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Allocating Resources Between Taking Action, Assessing Status, and Measuring Effectiveness of Conservation Actions

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ABSTRACT: Millions of dollars are spent annually on biodiversity conservation projects at natural areas around the world. Managers of natural areas must achieve a balance between taking conservation action, evaluating the effectiveness of actions taken, and monitoring the general status of biodiversity conservation targets and the threats they face. Conservation practitioners often struggle with decisions regarding the allocation of limited resources among these competing needs. Many conservation projects have only a limited monitoring component while other projects have an inexplicably high investment in a single type of monitoring. We offer a conceptual framework to help guide conservation practitioners towards a logical allocation of resources between taking action and different types of monitoring depending on the situation that they are facing. The framework consists of a decision tree that includes an explicit evaluation of three questions: (1) Are there substantial threats facing the conservation entities?; (2) Are there clear and feasible actions known to be effective at abating identified threats?; and (3) Does the project team have high confidence in their understanding of the overall conservation situation? Based on this tree, we present five scenarios that illustrate a range of logical allocations of resources between taking action and different categories of monitoring.

Index terms: conservation planning, monitoring, resource allocation

WHEN MONITORING AND EVALUATION GOES WRONG

Monitoring and evaluation (M&E) is the process of periodically collecting and using data to inform management decisions. There is currently a great deal of interest among practitioners and financial donors in developing and implementing M&E systems for conservation projects at all scales. M&E is vital for helping natural area managers get the information they need to improve their work. It is also essential for helping donors to assess the return on their investments.

Unfortunately, M&E activities can hinder rather than improve conservation when they fail to alert management to problems or when resources spent on M&E divert scarce resources from critical management priorities (Sheil 2001). Conservation practitioners often struggle with determining the right level of investment to make in their monitoring work. Several common problems are illustrated in the following cases, which, although fictitious, are composites drawn from real-world situations.

Case #1: Funding Basic Research In the Name of Monitoring

A non-profit organization is working with the government to manage a large tract of remote Alaskan wilderness. At the moment, there are no known threats to the conservation targets in the reserve, which is largely inaccessible for most of the year. The two senior scientists involved with the reserve both studied caribou biology for their Ph.D research. To this end, the scientists develop an elaborate and expensive research study to monitor long-term caribou populations, convincing their superiors that the caribou are an important indicator for monitoring the health of the park. Although the studies are published and well received, data are never used to make any management decisions….

Case #2: A Stitch in Time Could Have Saved Nine

A non-government organization (NGO) is working with a local community to promote coral reef conservation on a small island in the Pacific. The community has been harvesting fish and marine resources from nearby coral reefs for generations. As the NGO considers how to allocate their limited resources, they decide they do not need any fisheries monitoring. Their rationale is based on the steady total harvest levels over the last 10 years. Unfortunately, the steady harvest levels are a consequence of annual increases in fishing effort each year that mask declining populations of the harvested fish species. Undetected population declines continue until the fish populations suddenly begin to crash, making management efforts dramatically more difficult….

Case #3: Collecting Way Too Much Data Instead of Taking Action

An international NGO is attempting to pre-

serve a large remote tract of intact rainforest in the Amazon Basin. The primary threat is clearcut logging by large multinational companies that are currently working in other regions of the country. The project team, having been admonished by their organization to focus on monitoring and evaluation, duly begins a regular regime of identifying animal and plant species, surveying bird populations, tagging trees, counting hunting parties, sampling water quality, and tracking resource extraction permit applications. All of these data are put into an electronic database back at the NGO's headquarters, which gets bigger and bigger. Then the project runs out of money. A few years later, a technician cleaning up the computer notices this big data file that has not been modified and moves it to an archive….

Case #4: All Action and No Reflection

An invasive perennial grass is invading a network of small wetland natural areas throughout an ecoregion and creating monotypic stands. Conventional wisdom points to a single strategy that most land managers are implementing – treat the invasive stands with herbicides in June at peak flowering. There is little post-spraying monitoring to evaluate control of the invasive species or spray effects on native species. Typically, all green vegetation turns brown within a week of spraying, suggesting that the spraying kills all vegetation. Unfortunately, the following year the invasive species is usually back at nearly the same density and cover as before treatment. The typical management response is to apply more herbicide. Thousands of gallons of herbicide are applied annually throughout the ecoregion yet the invasive grass continues to spread….

