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# 2

# Using Limiting Factors Analysis to Overcome the Problem of Long Time Horizons

*Raymond Gullison, Jared Hardner*

**Abstract**

*In recent years, donors to biodiversity conservation projects have sought greater accountability, using professional evaluators to help assess the degree to which grantees are achieving conservation objectives. One of the most formidable challenges evaluators face is the time required both for ecological systems to respond to management interventions and over which grantees must maintain their biodiversity conservation gains. The authors present a simple methodology, called* limiting factors analysis, *which was developed during the course of evaluating several large portfolios of conservation projects. The method is a practical basis for rapidly assessing whether current conditions are likely to prevent grantees from achieving their long-term objectives. Use of the methodology is illustrated with examples from recent evaluations of the Andes Amazon Initiative and the Columbia Basin Water Transactions Program.* © Wiley Periodicals, Inc.

Biodiversity conservation projects attempt to halt or reverse the loss of the world's species and ecosystems through diverse activities, including restoring natural habitats, creating incentives for less destructive natural resource use, reintroducing species into areas where they have disappeared,



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and managing protected areas. Biodiversity conservation receives substantial support from philanthropic and government funders in the United States and abroad. For example, James, Gaston, and Balmford (2001) estimated that approximately $6 billion was spent annually managing the global protected areas network in the mid-1990s. Over the past decade, both donors and conservation practitioners have shown increased interest in monitoring the effectiveness of these investments (see Hockings, 2003; and CMP, 2008, for some examples).

There are various methodological challenges to evaluation of biodiversity projects and programs. In this chapter we draw on our recent experience in evaluating large biodiversity conservation programs to discuss a pragmatic approach we have used to overcome one such obstacle: the long time horizons that evaluators must grapple with when considering the merits of the biodiversity programs they are evaluating.

An obvious problem that the sometimes slow pace of ecological change can cause for evaluators is that the impacts of anthropogenic activities—both good and bad—can take a very long time to manifest. It may take decades or even hundreds of years to fully restore certain types of ecosystems or to recover a species. For example, the official recovery plan for the red cockaded woodpecker (RCW) describes a detailed series of measures that experts feel will be sufficient to prevent the species' extinction in the Southeastern United States (USFWS, 2003). Even with the substantial effort implied by the plan, the recovery team does not expect to remove the RCW from the endangered species list until 2075—nearly 100 years after formation of the original recovery plan. The problem that these long time horizons present for evaluators is clear. The current condition of a species or ecosystem may offer few clues as to the long-term success of the management actions that are the focus of the evaluation.

A related problem is that the one-to-three-year duration typical of funding for biodiversity conservation activities is usually much shorter than the time horizons relevant to biodiversity conservation projects. Evaluations conducted with the primary purpose of demonstrating accountability to donors must somehow deal with the disparity in time horizons between the funding they have awarded and the time required for ecological systems to respond.

A final problem is that even if ecological change does occur over a short time period, many of these gains need to be maintained in perpetuity if they are to have value. The long-term likelihood of success of a conservation program must therefore be a paramount consideration in the evaluation.

Of course, long time horizons are not a problem unique to evaluation of biodiversity conservation projects. However, well-designed, statistically rigorous trials available in other fields (e.g., medical trials; see Everitt and Pickles, 2004) are challenging to implement for biodiversity conservation projects. Among the reasons are (1) insufficient resources available to set up and monitor trials and (2) difficulty in selecting appropriate control sites and replication because of the unique nature of species and ecosystems.

Furthermore, because of the long time horizons required to see ecological change, it will depend on the conservation practitioners themselves, rather than the evaluators coming in at a later date, to set up long-term trials and conduct ecological monitoring. However, our experience is that few conservation practitioners are creating the conditions that would allow for a meaningful evaluation of impact at a later date. The urgency of implementing conservation actions and a general shortage of resources mean that allocation of resources to collecting baseline information, performing ecological monitoring, and conducting internal evaluation and formal adaptive management is typically meager, and we do not see strong indications that this situation is likely to change, at least in the near future.

Yet these obstacles must not be used as an excuse to avoid evaluating biodiversity conservation projects (Sutherland, Pullin, Dolman, & Knight, 2004; Ferraro and Pattanayak, 2006). Resources for conservation are scarce and must be allocated to greatest effect. Evaluation can help make the most of the limited resources available for biodiversity conservation.

