The Nature Conservancy's Conservation Measures Working Paper[1] No. 2
Jensen Reitz Montambault and Craig R. Groves

Improving Conservation Practice by Investing in Monitoring Strategy Effectiveness

Executive Summary

Monitoring is an investment that The Nature Conservancy (TNC) makes in many of its conservation projects. Monitoring can demonstrate the success of our best strategies, or alternatively guide a change of strategy when we are not achieving intended outcomes. Historically, TNC focused most monitoring efforts on the status of conservation targets on nature preserves. As we have grown and matured as an organization, we have expanded our monitoring efforts to include strategy effectiveness measures (SEM). Investment in SEM must be balanced against what else might be done with these resources. In this document we provide some guiding principles for deciding how much to invest in SEM. The key factors are the potential for risk to the organization (ecological, reputational, legal, and the risk of uncertainty) and leverage (potential for replication and/or institutional learning). We use concrete examples to illustrate the interplay between these factors with monitoring costs ranging from minimal (<$500/year) to significant (>$100,000/year) investments[2].

Although management decisions made without science or data can turn out to be good decisions, applying SEM links decisions to the best available evidence, the nature of which depends on the circumstances. For example, in a low-risk project managers might be able to make good decisions about the effectiveness of stream restoration activities based on a series of photographs (a relatively modest monitoring investment). If, in contrast, managers needed to be able to prove in a court of law that their restoration activities caused a specific benefit to humans or salmon, such as improved water supply or seasonal flow, they might require a robust experimental design and detailed quantitative measurements of water quality and flows for the same stream (a more significant monitoring investment).

In many cases we are not only concerned about site-specific or project-specific outcomes, but generalizations about strategies. On average, does shade grown coffee advance the conservation of biodiversity? For such a global generalization, we systematically compare outcomes over many sites and synthesize the results in a way that guides overall investment in the strategy. As an organization with many projects in many places, TNC has a tremendous opportunity to contribute to global learning about conservation strategies via these systematic reviews that are called either meta-analyses, or evidence-based conservation. There can be spatial, ecological, funding, or capacity limits to the monitoring conducted at individual sites. If TNC funds are invested in monitoring, then protocols should follow the best scientific principles possible in the given circumstances. This way the results from each site can form one piece of critical information in a larger analysis intended to improve the global practice of conservation.

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[1] This series of working papers on conservation measures is intended to communicate important issues on measuring and evaluating our work to scientists, conservation practitioners, and program managers across the organization.
[2] All cost values in this paper are given in 2009 U.S. dollars.

Introduction

Evaluating the effectiveness of the Nature Conservancy's (TNC) conservation activities through monitoring is an investment. The return on this investment is information for making better management decisions and improving conservation practice. Monitoring can demonstrate that TNC's strategies have a real effect on biological and human communities. This increases funder and partner confidence in TNC's strategies and actions, which can leverage more opportunities for collaboration and support. Major philanthropic organizations such as the Gates Foundation[3] are increasingly demanding rigorous plans for assessing the effectiveness of actions. On the other hand, monitoring requires resources and is not always necessary. The first part of this paper provides guidance for when TNC should invest in monitoring and at what level. We then illustrate how this guidance might be implemented with TNC examples along a spectrum of monitoring investment.

Regardless of how much is invested in monitoring, this investment will be most cost-effective when there is a clear plan for applying the information that is gathered. The second part of this paper discusses matching the level of inference to the type of information (e.g., qualitative or quantitative) that is gathered. Less data or more qualitative data may be sufficient for a particular set of decisions or management questions. We present a schematic to aid in deciding between qualitative or quantitative sampling design, evidence-based or meta-analysis approaches, and higher- and lower-inference experimental design. Resources are always a limiting factor and it is thus always important to consider the minimum amount of data that is needed to evaluate and adapt a given strategy.

This paper focuses on monitoring for strategy effectiveness measures (SEM). The term SEM refers to the process by which we i) articulate the aim of a conservation strategy, ii) design good strategies with measurable objectives, iii) select and monitor indicators related to strategy implementation and impact, and iv) analyze this data and adapt strategies based on what we learn through monitoring (TNC 2008, 2009). SEM helps us gauge progress toward benchmarks and evaluate whether our conservation actions are having intended biological and socioeconomic impact (Stem et al. 2005, Salzar and Salafsky 2006). For example, SEM might answer, "How does our strategy to establish no-take zones in the Gulf of California affect reef fish populations and household incomes?"