Case #5: A Lost Cause

A land trust is working to conserve forest in a fast growing Sunbelt state. They are planning to conserve a collection of small fragments of forest in an area of fast growing suburbs around a major city. Most of the fragments are on private lands and are threatened by outright conversion

to shopping malls, roads, and houses. The state prioritization effort has deemed that these are important tracts of forest based on historical records of rare plants and animals. As a result, the project team attempts to spend huge amounts of money to purchase and manage the tracts of land, only to find they are extremely fragmented and degraded….

THE RESOURCE ALLOCATION PROBLEM

Although these five cases are obviously simplified versions of reality, they are symptomatic of the problems faced by conservation practitioners. In a world in which there are vast challenges and limited resources, the managers of any given natural area have to allocate an appropriate amount of resources to two primary decisions. The first allocation decision involves finding the right balance between investing in taking action versus monitoring. The second allocation decision involves subdividing monitoring resources across different types of monitoring indicators.

In this paper, we first explore each of these questions in some detail to define the problem and consider potential solutions in different situations. We then integrate these two problems into a general decision tree that will help practitioners figure out what to do at their specific natural areas. We then revisit the five cases to illustrate different logical outcomes from the decision tree. Note that in this paper, we are assuming that practitioners have already gone through a prioritization process and have selected a given natural area as being important for conservation; we are not addressing the question of how you prioritize across multiple areas. We also assume that practitioners have completed a situation analysis of the threats affecting the biodiversity targets at the natural area.

Balancing Investments in Conservation Action vs. Monitoring

The first major decision facing practitioners at any given natural area is how much to invest in taking action versus monitoring. The key factors to consider here are the

presence of clearly defined threats to biodiversity and whether you have clear and feasible actions you can take to counter these threats.

As an analogy, think about how a doctor might care for a patient. If the patient appears to be healthy and has no obvious complaints or symptoms of disease, then there is no point in the doctor providing treatment. Instead, the doctor merely conducts a basic checkup to catch any signs of potential problems (as described in more detail in the next section). If the patient has an obvious problem, such as a broken leg or a bacterial infection, then the doctor should take action to fix the problem. If, however, the patient has a problem for which there is not yet a standard treatment, then the doctor may have to try multiple treatments to see if one will work. Integral to this approach is the need to monitor the results of these treatments very carefully.

It is the same for conservation. If you know there are no major current or future threats facing the target biodiversity at your natural area, then you do not need to take action. Instead, you should merely invest in monitoring the situation (again, see the next section). If there are obvious threats that you can deal with, then you should take action to counter them and monitor the results. In addition, if there are threats, but you are unsure how to effectively deal with them, you may have to experiment with different actions and monitor the results.

Investing in Different Types of M&E

The second major decision facing practitioners is how much to invest in different M&E efforts. Two of the most common reasons for undertaking M&E include: (1) Assessing Status – Answers the question, "How is the biodiversity we care about doing?" and (2) Measuring Effectiveness – Answers the question, "Are the actions that we are taking having their intended impact?"

Obviously, these two types of M&E are broadly related to one another. We often take actions in places with biodiversity

that we care about. Moreover, to measure whether our actions are having their intended impact, we have to understand the conservation status of biodiversity and threats where we are working. Although the same indicator may be used for both status and effectiveness measurements, the key distinction is whether we are looking for an assessment of the health or integrity of the system, or whether we are focusing on understanding the specific consequences of conservation interventions (see also Box 1 for additional discussion and examples).

Returning to our medical analogy, status assessments most commonly occur when the patient appears to be healthy and has no obvious complaints. In this case, the doctor is not going to undertake a detailed investigation of one organ or system. Instead, the doctor will undertake a routine checkup that covers broad indicators of health such as temperature, blood pressure, and resting pulse rate. If one of these general "early warning indicators" is outside of the normal range, only then will the doctor follow-up with more specific diagnostic tests to understand specifically what problem might be developing. In conservation, this is the case in which there are no major or current threats facing the target biodiversity at your natural area and so you do not need to take action. All you need to do is track the general early warning indicators, which can be either biodiversity target or human threat-based.