## Limiting Factors Analysis

The remainder of this chapter describes an approach to evaluating biodiversity conservation projects that helps address the problem of long time horizons. The basis of the approach is to work with the donor and grantees to develop a common understanding of the key factors that must be assessed, and if necessary (and possible) managed, for the biodiversity conservation project or program to be viable over the long run. This is a simple and qualitative approach to forecasting, with the goal of identifying currently unmanaged factors that are likely to prevent the grantee from achieving its objectives. We call this approach a "limiting factors analysis," borrowing the term *limiting factor* from the agricultural and ecological literature (van der Ploeg, Bohm, & Kirkham, 1999), where its use refers to the factor or factors that have the greatest influence in limiting the growth or abundance of an organism. In a similar spirit, we use the term to refer to those factors that present the greatest threat to a biodiversity conservation project.

Many factors may limit the ability of a conservation project to achieve its long-term conservation objectives, among them financial, policy, scientific, and social factors. These limiting factors may extend well beyond the boundaries of the project itself, requiring grantees and evaluators to consider the broadest possible context in which the conservation project is taking place. Thus evaluators must attempt to get the big picture and assess whether everything necessary is being done to reduce both short- and long-term risks to the conservation target, even if it is beyond the scope of what many would consider to be the grantee's normal activities.

We have found a consistent list of limiting factors relevant to a broad range of project types and ecological systems:

- *Scientific understanding* that is inadequate to formulate appropriate management actions to sustain the conservation target
- *Public policy* that does not support conservation of the target
- *Legislation* that does not offer sufficient legal protection to the conservation target
- *Institutional capacity* that is inadequate to perform conservation activities
- *Economic pressures* that cause destruction of the conservation target
- *Enforcement* of laws and regulations that is inadequate to implement the legislation on the ground to protect the conservation target
- *Stakeholder support* that is inadequate to conserve the target
- *Short-term funding* that is insufficient to establish an adequate level of conservation management, including capital expenditures on equipment and infrastructure
- *Long-term funding* that is inadequate to support the recurrent costs of conservation management activities

Although some categories may not be fully independent (e.g., legislation obviously influences enforcement, and availability of finance underpins institutional capacity), each category brings unique information for consideration. This list has been for us a useful starting point for evaluating a spectrum of biodiversity conservation programs in numerous locations.

We follow a three-step process to customize the list of limiting factors for each evaluation.

*Step one: identify limiting factors.* First, we ask grantees, stakeholders, and experts to review the core list of limiting factors and suggest the addition of other limiting factors, as appropriate to their project. This step yields a list of limiting factors as specific as possible to the program being evaluated. However, if a program has many project types, then the limiting factors must be defined very broadly (see Case Studies in the next section).

*Step two: score limiting factors.* Next, we work with grantees and others to rank the status of each limiting factor when the grantee began its activities (a retrospective baseline), and then again at the time of project completion (or point of evaluation, if grants are ongoing). We use a small number of coarse ordinal scoring categories ranging from "presenting a complete impasse to conservation" to "does not limit conservation in any way."

*Step three: understand the management response.* We then ask grantees and others to identify all of the entities (conservation groups, government agencies, and so on) that are working at overcoming the various limiting factors, their source of funding, how they are going about it, and their likelihood of success.

It is useful at this stage to consider whether limiting factors are internal or external to the project. Internal factors result from the activities of grantees (failure to carry out the necessary science to support project activities, insufficient engagement with project stakeholders to secure their

support for a project), while external factors derive from outside of the boundaries or limits of the project (for example, economic forces causing habitat and species loss). Grantees must also consider the degree of control or influence they have on the limiting factor. The time horizon is an important consideration here; as an example, over a short time period of one or several years grantees may have little influence over a particular piece of counterproductive legislation. However, over a longer time period grantees may in fact be able to work with others to influence legislators and effect change.

A particularly important class of limiting factors is external factors that are a serious or complete barrier to the long-term conservation of the target, and over which the grantee has no influence. If these factors exist, and if grantees cannot change their own activities to reduce the impact of these factors, donors and grantees may question whether the project is worth continuing.