Monitoring investments should increase with greater risk, or greater opportunities for leverage

Strategies with greater risk or greater potential for leverage (in this case learning and/or replicating a successful strategy across multiple projects) should include higher investment in monitoring. Figure 1 illustrates how these two factors interact to influence monitoring investment using several TNC examples. We consider four major kinds of risk. Does the project involve a significant *ecological* risk, such as a rare or endangered habitat, species, or system? Will this strategy present *reputational* risk, is it highly publicized, unusually expensive, or involve a partnership with non-environmentally-friendly organization? Do the results need to be

[3] http://www.gatesfoundation.org/about/Pages/our-approach-step-three-measure-progress.aspx

legally defensible? How *certain* are we of the strategy's outcome, and does uncertainty present significant risk? Values are relative because there is no established method for quantifying risk in conservation (Hummel et al. 2009). We also consider two major opportunities for leverage. Is this a *pilot* or *proof-of-concept project* intended to be replicated across TNC and partners? Does this activity present an opportunity for *institutional learning*, such as frequently applied strategy that lacks good data on its effectiveness?

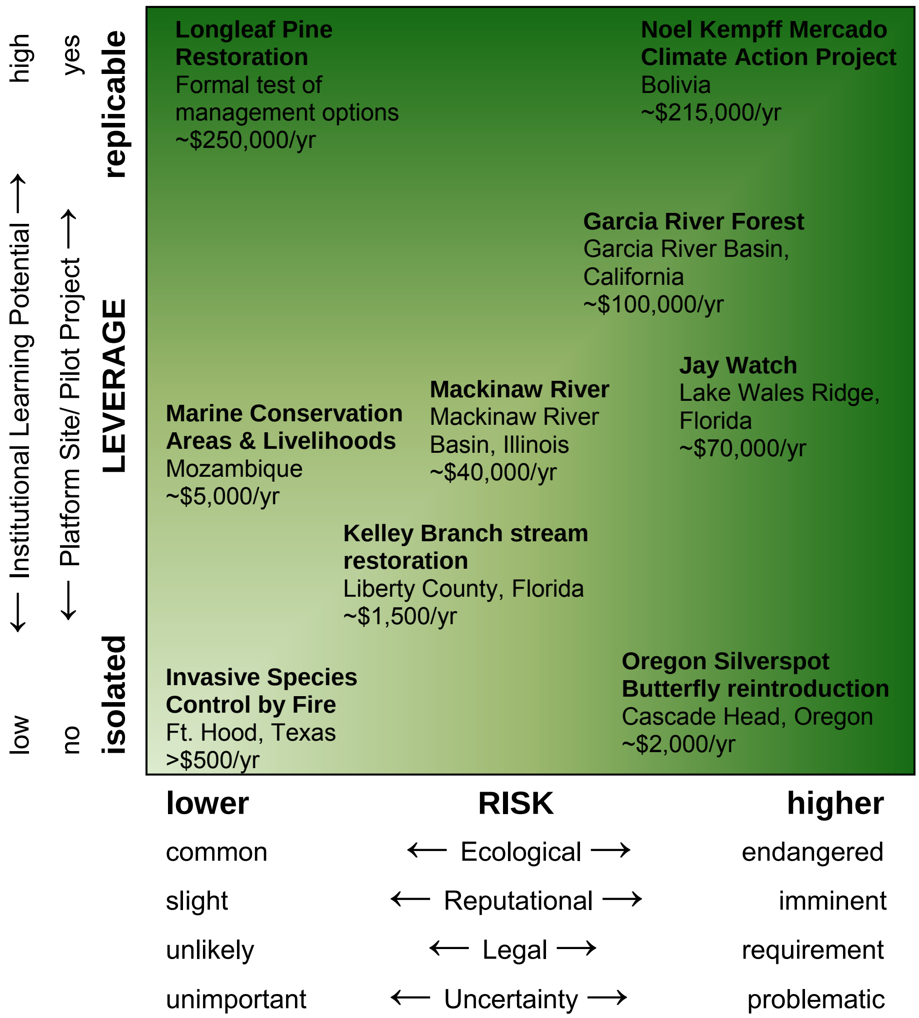

Figure 1. Potential risk and leverage influence the appropriate level of monitoring investment (framework after Theobald 2004). Darker green represents higher levels of investment.