Effectiveness measurements, by contrast, occur when the patient is receiving treatment for an obvious problem. In this case, the doctor will want to follow up the treatment by focusing on "diagnostic indicators" that help determine whether the specific treatment is working as planned (such as repeatedly x-raying the patient's broken leg over time to ensure the cast is holding the bones in place or doing a blood culture to ensure that the antibiotic is working). However, even if a patient has a broken leg, the doctor will still monitor the early warning indicators to make sure that no other problems are developing, such as a secondary infection. In conservation, this is the case where you are taking action to counter specific threats and need to monitor whether your actions are having

their desired outcome, but you also need to track new and potential threats.

Although diagnostic indicators are typically associated with effectiveness monitoring, they are also often used in status assessment. In our medical analogy, this is the case in which the patient has no current problems, but faces potential risk factors that need to be checked. For example, a person working in a radiology lab may be screened more often for early detection of cancer. A person with a family history of diabetes should be tested to see if they are maintaining proper blood sugar levels. In these cases, the doctor is checking specific diagnostic indicators in addition to the early warning indicators. In conservation, this is the case where you suspect certain threats may be coming, but they do not currently warrant action to counter them. To this end, you monitor both your early warning indicators as well as specific diagnostic indicators (again, either target or threat-based) that may help you detect these threats.

There is also one special case in which diagnostic indicators are used that involves neither status nor effectiveness measurements – when triage decisions need to be made. For example, in a battlefield hospital, if a patient is brought in with a severe wound to the heart, the doctor will focus on diagnosing the condition of the heart in deciding whether or not to invest in taking care of the patient at the expense of his or her other problems. In this case, it does not really matter if the patient has a predisposition to diabetes; the critical factor is the status of the heart. In conservation, this is the case where you are working at a natural area facing one or more large threats that may be very difficult to abate. You need to assess both the viability of the targets and the scope of the threats to decide whether you should invest any more resources in the natural area.

Finally, there is one other factor that needs to be considered in deciding how to allocate your monitoring effort – the level of confidence that you have in your understanding of the situation. If a doctor has less confidence in his or her diagnosis of the problem, he or she may monitor a

broader array of indicators to try to confirm the diagnosis. Similarly, in conservation, if you are relatively confident that you understand the system that you are working in, then you can reduce the amount of resources you put into assessing both early warning and diagnostic indicators. If, however, you are not so confident that you understand the system, then you have to make a higher investment in monitoring to ensure you are not missing serious threats to your conservation targets.

SO HOW DO WE BEST ALLOCATE OUR RESOURCES?

Figure 1 presents a flowchart designed to help practitioners and managers think about how to best allocate their resources. Note that we are making no assumptions about scale here – a natural area can range in size from a small pond to a large landscape.

Start: Priority Conservation Area?

The starting point for the flow chart assumes that the given natural area is already a priority for conservation and that specific biodiversity targets have been identified. We also assume the project team will go on to identify the biodiversity targets it will focus on, the causal chain of threats affecting these targets, and the team's specific target and threat objectives. This analysis can be completed using standard approaches, such as The Nature Conservancy's Conservation Action Planning framework (TNC 2005), conceptual modeling (Margoluis and Salafsky 1998), or whatever other technique the project team finds useful.

Substantial Threats?

The first decision node asks the question, "Are there substantial threats facing the targets at the conservation area?" If there are no substantial threats, then there is going to be no need to take conservation action. Instead, the project team will merely invest in early-warning indicators to detect potential threats that may arise. If there are substantial threats, then the project team will have to take action and conduct both status assessments using early warn-

BOX 1. ASSESSING STATUS VS. MONITORING EFFECTIVENESS

The distinctions between *status* and *effectiveness* monitoring and between *diagnostic* and *early warning* indicators can be illustrated with the following simplified conceptual model of a project with three focal conservation targets.