Information gained through site visits and interviews with independent stakeholders of the projects allows us to verify the information gained in steps 1 through 3. Application of the limiting factor analysis permits a number of useful observations:

- At the project level, it helps us understand how strategic grantees have been in prioritizing their activities, and the progress they have made on the limiting factors they are working on.
- At the site level, it helps us understand whether all the important limiting factors are being addressed, or whether important unmanaged limiting factors or weak links of the chain remain that threaten conservation at the site.
- At the program level, it helps us understand whether the program has a balance of project types that are an appropriate response to the most important factors limiting the conservation of the target, or whether some rebalancing would be beneficial.

Of course, situations are dynamic, and even if a project, site, or program receives high marks for resolving limiting factors this does not guarantee that it will achieve its long-term biodiversity conservation objectives. The exercise is, however, very useful in identifying situations where the converse is true, namely, identifying situations where conservation gains are unlikely to materialize or be sustained over time because of the failure of a grantee to address factors that are limiting the conservation of the target.

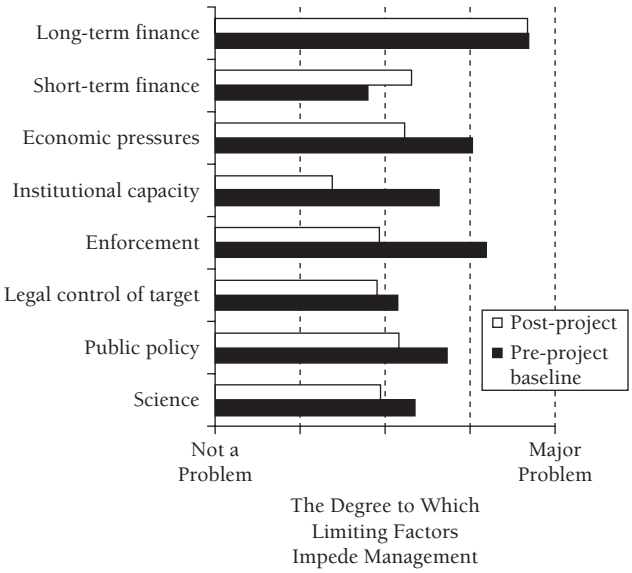
## Case Studies

We illustrate the utility of the limiting factors analysis with several examples. The first is our evaluation of the Gordon and Betty Moore Foundation's Andes Amazon Initiative or AAI (Hardner et al., 2006). AAI seeks to contribute to the preservation of the biodiversity and hydrologic function of the

Amazon Basin. Failure to maintain a critical threshold area of forest cover may put the entire basin's hydrology and biodiversity at risk (Shukla, Nobre, & Sellers, 1990). At the time of the evaluation, AAI had determined that an additional 140 million hectares of protected areas were needed, and that effective management of the basin's entire protected area complex would need to be put in place, presumably in perpetuity.

Only time will tell whether the objectives of creating and effectively managing enough protected areas to conserve the basin's biodiversity and hydrologic cycle are achieved. At this early stage in the program, a major goal of the evaluation was simply to determine whether there were unaddressed limiting factors that would raise doubts as to whether AAI and its grantees could achieve their goals. We developed a list of factors relevant to AAI projects that were capable of limiting or even preventing long-term conservation of individual protected areas (these are the same as the core list presented above). We then surveyed grantees, interviewed project stakeholders, and visited project sites to score each limiting factor before and after AAI's investment at all of the sites where its grantees worked (Figure 2.1). This identified those factors grantees were successfully managing (for example, enforcement of conservation laws and building institutional capacity) and those that grantees were not (such as securing adequate short- and long-term financing). It also identified the factors most likely to prevent achievement of long-term objectives, the most important of which was the inability of grantees to secure adequate financing for long-term management

**Figure 2.1. Progress on Limiting Factors Made by Grantees in the Andes Amazon Initiative (AAI)**



of the sites. These findings led to specific oversight and monitoring suggestions for the program, including development of a long-term financing strategy to support protected areas in the region.

Our 2006 evaluation of the Columbia Basin Water Transactions Program (CBWTP) is the second example of use of the limiting factors methodology (Hardner & Gullison, 2007). The CBWTP is a partnership between Bonneville Power Administration and the National Fish and Wildlife Foundation (NFWF). The goal of CBWTP is to support nongovernmental organizations and state agencies in acquiring water rights for the benefit of salmon and other fish species in the Columbia Basin, located in the northwestern United States. CBWTP's grantees are experimenting with various types of innovative water transactions and seeking to integrate their efforts with those of other groups working on other aspects of habitat restoration that together will lead to fully restored fish habitat.

