Due to its vast scale, GBR is likely to produce a rich spectrum of ecosystem goods and services.

Ideally, these outcomes should be measured or predicted via analysis of actual conditions versus the counter-factual scenario. The counter-factual scenario is a predicted state of the forest ecosystem without the land use protections and EBM forestry rules that have resulted from the GBR agreement. Potentially important conservation benefits include:

### **Preservation of Species Abundance**

This is the focal goal of the GBR agreement. The GBR deal can be expected to protect a wide range of terrestrial, aquatic, and avian species from declines. The benefits of protection are a function of avoided declines that would have occurred absent the protection agreement. Depending on the species in question, they will be valuable for a variety of reasons: subsistence, recreation, commercial harvest, and/or their inherent existence.

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<sup>11</sup> Calculated from the Awards Summary, Coast Opportunity Funds, Period: October 1, 2008 to December 17, 2010. <http://www.coastfunds.com/system/files/AwardsSummary1.pdf> (accessed May 12, 2014).

### **Protection of Culturally and Aesthetically Valuable Natural Resources**

Natural resources are inextricably tied to the cultural and spiritual identity of the First Nations population located in GBR. Protected cultural resources threatened in the absence of the agreement should be counted as biophysical gains.

### **Preserved Water Quality**

Forest protection and EBM forestry can be expected to avoid or sequester a range of pollutants, including fecal bacteria and sediments relative to the unprotected scenario and thereby improve both surface and groundwater and marine water quality.

### ***Measurement of Social Outcomes, Including Economic Benefits***

As noted earlier, a goal of the GBR agreement is improved human wellbeing and other social outcomes. Provisional human wellbeing indicators have been identified, but agreement on indicators and implementation of monitoring (by the responsible “adaptive management working group”) has yet to occur. Going forward, it is likely that social and economic assessment in GBR will be focused on First Nations communities. The First Nations have plans to monitor certain economic activities associated with their lands, including tourism, aquaculture, and fisheries. But the relevance of this monitoring to ROI analysis hinges on the development of counter-factual estimates of commercial activity in the absence of the GBR agreement.<sup>12</sup>

Also, as noted earlier, the CIT produced in 2004 a set of “Economic Gain Spatial Analyses” to identify sites with existing economic value or potential economic value and to estimate that value in terms of revenues and jobs. The purpose of these studies was not to depict social gains arising from the GBR agreement. Their purpose was to help identify land parcels and economic development options relevant to subsequent land use planning. They do not, for example, describe social gains arising from forest protection due to increased biodiversity, or water quality.

However, the studies do provide insight into the relationship between natural resources and different economic uses, including tourism. By identifying locations most suitable for economic development, the studies in effect predict the location of specific ecosystem service beneficiaries.

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<sup>12</sup> Note that the agreement—by design—will have reduced the value of certain commercial activities, particularly those not dependent on forest preservation.

### ***Program Costs***

The GBR agreement is best thought of as a “grand bargain” among multiple interests to protect the rainforest from logging, mining, and other threats. So what was the cost of this grand bargain?

It is tempting to say \$C 120M, the amount of money raised for the Coast Opportunity Funds, of which \$35M was contributed by TNC. But that number is inaccurate—and an underestimate—for at least two reasons. First, the costs of the agreement include more than a decade’s worth of planning and negotiation by multiple parties, including First Nations, the BC government, industry, and NGOs. The CIT’s \$C 3.3M budget is an easily identified addition to the total cost. Other institution’s contributions are more difficult to document. Second, timber companies are being compensated for accepting EBM management restrictions. They receive a \$2.75 credit from the government for each cubic meter of timber harvested. These costs are borne by the Canadian taxpayer.<sup>13</sup>

Another issue is whether the Coast Funds can be termed “payments for conservation.” Clearly, both funds were part of a political accommodation necessary to the GBR agreement. Equally clearly, they represent real costs to TNC, its partner organizations, and the BC government. In that sense, they can be interpreted as payment for GBR conservation. But in contractual and legal terms they are not payments for the conservation achievements of the GBR agreement.

The funds finance *future* economic development and conservation projects. They are not compensation for changes in land ownership, property rights, or costs borne by forestry companies or other commercial enterprises. Specifically, the Development Fund (\$60M) will be paid out to fund First Nations economic development projects. The Conservation Fund (\$60M) is an endowment whose returns are earmarked to finance future conservation-related activities. Conservation funds are to be spent on research and monitoring, resource planning, habitat restoration, and capacity building for First Nations conservation programs. They are expressly prohibited from funding costs associated with meeting statutory obligations, including the GBR agreement’s protected area designations and EBM compliance rules.