The Riparian System target is directly threatened by groundwater pumping which is in turn affected by the indirect threat of agricultural practices. The project is taking action aimed at the indirect threat by using incentives or legislative mandates to convince farmers to switch to crops that require less water. Effectiveness monitoring includes tracking changes in the status of the indirect threat (agricultural practices), the direct threat (groundwater pumping), and the key ecological attributes that are impacted by the direct threat (river flow measured as the number of days per year that river flows drop below a specified flow regime). These three indicators are all di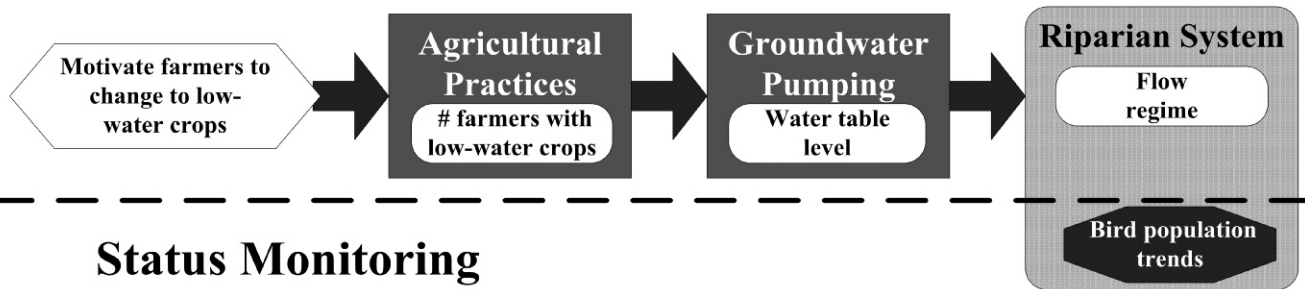agnostic indicators of effectiveness, because they are designed to measure the response of known threats that are the subject of current conservation interventions. In addition to the ground water pumping threat, the Riparian System target will have other key ecological attributes unrelated to the hydrological regime that may have no known threats, such as the status of bird populations in riparian forests. The project team will devote some resources to assessing the status of early-warning indicators related to these attributes that can potentially signal the presence of currently unknown stresses to the target.

Non-native understory grasses threaten the Upland Forest target, but this threat is not currently the focus of any current conservation action. The project is monitoring the status of the non-native species population along with changes in the overall plant community diversity as diagnostic indicators of the impact of the non-native species. The primary purpose of this monitoring is to determine whether conservation actions are warranted. As with the Riparian System example, the proj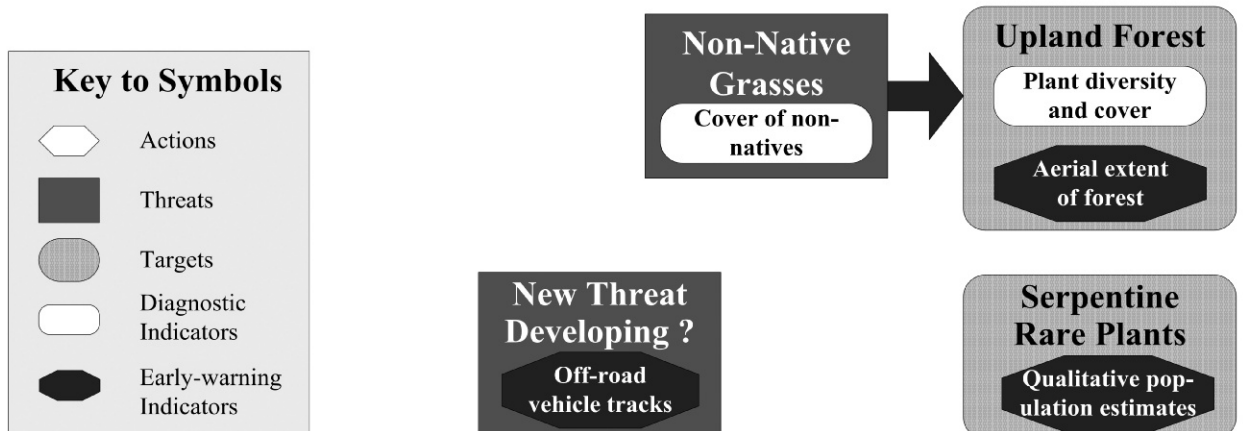ect may also track other indicators, such as the aerial extent of the Upland Forest that serve as early-warning indicators of new potential problems.