Annual monitoring costs for evaluating the effectiveness of conservation strategies range from negligible to hundreds of thousands of dollars. Monitoring may have a minimal additional cost to TNC, taking advantage of staff time that is already paid for whether or not the monitoring occurs. For example, full-time technicians have been hired in Ft. Hood, Texas to conduct prescribed burns. The burn strategy is aimed at controlling encroachment of the invasive natives Ashe juniper and honey mesquite. A simple monitoring protocol has been integrated into the fire team's ongoing field work at no extra cost to TNC (Figure 1). By assessing the condition of these plants pre- and post-burn, the crew can judge each fire's effectiveness. Over time, this information helps managers to decide under what conditions fire should be applied to maximize conservation results.

A slightly higher level of investment was needed for Kelley Branch stream restoration on TNC lands in northern Florida. The strategy involved restoring a natural flow regime and reconnecting the stream to the Apalachicola River by removing a dam and culvert. The intent was to restore connectivity of process and movement of aquatic organisms. The degree to which fish and other organisms would recolonize the reconnected areas was uncertain. Data on the ecological response was needed to understand whether this strategy could be replicated across the region. Baseline conditions were established by partners before the dam removal was carried out. A standardized electroshock monitoring protocol is carried out a twice a year to assess fish community composition. Start-up costs included electroshock equipment that is shared among the chapter's freshwater programs. Recurring costs of monitoring requires a week of a staff scientist's time (~$1,500/yr). Following strategy implementation, the fish community shifted from one that is characteristic of stagnant water to one typical of a flowing stream. Of the many potential indicators of freshwater health, TNC scientists determined that sampling the composition of the fish community gave the best information for the cost.

Endangered populations have an inherently high ecological risk (i.e., extirpation) and also have legal monitoring requirements in the U.S. and some other countries. For example, the Oregon silverspot butterfly was once widespread in Pacific Northwest coastal grasslands and has been reduced to four populations. The population on TNC's Cascade Head preserve (Oregon) has been in severe decline, giving this project a higher ecological risk. An active adaptive management program identified potential strategies that might improve habitat for the butterfly, but attempts to implement have not yet been successful. As a stop-gap measure to prevent extirpation, TNC and the U.S. Fish and Wildlife Service, in partnership with local zoos, implemented a captive rearing and release program. The effectiveness of this strategy was evaluated through transect monitoring that requires two weeks of staff time plus travel (~$2,000/yr). Results showed that captive rearing and release is effective and is buying conservationists time to continue management activities focused on habitat improvement, which is ultimately what is needed to save the species.

One way TNC is growing as an organization is by increasing its emphasis on socioeconomic issues and conducting work through close partnerships. An example is a marine protected area strategy in Mozambique that combines creating marine reserves, controlling illegal fishing and diversifying livelihoods through sustainable agriculture. This project is a unique partnership with WWF and CARE and includes 24 fishing communities in northern Mozambique. While TNC hopes to learn and potentially leverage this strategy to other parts of Africa, risk is relatively low and investment of TNC resources is moderate at this time. Monitoring investment for conducting conservation audits and remote sensing analysis is correspondingly moderate (~$5,000/yr).

Another opportunity for institutional learning is represented by the Garcia River Forest project. The property is owned and managed by The Conservation Fund. TNC owns a Working Forest Conservation Easement on the property that prohibits development and prescribes that only sustainable forestry practices can be used. Working Forest Conservation Easements hold promise as a conservation strategy, but there is yet little concrete evidence that intended positive impacts will occur on the ground (Lindenmayer et al. 2006). This project's objectives include increasing timber volumes and late-seral forest structural elements with forestry treatments. It will also reduce the fine sediment load delivered to streams, improving conditions for salmonids over time through road upgrades and improved forest management. TNC is monitoring water quality indicators and forest condition to measure progress towards meeting these objectives. Results from this significant investment in monitoring (~$100,000/yr) will be used to inform future management and evaluate the effectiveness of the working forest easement agreement.