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<sup>13</sup> Rainforest Solutions Project, “‘The war is over’: Great Bear Rainforest plan reached,” (March 2009), [www.savethegreatbear.org/news/detail/the\\_war\\_is\\_over\\_great\\_bear\\_rainforest\\_plan\\_reached](http://www.savethegreatbear.org/news/detail/the_war_is_over_great_bear_rainforest_plan_reached).

In the future, it will be easy to track the disbursement of Coast Funds and thereby track the costs of conservation investments made under them. A complete list of awards to date is already publicly available.<sup>14</sup>

### ***Summary and Implications for ROI Analysis***

The GBR agreement presents several challenges to an analysis of ROI. The first is the scale of the conservation intervention (an area the size of Switzerland) and the associated breadth of its potential benefits to diverse communities and other beneficiaries. Even if the agreement's social and ecological effectiveness monitoring programs were already in operation, the scope of quantitative assessments of biophysical conditions and changes would have to match the scale of the agreement itself. Some analysis of threats—to cultural resources, in particular—was conducted and applied to planning and the definition of protected areas. However, additional “counterfactual” analysis of predicted land cover change in the protected areas would be desirable. Monitoring programs are in place that will make it relatively straightforward to measure compliance with the old growth goals of the agreement.

In terms of broader social and ecological effectiveness evaluation, long-term monitoring is a stated objective that runs throughout the GBR agreement, though funding for, and institutional momentum behind, these programs (via the Adaptive Management Working Group) is in question. More tangible in their progress (though still under development) are First Nations monitoring programs associated with the Coastal Guardian Watchmen. Dedicated funding is available via the \$60M Conservation Fund. Note, though, that the Watchmen programs are designed to measure the use and effectiveness of more specific natural resource management initiatives, not the effectiveness of the GBR agreement as a whole. Also, access to that monitoring information by TNC and other researchers will require potentially significant effort, given its ownership and control by individual First Nations.

A second set of challenges relates to the agreement's complexity, the number of institutional partners involved, and decade long duration of the agreement's development process. This complexity complicates estimation of the investment made. TNC's \$35M investment is clear, but would not by itself have been enough to achieve the agreement. And as

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<sup>14</sup> [www.coastfunds.ca/awards-projects](http://www.coastfunds.ca/awards-projects).

described earlier, the \$120M Coast Funds are themselves a significant underestimate of the agreement's costs.

From TNC's perspective, its \$35M investment can be argued to have produced enormous financial leverage, generating a "return" of the additional \$115M raised from its partners in philanthropy and government. A more conventional accounting approach, though, would treat TNC's investment as a fraction of the larger investment needed to secure the agreement, earning TNC a corresponding fractional share of the entire agreement's benefits.

It is possible to quantify the forests and habitats protected by the agreement. It is harder to quantify the probability, and date at which, they would have been degraded or destroyed by logging, mining, and other economic activities. It is even harder to depict the agreement's broader economic returns given that effectiveness monitoring programs remain in development. However, the potential magnitude of the GBR agreement's economic benefits is undeniably significant. The protection of cultural values for communities that place natural resources at the center of their spiritual and cultural identity are clearly important. So too is the value to the global community of such a huge, contiguous, and relatively scarce, set of ecosystems and wilderness.

Going forward, TNC engages in a range of partnerships with First Nations, NGOs, and the provincial government. These ongoing efforts will have returns of their own in the form of more sustainable resource management in the GBR.

## **Warm Springs Mountain**

### ***Setting and Conservation Program Overview***

TNC acquired the 9250-acre Warm Springs Mountain (WSM) preserve in 2002 for \$6.2M. The site is a 13-mile stretch of mostly forested upper slope and ridge that sits above Virginia's Cowpasture River and the Homestead, a 250-year old thermal springs resort area. The river is considered to be one of the most pristine in Virginia. Elevations on the parcel reach 4000 feet in several places. Located near the border with West Virginia, the setting is rural, but proximity to the Homestead means that the site is of above-average recreational and aesthetic importance.