Finally, the Serpentine Rare Plant target occurs on unusual soil types and lacks known threats. Thus, there are no diagnostic indicators for this target, and the only monitoring required is low-cost status monitoring to validate the project's assumption that the population is stable and secure. In addition to tracking early-warning indicators for the status of conservation targets, the team should vigilantly work to detect new threats. The most cost-effective threat abatement solutions are often found by directly discovering and acting on new threats rather than waiting until the threat is detected via changes in target-status monitoring indicators. For example, the project team may be able to react to a new threat to the Serpentine Rare Plant population if they find tire tracks from off-road vehicles during a routine monitoring visit and install a gate to bar the vehicles from entering the area.
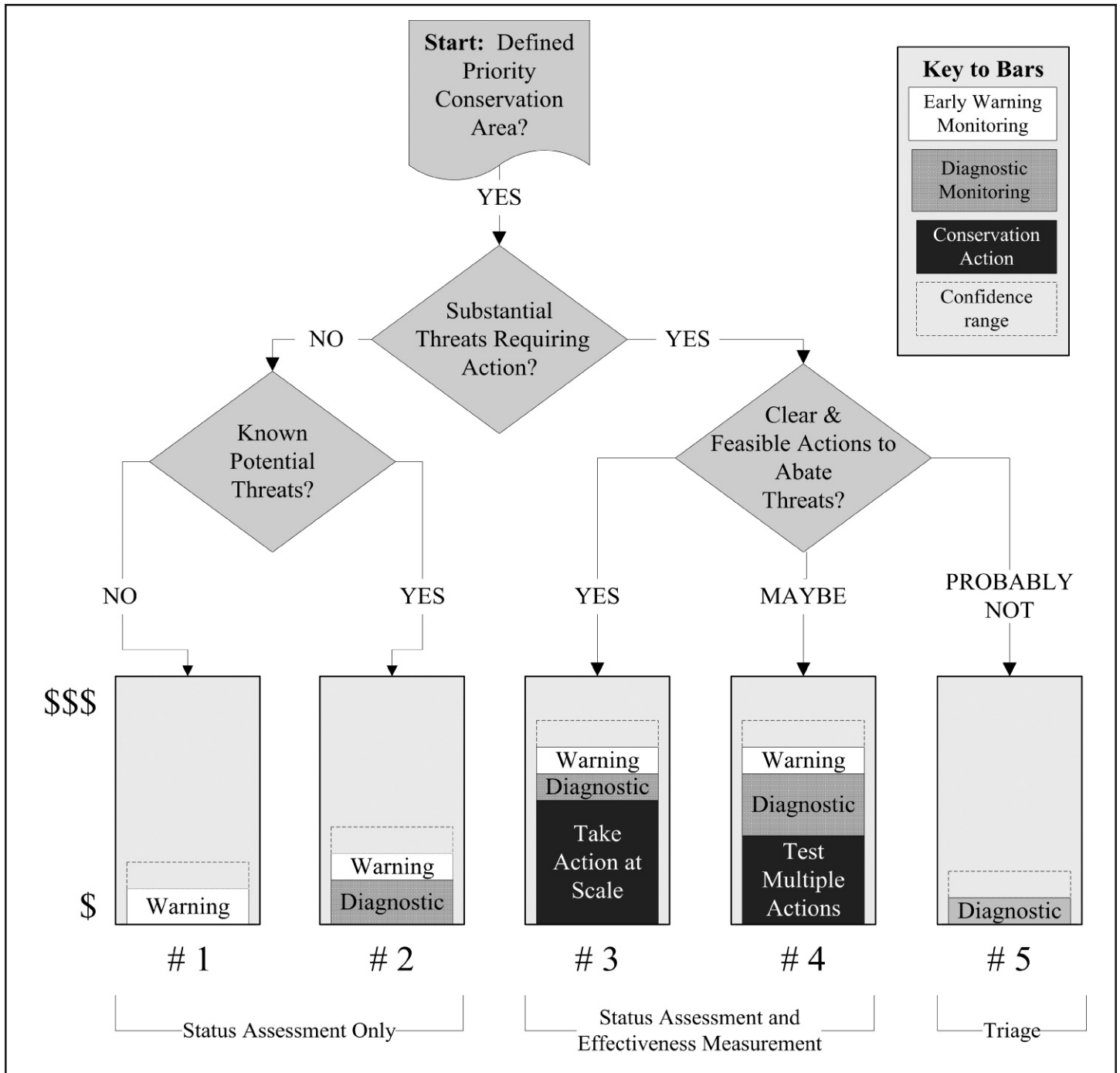
Figure 1. A decision tree for allocating resources between taking conservation action (black portion of bars), monitoring early warning indicators (white portion of bars labeled as "Warning") and monitoring diagnostic monitoring indicators (shaded portion of bars labeled as "Diagnostic"). The dashed line at the top of the bars indicates a range of resource investment that varies based on the level of confidence in the situation analysis. See text for details.