The Noel Kempff Mercado Climate Action Project in Bolivia, a collaboration of TNC and Fundación Amigos de la Naturaleza, is a significant leverage opportunity to advance a REDD[4] strategy. To avoid degradation from timber harvesting, project developers worked with the Government of Bolivia to close area logging concessions and incorporate the land into an existing national park. To avoid deforestation from agricultural expansion, project developers used a multi-faceted community development program targeting the areas of education, healthcare, sustainable employment alternatives, self-organization and land tenure. A comprehensive plan to monitor deforestation, degradation and socioeconomic impacts is in place. Monitoring and third-party verification have shown that between 1997 and 2005, the release of 1,034,137 metric tons of CO_2 was avoided by project activities. In 2005, Noel Kempff Mercado was the first forest emissions reduction project to be verified by a third party based on an adaptation of the Clean Development Mechanism[5]. Lessons learned from this pilot project are being leveraged worldwide, helping inform REDD projects developed by TNC and other organizations, as well as project standards like the Voluntary Carbon Standard. Given the high risk of uncertainty and high potential for leverage, this work required a substantial investment in monitoring (~$215,000/yr).

Strength of inference needed for conservation decisions

Efficient monitoring requires managers and scientists to work as a team to identify the strength of inference needed to answer conservation questions. Figure 2 presents two important questions for the team to answer. To address these questions, programs must have already articulated the purpose of a conservation strategy and designed good strategies with measurable objectives through a Conservation Action Plan[6] (CAP) or other strategic planning process. The first question is, "Do you need to establish cause-and-effect or ascertain which of multiple strategies works best?" If so, then it is important to invest in a monitoring plan with robust experimental design and analysis. Experimental designs are stronger when they use controls, replicates and other methods to account for variability in the system (see Table 1). These designs have a higher strength of inference, meaning the results of this monitoring can be applied more broadly than to what is actually being measured, and will be more compelling to skeptical evaluators or critics.

The Mackinaw River watershed in Illinois, U.S. is an example where investing in experimental design yielded good information to inform management decisions. The high biodiversity of the this watershed (see Figure 1) is threatened by nutrient run-off and changes in hydrology due to

[4] Reduced Emissions from Deforestation and Forest Degradation
[5] The Clean Development Mechanism provides for entities from economically developed nations to offset their greenhouse gas (GHG) emissions by investing in GHG emission reduction projects in developing nations.
[6] http://conserveonline.org/workspaces/cbdgateway/cap/index_html

common agricultural practices. Through a best-management practices (BMP) outreach strategy, TNC successfully convinced farmers to use grass waterways, riparian buffers and reduced tillage planting. However, monitoring of water quality and other biological indicators showed no difference between the BMP watershed and a control. These results suggest that the strategy was ineffective at addressing the threat and the Mackinaw River team has adapted their strategy. They are now investing in a more expensive strategy of creating wetlands to reduce nutrient run-off and improve hydrology. The design would have stronger inference if the strategy had been replicated over multiple watersheds, but only at great cost. The ideal use of replication and controls is not always possible in conservation. For instance, when dealing with a single remaining population or an isolated ecosystem, replication or controls may be infeasible.