WSM is part of a much larger mosaic of ecologically significant lands, including a 77,000-acre unfragmented and virtually roadless forest block and the 1.1 M-acre George Washington National Forest. These areas are important components of the much larger, 7M-acre

Central Appalachian ecoregion, which includes parts of Pennsylvania, Maryland, Virginia, West Virginia, Kentucky, and Tennessee.

The property's purchase protects against land development and commercial logging, both of which are local threats to forest landcover. The project features several adaptive management approaches to invasive species and fire restoration. Also, TNC leverages its conservation strategy by partnering with the US Forest Service on a fire restoration project involving 18,000 acres of forest that includes the WSM preserve.

### ***Program Interventions and Desired Outcomes***

The WSM preserve's principle objectives are to provide suitable habitat for rare and threatened bird and mammal populations and develop collaborations with federal land managers to achieve large-scale forest conservation. Three rare plants, 8 rare invertebrates, and 3 rare plant communities have been identified on the mountain, including a globally rare pine barren system. Specific conservation targets include preservation, improvement or restoration of cave invertebrate communities and bats, and several ecological systems, including a Central Appalachian river aquatic system, a Central Appalachians mixed hardwoods forest matrix, pine-oak heath woodlands, outcrops/barrens/acidic woodlands, alluvial floodplain forests and grassland and montane non-alluvial wetlands. Protection of these systems is important to the biodiversity of the larger Central Appalachians region because they support a range of migratory, forage, and reproductive functions. Other stated goals include water quality protection (the area includes tributaries to both the Cowpasture and Jackson rivers, which are the headwaters to the James River), preservation of scenic beauty, and provision of public recreational opportunities.

The parcel's purchase protects the 9,000 acres from commercial logging and land development. The probability and timing of these threats were not quantitatively evaluated, but vacation home development and logging of similar lands in the immediate vicinity already occur. In fact, residential development on lower slope parcels occurred as a result of the property transaction that led to creation of the preserve. In terms of commercial logging, it is not only locally present but also has taken the form of "high grade" harvests. High grade harvests are selective, choosing the species that are most economically valuable. Unfortunately in this case those same species are particularly valuable ecologically. Selective harvests have removed native hardwoods, for example, leaving forests to regenerate around lower quality, non-native, and disease-susceptible species. Combined with the cumulative effects of fire suppression over a century, these harvests lead to denser, even-aged forests that further challenge restoration of

historic fire regimes. The resulting changes in vegetation are thought to have correspondingly negative effects on habitat for a range of other species.

In addition to the protection of existing resource conditions via the parcel's purchase, the WSM project is also engaged in a set of specific management activities designed to improve and restore the ecology of WSM. Over the last two hundred years, logging and fire suppression have degraded the Central Appalachian region's native forest habitats. Native species, such as oak and pine, rely on fire for reproduction and regeneration. TNC is engaged in a set of fire-dependent habitat restoration experiments at WSM. Five controlled burns have been conducted covering 2200 acres, two in 2008, one in 2010, and two in 2011. The goal of these experiments is to evaluate managed burns' ability to regenerate native and now scarce timber stands and ecologically valuable habitats. These experiments are part of a partnership with state, federal, and private land managers (the Fire Learning Network ((FLN)) designed to leverage what is learned at WSM across the larger Appalachian landscape. In particular, the experiments and FLN are expected to influence the US Forest Service's Forest Management Plans and thereby leverage WSM restoration experiences across the Forest Service's forest holdings.

The project has also conducted experiments in control of garlic mustard, an invasive species damaging to a variety of native tree, insect, and understory species. Specifically, a five-year WSM experiment in herbicide-based control of garlic mustard demonstrated that Glyphosate did reduce garlic mustard coverage initially, but also reduced native plant coverage. The effects also appeared to be short-term. Future experiments with control of other species—Norway maple, oriental bittersweet, and barberry—may be conducted pending analysis of a recent non-native species inventory.

To control deer, which can damage young native trees, the preserve has issued a revenue-generating (\$23,500 per year) hunting lease. (Fire also reduces deer damage by stimulating growth of edible grasses that deer can consume instead of saplings.) The hunting lease program also signaled to area residents that TNC recognizes the importance of this historically important activity to the community.

### ***How Was the Project's Location Chosen?***

The Central Appalachian ecoregion is ecologically important for several reasons. First, it includes a high level of existing biodiversity. Second, it includes large, contiguous forested corridors running north to south with relatively few habitat obstructions and a high percentage of lands in public ownership. The area's north-south connectivity, along with significant changes in

elevation, is likely to provide habitat and species resilience to climate change (as they are able to migrate unimpeded northward and upslope).