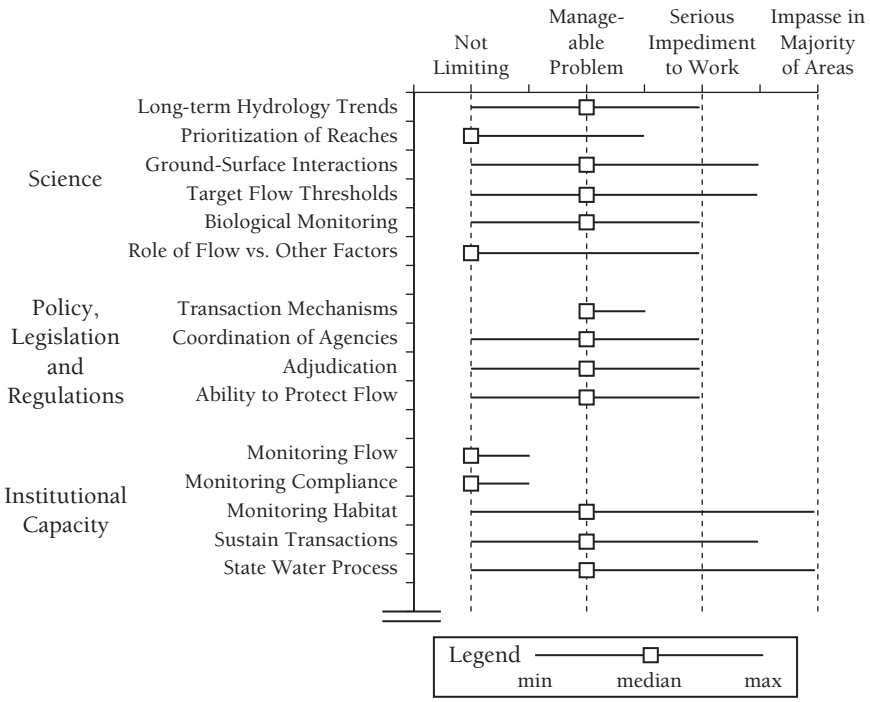
A key focus of the evaluation was to examine the potential of CBWTP to scale up and address the water flow needs of all priority rivers and streams in the Columbia Basin. The youth of the program made addressing this question challenging. At the time of the evaluation the program was only in its fourth year, which was too early to demonstrate ability to implement water transactions on a large geographic scale, or demonstrate that it could maintain biologically significant water flows over a long period of time. The limiting factor analysis was very helpful in anticipating CBWTP's ability to grow to the scale it desired. Working together with grantees and program staff, we developed a list of limiting factors relevant to the CBWTP program. Because grantees worked in the same basin and conducted similar activities, we were able to develop a list of limiting factors that was much more detailed than in the case of the AAI, though the broad categories of limiting factors were very similar. The grantees then rated each limiting factor for subbasins where they worked.

The results (partially shown in Figure 2.2) clearly identify those factors that grantees have effectively mastered (such as the ability of grantees to monitor water flow and other aspects of compliance to the transactions), and those factors that are creating a serious impediment or impasse to work for the majority of grantees (poor coordination of donor support, high transaction costs) and hence are presenting barriers to scaling up the number of water transactions in the Columbia Basin and beyond. The evaluation concluded that none of the factors most limiting grantee efforts pose insurmountable problems, but they do demand increased attention from both grantees and program staff alike if CBWTP is to reach the scale it desires.

## Discussion

The limiting factor analysis is not a stand-alone approach. It is meant to complement other evaluation approaches, such as assessing the scientific basis of project activities, the degree to which project activities are

**Figure 2.2. Some Factors Limiting the Ability of Columbia Basin Water Transactions Program (CBWTP) Grantees to Expand Their Work**




adequately resourced and implemented, and the degree to which projects address conservation priorities. As we have attempted to demonstrate in this chapter, the role of limiting factors analysis is to help us anticipate or forecast the long-term fate of biodiversity conservation projects. It does this by assessing the extent to which practitioners have identified and are managing (if possible) the full range of social, economic, ecological, and other factors that might jeopardize the project and threaten its long-term viability. As such, it is one way of at least partially addressing the problem that the long time horizons characteristic of biodiversity conservation projects present to evaluators.