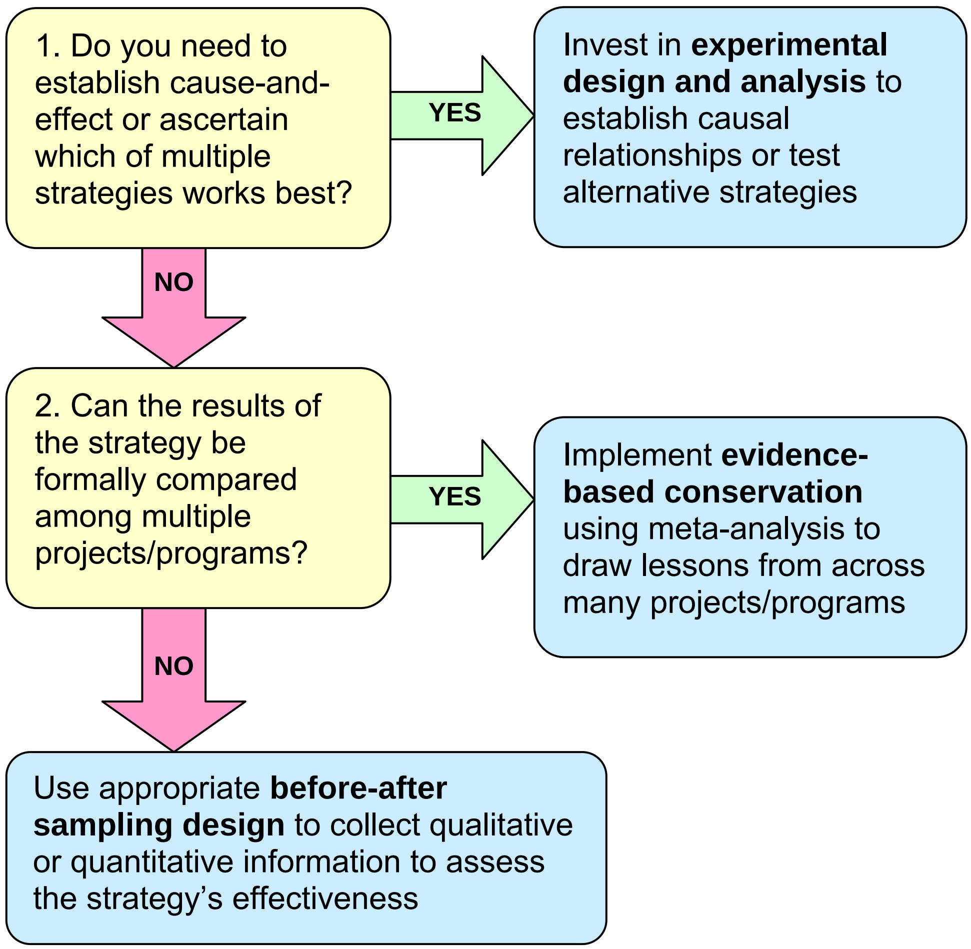

Figure 2. Selecting a design for applying monitoring information to management decisions.

Replication of conservation strategies is very different than a laboratory setting, sometimes making it challenging or impossible to set up good controls. For example, the Indonesia program wanted to know whether it was worth investing in conservation areas in East Kalimantan. Managers asked, "How much deforestation would have occurred if TNC had not initiated any conservation programs in East Kalimantan's rainforest?" Scientists examined deforestation rates in 5 conservation areas and 40 randomly selected control sites facing similar threat levels. They found that deforestation rates were not statistically different among treatments (protected areas) and controls (non-protected sites). This was due to high variation among control sites, suggesting that threat level or other classifications needed to be improved. In addition, the conservation areas were not exact strategy replicates. Two were TNC field sites, two Forest Stewardship Council certified timber concessions, and one a national park without TNC involvement.

Table 1. Choices for monitoring design and analysis based on the level of inference needed to improve conservation practice.

Monitoring and Analysis Design	**Strength of Inference**					**TNC Examples (details in text)**
	Inference Score [a]	Treatment controlled by observer	Replicated treatments	Control group	Randomized treatments [b]	
Before-after sampling design	1	+	–	–	–	Jay Watch – compares data before and after implementing strategy at 67 sites. Scope: Not attempting to apply results beyond sites.
Evidence-based Conservation	2	+	+	–	–	Conservation Easements – meta-analysis of the results of monitoring 119 TNC easement projects. Scope: Attempting to assess the easement strategy across TNC.
Experimental design and analysis	2	+	–	+	–	Mackinaw River – monitoring in paired watersheds, one treatment (where strategy was implemented) and one control (where strategy was not implemented). Scope: Not attempting to extend conclusions beyond these watersheds.
	3	+	+	+	–	Borneo Forest Conservation – Compare reduction in deforestation rate in 5 conservation areas to 20 randomly selected control sites. Scope: Beyond conservation areas, but limited to Borneo.
	4	+	+	+	+	Longleaf Pine Restoration – Comparing the effectiveness of burning, herbicide, and mechanical treatments. Scope: Testing the effectiveness of management strategies for wide replication.

a) 0 = no ability to demonstrate a causal relationship, 4 = strong evidence of causal relationship (adapted from James and McCulloch 1995). b) Random application of treatments is rare in conservation (Ferraro and Pattanayak 2006).