The site was chosen based on several factors, some quantitative, some not. The quantitative analysis most influential in the choice of WSM was the regional Central Appalachian Forest Ecoregional Plan (CAFEP) conducted by TNC in 2001. The CAFEP was a data-intensive priority-setting tool designed to identify land parcels important to regional biodiversity goals. Using Natural Heritage and other data, the CAFEP mapped the larger region and identified conservation targets based on existing biodiversity, habitat features, and connectivity to other protected lands.

The CAFEP was representative of TNC's ecoregional planning at that time. It represented a large commitment to organizational capacity, teams of researchers, data collection, and evaluation. Like other ecoregional plans, CAFEP benefited from the relative wealth of data available to U.S. planners – data that is not usually available internationally. (It is worth noting that a new, revised Conservation Action Plan (CAP) for the Central Appalachians is in progress. The new plan features increased attention to climate change resilience and finer resolution data.)

CAFEP and its underlying methodology predicted that WSM would be a high value site to preserve existing biodiversity throughout the Central Appalachian Region. WSM “scored well” because of the site's existing biodiversity, presence of priority plant communities and habitats, and its connectivity to other protected lands.

The CAFEP did not include threat analysis of land development patterns and probabilities, forestry, or other social stressors. In fact, the CAFEP played down the importance of development threats in its assessment of the site: “Unlike most conservation areas in Virginia where the highest ranked threat is often development, forest pathogens and invasive plant species are driving the decline of forests here.... Relative to other conservation areas, there are few local threats to the targets at this time. Rather, the most problematic threats are regional in scope, such as invasive pathogens and plant species, deer management, acid deposition, and fire exclusion.” (p. 47). It is also worth noting that the CAFEP did not include analysis of land acquisition costs. Priority conservation lands were defined purely on the basis of the biodiversity value, not on the basis of biodiversity value per dollar spent on protection.

Qualitatively, the threat of development did play into the selection choice of WSM. When the Homestead resort announced its divestiture of property in and around WSM, this raised the distinct prospect (if not likelihood) that the mountain would be developed. Because of the resort, the area is not your average rural Virginia community, with correspondingly average

probabilities of land conversion. Rather, the resort's proximity and observable interest on the part of land developers signaled a clear threat that the land would be altered.

### ***Measurement of Improved Biophysical Outcomes***

WSM is engaged in a variety of monitoring and modeling activities designed to assess conservation status and outcomes. The adaptive management approach to invasive species controls and fire restoration are particularly noteworthy. As noted earlier, a garlic mustard control program was empirically evaluated based on monitored outcomes. After five years, compared to control plots, the mustard's coverage had increased (by 1.3 percent) and native species' cover had decreased (by 11 percent), likely due to inevitable overspray of the herbicide. While the invasive control program was found to be ecologically undesirable, the commitment to data collection and evaluation is laudable.

The most significant monitoring activities are associated with the fire restoration experiments. Both the WSM CAP and the CAFEP identified fire suppression as an important ecological threat. The fire restoration experiments are designed to measure the efficacy of controlled fire as a forest restoration strategy, with associated benefits for biodiversity.

Pre- and post-fire monitoring focuses primarily on vegetation (habitat) monitoring of forest composition and structure. Baseline inventories have been conducted for all areas of the preserve where fire restoration will occur, as well as for additional areas that will serve as control plots. Initial post-burn inventories have been completed for the 2009 and 2010 burns. The 2011 burn post-burn inventory will be conducted in summer 2012. Subsequent monitoring will occur every five to seven years. Because forest re-growth takes decades, the definitive results of these experiments will not be known for some time. However, initial surveys suggest that post-fire re-growth features positive restoration trends (for example, a reduction in mid-story small diameter tree and shrub stems: often cited in publications as a primary barrier to oak and pine regeneration).

Also, in 2010 TNC and the Forest Service began a cooperative, cost shared avian monitoring program that will track bird species occurrences and abundance in and around WSM. Using relatively standard breeding bird survey methods, the data should provide a baseline of bird usage in specific habitat types, and, over time, allow TNC to further quantify our restoration progress.