Our approach has evolved independently of, but has much in common with, other evaluation approaches that attempt to assess the degree to which conservation practitioners are adequately diagnosing and managing the factors influencing the outcome of their projects. Salafsky and Margoluis (1999) and Hockings (2000) usefully review other threat-based approaches to evaluation of biodiversity conservation projects. The Threat Reduction

Assessment (TRA) presented by Salafsky and Margoluis (1999) is perhaps one of the best known. Both TRA and the limiting factor analysis ask grantees to systematically assess the immediate importance of specific threats to the sites where they work and judge the effectiveness of their response to them. However, the TRA is a more formalized process, meant as an in-depth management planning tool for specific sites, in addition to acting as the basis for assessing the effectiveness of management of these threats. Our limiting factor analysis should be considered more as a process, designed for evaluators, grantees, and other stakeholders to rapidly gain an understanding of the context in which grantees are working (the limiting factor list can often be developed in an afternoon with grantees and other stakeholders), often across broad portfolios of hundreds of project types. Another difference between the two approaches is that the TRA normalizes threats and threat reduction at every site with a threat reduction index. This is a very useful approach for grantees for every site to identify priority actions. In contrast, our approach does not normalize scores, which is useful for donors who may wish to compare conservation needs across sites (rather than within a site) when deciding how to prioritize their investments. A final difference is that TRA focuses on current direct threats to biodiversity (such as logging and hunting that are actually taking place). In contrast, the limiting factor analysis casts its net broader and farther into the future by also including other factors such as long-term financing and the policy and legal framework that will ultimately determine the ability of a biodiversity conservation project or program to manage any and all threats that appear down the road. This is a particularly important difference because as evaluators we need to anticipate the long-term fate of projects, not just consider how they are responding to current challenges.

The limiting factors analysis also has features in common with empowerment evaluation (Fetterman, Kaftarian, & Wandersman, 1996). Both approaches engage program participants to develop a framework for evaluating past program performance. However, the emphases of the two approaches differ. In combination with other methodologies, we use limiting factor analysis as a methodology to contribute to an accurate understanding of a program's true impact to date, and we build in considerable third-party consultation to both develop the limiting framework and verify the status of limiting factors. In contrast, the goal of empowerment evaluation is to engage mainly program participants, particularly those whose voices are not necessarily heard or valued as much as those in power, in a forward-looking strategic planning and adaptive management process.

We cannot see any reason in principle for the limiting factor analysis methodology not to be useful in other environmental fields where similar approaches do not already exist. One obvious application is helping to assess the long-term sustainability of natural resource management, such as forests or fisheries. In fact, the certification standards that have evolved to

assess the sustainability of some natural resources (e.g., the Forest Stewardship Council standards for forest management) include a comprehensive list of social, economic, and environmental limiting factors that must be met for a particular managed forest to be certified. A similar extension can be made to other areas of practice in the public and nonprofit sectors where donors and grantees operate on a short-term time frame directed toward long-term results.

We find that the limiting factor methodology evolves and improves with every new application. One area where we seek further improvement is in developing ways to reduce the subjectivity of grantees and stakeholders in scoring the extent to which particular factors are impeding conservation at their sites. This may best be accomplished by coming up with increasingly detailed and objective criteria for every possible score that can be assigned to the limiting factors. It is particularly important that grantees at different sites interpret the rankings consistently if the results are to be compared across sites, and that diverse voices be included in the process to ensure that all relevant factors are identified and considered. When the evaluation budget and scope allows, we reduce subjectivity by verifying grantee ratings with site visits and interviews with project stakeholders. In the future, we will also seek validation of the approach itself by comparing the fate of biodiversity conservation projects having unmanaged important limiting factors with the fate of those projects that were characterized in earlier evaluations as effectively managing their limiting factors.

In conclusion, we look forward to the day when grantees are able to integrate more sophisticated evaluation and monitoring into their own projects, including ecological monitoring of their conservation targets, and when grantees have track records commensurate with the time horizons required to detect changes in natural systems. Until that time, however, we have to rely on pragmatic approaches such as the one described here to evaluate grantee accomplishments and understand the long-term likelihood of success.

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*RAYMOND GULLISON and JARED HARDNER are partners in the private consulting firm Hardner & Gullison Associates, based in New Hampshire. Gullison is also an honorary research associate at the Centre of Biodiversity Research at the University of British Columbia in Vancouver.*