In some cases, it is necessary to formally test different management options using a robust experimental design (McCarthy and Possingham 2007). This conservation-oriented research can be costly in terms of funding and effort, but the results can lead to more efficient use of conservation resources. This is particularly important for leverage strategies which will be replicated throughout TNC and partners. One example within TNC was formal testing of longleaf pine restoration management techniques at Eglin Air Force Base, Florida (Provencher et al. 2007). The experimental design tested the effectiveness of three hardwood reduction techniques (fire, herbicide, mechanical) and a no action alternative. A randomized complete block design (a specific type of experimental design) used 81 hectare plots of similar habitat in the northern section of the base. The results of the four treatments were compared to reference plots that were functional longleaf pine ecosystems with consistent fire management. This comparison directly addressed managers' need to identify treatments that most rapidly restored altered sandhills to the desired reference condition. Results indicated that repeated prescribed fire was generally the most cost-efficient restoration strategy. Scientists were also able to demonstrate specific management conditions and objectives under which the high cost of other strategies would be worthwhile. This intensive monitoring and formal testing was expensive (~$250,000/yr), but the information learned was applicable to multiple taxa in longleaf pine systems across the southeastern U.S.

If robust experimental design and analysis is not possible or necessary, the second question that Figure 2 addresses is, "Can the results of the strategy be formally compared among multiple projects/programs?" If so, we learn broad lessons about what works across multiple case studies through Evidence-based Conservation (EBC)[7]. EBC promotes evaluating strategy effectiveness by systematically documenting conservation results and reviewing published studies (Pullin and Stewart 2006). Venues for sharing TNC case studies include:

1) ConserveOnline[8], an open-access website for posting documents and publicizing case-studies for the conservation community,
2) ConPro[9], a searchable database for TNC and partner projects, and
3) *Conservation Evidence*[10], an online peer-reviewed journal for EBC.

Projects and programs with similar methods and indicators can be statistically compared through a meta-analysis. This helps us learn under which conditions a strategy functions best so we know when or whether to apply it again. For example, TNC conducted a meta-analysis of the effectiveness of conservation easements by assessing 119 easements across TNC. The results indicated that too few easements had a quantitative monitoring program to reliably evaluate their effectiveness (Kiesecker et al. 2007). This quantitative analysis identified a needed change in TNC's management of conservation easements.

Not every strategy should be tested through robust experimental designs or formally compared across multiple projects or programs. Sometimes there are spatial or ecological limits on using controls or replicates. Funding and staff capacity for monitoring may be limited. In other occasions, the management questions can be satisfied without this level of monitoring design and analysis. It is essential to still follow the principles of critical thinking and standardized approaches to collecting and organizing data and reporting on results. These best business practices promote transparency and accountability and facilitate replication or application of EBC in the future.

For example, the TNC Florida (U.S.) chapter would like to improve conditions for the federally threatened Florida scrub jay. One conservation strategy is to make recommendations to public land managers interested in improving scrub jay habitat. The chapter coordinates a Jay Watch program where over 200 volunteers monitor the jays on 67 tracts of separately managed land. A Florida staff member checks the quality of volunteer-generated data against 3 sites surveyed by professional biologists and uses the information to recommend management action. The trend data from seven years of monitoring provides correlative evidence for site-based adaptive

[7] http://www.cebc.bangor.ac.uk/ebconservation
[8] http://www.conserveonline.org/
[9] http://conpro.tnc.org/
[10] http://www.conservationevidence.com/

management of jay habitat. Because different strategic actions are carried out at each site, the results cannot be extrapolated beyond the sites. This level of inference satisfies management needs and fits within reasonable budgeting and fundraising possibilities for the Florida chapter. Information collected was both quantitative (i.e., number of birds) and qualitative (i.e., position of family groups on hand-drawn maps).