A range of additional biodiversity monitoring activities occurs in and around WSM. TNC, the state of Virginia, or other partners and experts, depending on the species,

“periodically” monitor the occurrence of fish, moths, invertebrates, plants, and community assemblages. Generally, these monitoring efforts are conducted by state agencies, including the VA Dept. of Conservation and Recreation, Natural Heritage Division, or the VA Dept. of Game and Inland Fisheries as part of their statewide program of work. These monitoring efforts are not built into TNC’s budget and so do not occur on a pre-determined schedule or adhere to a consistent measurement protocol. Also, these monitoring activities are not tied to specific management interventions, such as the fire program. However, this larger set of data collection activities may be useful in the future to assess long-term trends on or near the preserve. The preserve is also being used for several academic studies that may eventually be pertinent to management of WSM, including studies of the woody adelgid (a pest that threatens eastern hemlock), the dynamics of pine barren plant communities, coyote range and diet, shale weathering, and a set of projects on ecological responses to controlled burns.

Of particular interest is an “ecological zone” modeling tool recently developed by a retired US Forest Service botanist and applied to the WSM area with TNC’s cooperation. The tool has been used to produce high-resolution (10m) maps covering 5.6M acres of the Southern and Central Appalachians, including WSM and surrounding national forest. The calibrated models predict current and potential plant community types as a function of 25 environmental variables (including site topography, average annual precipitation, aspect, slope, soil and geology). The tool will be used to help TNC and partners plan future fire restoration projects and measure progress towards desired landscape conditions. The tool’s predictive capabilities provide insight into forest succession and disturbance pathways and can help identify areas where fire suppression is likely to lead to vegetation changes that are particularly damaging to biodiversity. The tool is already being used to identify areas most likely to support plant communities that are “most adapted” to natural fire processes (and thus most likely to benefit from prescribed burns). It is also being used to identify current and future habitat locations for specific threatened and endangered species (i.e., cerulean and golden-winged warblers).

### ***Likely, But Unmeasured, Biophysical Outcomes***

Planning, measurement, and experimentation at WSM has to date been focused exclusively on biodiversity outcomes. However, the preserve likely provides a variety of additional ecosystem services that contribute to social and ecological returns.

### **Avoided Aesthetic, Cultural, and Recreational Costs**

The site is distinctive in part because of its proximity to the Homestead resort and Warm Springs Valley. The mountain dominates the viewshed, providing the scenic backdrop to

recreation and tourism in Bath County. Residential or other building on the mountain would compromise those views and sense of an undisturbed setting, as well as recreational access to the site (which is in desirable proximity to Homestead visitors and residents). It is also worth noting that the Warm Springs Valley has been a recreational destination since the 1760s. Promotion of outdoor recreation and the region's scenic beauty is a focus of Bath County's new Tourism Plan, developed in January 2010.

### **Avoided Water Quality Degradation**

The forest's protection is also likely to improve water quality relative to a land development scenario. The mountain's hydrological role in feeding the warm springs, drinking water supplies in the valley, and the Cowpasture River has not been analyzed. However, the topology and geology of the area suggest that the preserve plays an important role as catchment for those water resources. In fact, one of the reasons the Homestead originally purchased WSM lands was to protect its valuable investment in the warm springs.

### **Avoided Costs Due to Changed Surface Water Flows**

It is also likely that development on the mountain would change the timing and amount of runoff from the mountain into the Cowpasture River and James River system. Protection may, therefore, avoid ecological and social costs by regulating runoff and avoiding both seasonal low-flow and high-flow (flood) events. Low-flow conditions can create ecological stresses that affect riverine biodiversity. Flood conditions can create agricultural, infrastructure, and property damages.

### **Avoided Carbon Emissions**

The preserve protects the mountain from deforestation that would lead to net carbon emissions. As always, the scale of this benefit depends on the amount of deforestation expected in the counter-factual (development) scenario.

### **Avoided Air Quality Degradation**

Similarly, protection guarantees that the forest will continue to capture and sequester air pollutants, functions that would be lost should deforestation occur. We note that several of these ecosystem services benefits – specifically, avoided carbon emissions and sediment loads – could be analyzed using new assessment tools, such as InVEST.

### ***Measurement of Social Outcomes, Including Economic Benefits***

No social evaluations of WSM's benefits have been conducted, such as quantitative identification of beneficiaries, or economic valuation of the project's various benefits. In the future, we hypothesize that two types of pertinent social data could be collected relatively easily. The first relates to recreational visitation rates and activity surveys for Bath County and the Homestead. This kind of data would allow for, at least, raw counts of beneficiaries enjoying WSM's aesthetic and recreational features. The second relates to the use of groundwater for drinking and warm springs recreation. The number of households, community organizations, and businesses drawing well water from aquifers fed by the preserve would provide a useful indicator of water treatment needs that might have arisen had the mountain been developed.