ing indicators (to detect potential threats) and effectiveness measurements using diagnostic indicators. Note that in cases where there are no current threats, but the targets require restoration from the impacts of past threats, you can treat your situation as if you have substantial threats requiring action; the only difference is that you will

be taking restoration actions rather than threat abatement actions.

Known Potential Threats?

If there are no substantial threats, then the next decision node asks the question,

"Are there known potential threats?" If there are not, then the project will merely have to invest a small amount of resources in monitoring early warning indicators to detect any new threats that might develop (Case #1 in the flow chart).

Example of Case #1: Alaskan Wilderness

At the moment, there are no potential threats to the targets in the wilderness reserve, so there is no need to take any action or monitor diagnostic indicators. The project team responsible for this area should devote a small amount of resources towards monitoring relevant government agencies in Washington D.C. and the state capital to ensure that no plans are being developed that would allow resource extraction in the area. The team should also fly over the area once a year to ensure that there are no signs of human resource extraction activities and conduct periodic ground surveys to detect any non-native species invasions. The two scientists could apply to NSF for funding to conduct their caribou research. If there are known potential threats, then the project will have to invest a bit more resources in diagnostic indicators that are focused explicitly on these threats as well as the more general early warning indicators (Case #2).

Example of Case #2: Pacific Island Coral Reef

Here the primary threat is from the fishing done by local subsistence fishers. The harvest levels appear stable, but without additional monitoring information, it is not possible to determine whether the current resource extraction levels are sustainable. In this case, the project team should focus primarily on monitoring the fish species that are being harvested by working with the fishers to assess catch per unit effort and average size of fish caught. (By involving the local community in the monitoring, the team also greatly enhances the chances that the fishers will be willing to modify their harvest practices.) In addition, the project team should also monitor status indicators, such as the extent of coral reef cover and presence of disturbance-linked species (such as crown-of-thorns starfish (*Acanthaster planci*)) to obtain early warning of whether other problems might be developing.

Clear Actions to Abate Threats?

If there are substantial threats, then the next decision node asks the question, "Are there clear and feasible actions to effectively abate the threats that have been identified?" If there are, then the project team should invest the bulk of their resources in these actions at the appropriate scale needed to abate the threats (Case #3). The project will also need to spend a limited amount of resources on diagnostic indicators of the effectiveness of these actions as well as on early warning indicators to detect new potential threats.

Example of Case #3: Amazon Basin Rainforest

In this situation, the primary threat is from logging by large multinational companies. In this case, the project team knows that their best hope for protecting the forest is to have it declared as a national park and to then build up the National Park Service's ability to manage the area. To this end, the team should allocate almost all of their resources toward taking action to help gazette the park and to train and equip Park Service staff. The team should also invest a little bit in assessing how well they are doing in reaching the appropriate government officials and a little more in periodically obtaining satellite imagery to ensure that there are no unexpected roads being built into the national park.

If there might be clear and feasible actions that can be taken, but the project team is not certain which action is most appropriate, then the team will have to test multiple actions and invest more of its resources in diagnostic indicators (Case #4).