Conclusions

Monitoring at TNC has its roots in assessing the populations of species and the condition of ecosystems on nature preserves. We now apply a broad spectrum of conservation strategies throughout the globe. Through these strategies we seek to influence both ecological and interdependent human systems. We use monitoring to gauge the effectiveness of our conservation strategies at influencing these systems. The details of any monitoring plan depend on the system and the options available for conservation practice. Our research into monitoring programs has elicited four key principles of monitoring:

1) *Monitoring costs range from very inexpensive to a significant investment by TNC.* For example, the Alabama Chapter is monitoring the effects of dam removal on mollusks and fish in the Cahaba River. It organizes 20 partners who donate time, travel and equipment (equivalent to ~$10,000/yr) to this effort. After four years, snail species indicative of a natural freshwater system have increased up to 5,000 times pre-dam-removal densities. One disadvantage is that the decision to conduct monitoring in a given year may not be under TNC's control. A strategy representing more significant financial investment, risk or potential for leverage, might require TNC to assume more of the monitoring costs.
2) *Interpreting monitoring results does not necessarily require statistics.* TNC field staff and community partners are monitoring spawning aggregation sites of three species of grouper in New Ireland (Papua New Guinea - PNG). Five years after sites were placed under *tambu*, a traditional fishing ban, fish density and area of the aggregations have both increased dramatically. In an ideal academic world, there would be more replicates and control sites for comparison. In the real world of conservation, less formal sampling was conducted at controls (non-*tambu* sites facing similar threat levels). Fish populations at similar sites without a *tambu* have not recovered during the same time period. These informal controls provide adequate evidence to managers that improvements at *tambu* sites were due to conservation actions, not environmental factors. Monitoring was critical to defining closed seasons for fisheries management and assessing effectiveness of the community-based customary management strategy in PNG.
3) *Conclusions from a thoughtful monitoring program are relevant to day-to-day conservation management.* Monitoring strategy effectiveness allows us to track progress toward goals and adapt our strategies if progress is not being made. That said, we cannot and should not monitor everything in our CAP, results chain[11], or other strategic thinking framework. Our time and money are precious. There is no point in tediously counting species or tracking project activities if nothing will be altered by the data gathered. We should first decide how much effort should be invested in monitoring based on a project's potential for risk and replication. Then we determine the level of inference required to answer managers' questions. This combination of appropriate levels of investment and

[11] http://conserveonline.org/workspaces/cbdgateway/documents/strategy-effectiveness-measures

inference should guide the selection of practical indicators that answer managers' questions.

4) *Implementing best monitoring practices for all levels of investment and inference is good for TNC as an organization.* By implementing best monitoring practices in any project, the organization
   a. Confirms to the public, our partners, donors and ourselves that we are a science-based organization
   b. Gathers and use the best evidence available for making thoughtful decisions about our conservation strategies
   c. Contributes to improving the practice of conservation by developing well-supported stories of conservation success
   d. Documents planning logic and evaluation data, which can contribute to future endeavors to evaluate strategies across projects and organizations.

   In the future, the measures page on the Conservation by Design Gateway[12] will be a repository for TNC monitoring stories and examples. This working paper series will also provide additional guidance on designing efficient and informative monitoring programs.

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Additional Contact Information

For suggestions and questions related to monitoring at TNC, please contact Jensen Montambault (jmontambault@tnc.org).

For more information on examples of TNC projects in this paper, please contact: Borneo Forest Conservation – Lenny Christy, Cahaba River dam removal – Paul Freeman, TNC Conservation Easements – Joe Kiesecker, Garcia River Forest – Jen Carah, Invasive Species Control by Fire – Charlotte Reemts, Jay Watch – Cheryl Millett, Kelley Branch stream restoration – Steve Herrington, Longleaf Pine Restoration – Louis Provencher, Mackinaw River – Jim Herkert, Marine Conservation Areas & Livelihoods – Matt Brown, New Ireland spawning aggregations – Rick Hamilton, Noel Kempff Mercado Climate Action Project – Nikki Virgilio, Oregon Silverspot Butterfly reintroduction – Deb Pickering.

[12] http://conserveonline.org/workspaces/cbdgateway/documents/conservation-measures

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