### ***Program Costs***

There is extensive documentation of the costs of the preserve's acquisition. As noted earlier, the purchase price in 2002 was \$6.2M. TNC's Allegheny Highlands program (which manages WSM as well as a larger portfolio (mostly) easements in the region) produces annual capital budgets that reflect revenues into the program, interest payments, tax liabilities etc. The capital budgets could be used to calculate the "true costs" of the WSM acquisition, taking into account the timing of liabilities and debt service. The program also generates annual operating budgets that include expenses associated with personnel, equipment, occupancy, travel, etc. These budgets are useful to track the costs associated with specific programs conducted at WSM. For example, total expenses to date associated with the prescribed burn experiments amount to approximately \$200K.

Costs associated with invasives control experiments are calculated on a per-acre basis. For example, the garlic mustard invasives project costs were \$50-acre-year for herbicide application. Additional costs were incurred to manage and monitor the project. The total cost of the project was approximately \$20,000. WSM managers estimate that treatment costs for other invasive species such as Norway maple and barberry will be roughly double the amount for garlic mustard, due to the need for mechanical removal of those species.

The project team's monitoring costs, both for vegetation and the avian survey, amount to \$2-acre-sample. This amounts to total monitoring costs of, for example \$1000 per burn per survey (assuming an average 500 acre burn). The avian monitoring program is budgeted at approximately \$15,000 per survey.

### ***Summary and Implications for ROI analysis***

WSM is distinctive both as a site targeted for protection and as an experimental landscape. In terms of analysis and quantification, the focus of WSM is squarely on biodiversity outcomes. That is not to say that other ecosystem services are not being provided – quite the contrary. But site selection, planning, experimentation, and evaluation have been geared toward TNC’s biodiversity mission, rather than the newer emphasis on ecosystem services. For several reasons, it will take additional work to conduct a comprehensive ROI analysis for WSM. In part this is due to the lack of existing social or economic analyses. In part, it is due to the focus on biodiversity, as opposed to other ecosystem services.

In terms of biodiversity, the selection of the site was based in large part on TNC’s ecoregional planning practices. These tools harness a wealth of ecological data and modeling activity designed to select the most ecologically important conservation targets. WSM emerged as a target due to both its inherent natural and biological characteristics (e.g., on-site biodiversity and rare plant communities) and its connectivity to a larger network of protected lands. Increased connectivity is ecologically valuable because it fosters the movement and migration of species over time, and thus promotes species resilience. Resilience is valuable because of expected stresses associated with climate change and land use pressures on the eastern seaboard. A challenge for conservation evaluation of the site (and thus for ROI analysis) is that the site contributes to the health of this much larger system. Ecological conditions on site do not, and will not, be enough to depict its contributions to biodiversity protection.

Like any protection investment, the return should be judged on the basis of how it compares to a predicted, or speculative alternative future scenario—the “counterfactual.” Effort has not to date been directed towards such a predictive analysis. However, WSM’s location, and the larger ecoregion’s location relative to development and commercial pressures, contributes to our intuition about the site’s value.

WSM is particularly notable for its commitment to landscape management experiments. In particular, the commitment to fire experiments and biodiversity monitoring will over the next decades allow us to measure the “biological returns to prescribed fire restoration.” These experiments require planning, coordination, and commitment of resources over long time horizons. These experiments are notable, in part because they are so rarely attempted.

WSM has also generated “returns” by influencing its partners in state and federal forest management. In particular, the Conservancy has used WSM and its fire experiments to promote partnership with the US Forest Service and state forestry programs. By including its own lands

and accepting management responsibility, TNC shared risks and thus promoted innovations by public land management agencies. In effect, TNC has leveraged the WSM fire program into a broader set of initiatives (the FLN) across the George Washington and Jefferson National Forests. Not only is prescribed burning now being conducted across a broader landscape (including outcome monitoring), but also TNC has been able to play an advisory role for upcoming National Forest plan revisions. These revised plans will govern national forest management practices over millions of acres for the next 15 years. While difficult to quantify, these leveraged outcomes should also be counted as returns to the WSM project.