Example of Case #4: Wetlands in the Ecoregion

Here, most natural area managers repeatedly used a single control strategy, the spraying of herbicides in June, without checking to see if it was working as planned or evaluating alternative strategies. A project should be initiated at several of the natural areas to experiment with different ways of applying the herbicide and other

control mechanisms. These studies should invest in carefully monitoring the results of these experiments to see if they can test the assumptions they are making. In doing so, the natural area staff might discover that spraying is more effective in fall when the invasive species are sending nutrients down towards their large root systems rather than upwards towards their flowers and leaves. In doing so, the natural areas' staff are advancing both their and (if they share their results) the world's knowledge. The natural areas' staff should also invest in early-warning indicators to detect new potential threats.

Finally, if it is likely that there are no clear and feasible actions that can be taken, the project team will want to merely focus on a few diagnostic indicators to help them make a triage decision (Case #5). If the indicators show that action is feasible and the area is worthy of investment, the situation will evolve into either Case #3 or Case #4. However, if it is not, then the team will have to consider abandoning the area in favor of other locations that are more tractable.

Example of Case #5: Fragmented Forests in the Sunbelt

In this case, given the fast growing human population, the obvious conservation strategy is to purchase the land outright. Unfortunately, this strategy is extremely expensive. Before diving in, the team should invest some limited resources in collecting diagnostic indicators that help assess the quality of the targets at the natural area and the willingness of local residents to help support conservation issues. If the target forest proves to be too fragmented and/or there is not enough local interest, the project team will report to their organization, take the natural area off the priority list, and perhaps try to find a local open-space conservancy to take on the project.

Confidence in Situation Analysis?

Although it is not shown explicitly in the diagram, the final decision node asks the question, "Does the project team have confidence in its situation analysis?" If

the answer is yes, the team is reasonably sure that they have identified all the threats and only has to invest minimal funds in assessing the status of the area over time. If, however, the answer is no, then the uncertainty means that the project team should probably invest a bit more of its resources in assessing the status of the natural area by increasing investment in early warning and/or diagnostic indicators as shown by the dashed lines in each of the boxes.

As an example, consider a project that has been working to protect a natural area that includes a large tract of floodplain habitat. The project team did an initial situation analysis and concluded that the major threats to the biodiversity in this project are habitat destruction for housing developments and altered flooding processes (caused by levees) that interfere with the establishment of riparian plant communities. Based on this analysis, the project team invested a great deal of money in acquiring land, removing the levees, and restoring the floodplain. Effectiveness monitoring reveals that this work has been very successful in producing expansive stands of valley oak riparian vegetation of multiple size classes supporting a wide range of wildlife species. Over time, however, the project managers were puzzled by the fact that despite the availability of prime habitat, many birds were having low nesting success. The team then invested some more funds to install video cameras at a sample of nests. Their cameras captured images of black rats (*Rattus rattus;* an exotic species) taking eggs and young from nests. A previously unknown threat, black rats, was causing large-scale declines that escaped detection under the effectiveness-monitoring program. In this case, the initial situation analysis proved to be incomplete; by investing a bit more money in a status assessment and by using their situation analysis to uncover hidden problems, the team was able to identify and then deal with a critical and previously unknown threat.

A FINAL WORD

The examples that we presented in this paper are obviously simplified versions of reality. In the real world, situations are generally much more complex and difficult. For example, in many cases you may have clear actions to abate some threats and not have clear actions to deal with others. If we have learned one thing, however, it is that the optimal allocation of resources across action and different types of monitoring indicators at any given natural area must be determined by the specific conditions present at that area. The types of targets you are working to protect, the threats you are facing, the level of resources that you have available, and your own knowledge and capacity influence this allocation decision. It is our hope, however, that the framework and decision tree presented in this paper will give you some helpful guidance in making these critical decisions.

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Daniel Salzer is the Conservation Measures Manager for The Nature Conservancy. He works to support and sustain the adoption of project-based measures of success through the Conservancy's Conservation Action Planning process, an integrated process for planning, implementing, and measuring conservation success for conservation projects that provides an objective, consistent, and transparent accounting of conservation actions and the intended and actual outcomes of conservation projects.

Nick Salafsky is Co-Director of Foundations of Success (FOS), an organization that works with conservation practitioners around the world to define clear and practical measures of conservation success, determine sound guiding principles for using conservation strategies, and develop the knowledge and skills of individuals and organizations to do good adaptive management.

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