Development of a rapid assessment tool for ecological restoration

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MANAGERS OF PARKS AND NATURAL areas are increasingly faced with difficult decisions concerning restoration of disturbed lands. Financial and workforce resources often limit these restoration efforts, and rarely can a manager afford to address all concerns within the area of interest. With limited resources, managers and scientists have to decide which areas will be targeted for restoration and which restoration treatments to use in these areas. A broad range of approaches are used to make such decisions, from well-researched expert opinions (Cipollini et al. 2005) to gut feeling, with variable degrees of input from site visits, data collection, and data analysis used to support the decision. A standardized approach including an analytical assessment of site characteristics based on the best information available, with a written or electronic record of all the steps taken along the way, would make comparisons among a group of sites easier and lend credibility through use of common, documented criteria at all sites.

In response to these concerns, we have developed the Restoration Rapid Assessment Tool (RRAT). RRAT is based on field observations of key indicators of site degradation, stressors influencing the site, value of the site with respect to larger management objectives, likelihood of achieving the management goals, and logistical constraints to restoration. The purpose of RRAT is not to make restoration decisions or prescribe methods, but rather to ensure that a basic set of pertinent issues are considered for each site and to facilitate comparisons among sites.

Several concepts have been central to the development of RRAT. First, the management goal (also known as desired future condition) of any site under evaluation should be defined before the field evaluation begins. Second, the evaluation should be based upon readily observable indicators so as to avoid cumbersome field methods. Third, the ease with which site stressors can be ameliorated must be factored into the evaluation. Fourth, intrinsic site value must be assessed independently of current condition. Finally, logistical considerations must also be addressed. Our initial focus has been on riparian areas because they are among the most heavily impacted habitat types, and RRAT indicators reflect this focus.

User inputs

Management Goal. Before any restoration can be undertaken, the goal for that restoration must be clearly articulated (Ehrenfeld 2000). Prior to undertaking the site evaluation, the user enters the management goals as part of the site description, which ensures that they are both explicitly stated and available to whoever does the evaluation in the field. Evaluation of indicators in the field requires an understanding of the difference between the current and desired condition, as well as the impediments to achieving the desired condition. To help ensure a comprehensive statement of restoration goals, we suggest that the user become familiar with the indicators before defining the management goal.

Indicators. RRAT indicators are arranged into six modules: hydrology and landform, soil and water quality, nonnative animals, nonnative plants, native animals, and native plants. These categories, and the 40 specific indicators within them, were vetted through a series of workshops followed by field testing and refinement (Richey 2005). Hydrology, landform, and soil indicators are based largely on descriptions in Pellant et al. (2005); these and all other indicators also were formally evaluated at two workshops. Indicators were tested in 2004 at national parks throughout the United States to confirm their relationship to characteristics for which they were thought to be indicators (Richey 2005). In addition, we assessed correlations among indicators and combined those that were strongly correlated.

Indicators are scored in two ways. First, the departure of current condition of the site from "natural" is scored with respect to an indicator; then, the departure of the desired condition from current condition is scored with respect to the same indicator. Although "natural" is a subjective concept, we believe it is a useful point of comparison when several sites are being assessed. For example, a severely degraded site with a modest management goal could be judged as readily restorable, much as a more pristine site might be restored to a nearly natural condition. However, by comparing each site with a "natural" standard, the two sites are more clearly differentiated.

Stressor Removal Effort. After scoring the indicators, the user selects from a list of 40 stressors that require amelioration in the course of restoration. The user also is asked to estimate the amount of effort needed to remove the stressor, ranging from "easy," through "difficult," to "impossible." Stressors rated impossible to remove are highlighted in the output but do not contribute to the stressor removal index (defined on the next page).

Table 1. Index formulations for the Restoration Rapid Assessment Tool

Index	Range of values	User inputs	Formulation
Convergence (C)	0–100 (from least to most similar to natural or management goal)	Indicator Departure from Natural (IDN), a direct rating by user; 100 = no departure from natural, 75 = low, 50 = moderate, 25 = high, 0 = severe, don't know/NA = index omitted.	(IDN1 + IDN2 + IDN3 + … IDN*n*) / *n*
Stressor Removal Potential (SR)	0–100	A listing of stressors is compiled for each instance when IDN – IFG (Indicator Future Goal) >2; the user rates the difficulty of removal for each stressor (Easy, Moderate, or Difficult).	SR = (1 – ((1 – (0.85) ^ ([*n* Easy] * 0.2)) + (1 – (0.80) ^ ([*n* Moderate] * 0.5)) + (1 – (0.75) ^ ([*n* difficult] * 0.8))) * 100
Ecological Restoration Potential	0–100	None—composite metric	(C + SR) / 2
Restoration Logistics (RL)	0–100 (least feasible to most feasible logistically)	Disturbance size (DS) Site accessibility (SA) Wilderness (W)	(DS + SA + W) / 3
Ease of Restoration	0–100 (0 = hardest to restore, 100 = easiest to restore)	None—composite metric	(C + SR + RL) / 3
Gain for Effort	0–100 plus 9,999; 0 is least gain for effort, 100 is most gain for effort. 9,999 reported when SR + RL = 200.	None—composite metric	C / (200 – (SR + RL))
Site Value	0–100	Future site value (SVf): A direct rating by user; 100 = extremely valuable, 75 = highly, 5 = moderately, 25 = minimally, 0 = not, don't know/NA = index omitted.	(SVf1 + SVf2 … + SVf*n*) / *n*

Note: n is the sample size.

Site Value. Reasons for wishing to restore a site are inherently subjective; we therefore separate the intrinsic value of a site from more objective indicators of its condition. The site value categories in RRAT include animal and plant community diversity, the presence of habitat for threatened or endangered species, recreation or aesthetic values, emblematic features, landscape rarity or importance, and cultural or historic values. The user assigns each a score as if the site were restored to the management goal, rather than based on the site's current condition.

Logistical Considerations. The size of the area to be restored, its distance from a road, and whether or not it is within a designated wilderness are used to assess the logistical difficulty of restoring the site.

Indexes

We developed seven indexes to provide both a site profile and a basis for comparison among sites being considered for ecological restoration. The indexes emphasize simple averages, ratios, and other easily understood functions (table 1). We standardized the values of the indexes so that higher numbers always signify a more favorable condition for restoration than lower numbers. The reliability of the assessment is greatest when most indicators are evaluated. Users should consult with experts or others who are familiar with a site under consideration to determine values for as many indicators as possible.

Of the indexes related to ecological site condition, two are calculated directly from user input: *Convergence* and *Stressor Removal Potential*. *Convergence* refers to the degree to which indicators approach either a natural condition or a management goal. *Stressor Removal Potential* depends upon both the number of stressors that require removal and how difficult they are to remove. Because we assumed that overall difficulty would increase at a faster rate for stressors that were more difficult to remove, the change in stressor removal potential has a steeper slope for more difficult-to-remove stressors than for those that are more easily removed. *Ecological Restoration Potential* is a composite variable calculated as the mean of *Convergence* and *Stressor Removal Potential*.

Two indexes directly involve the physical difficulty in conducting restoration activities at a site. *Restoration Logistics* takes into account size, accessibility, and whether or not the site is within a designated wilderness area, which may restrict the kinds of equipment that

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can be used. *Ease of Restoration* is a simple average of *Convergence*, *Stressor Removal Potential*, and *Restoration Logistics*.

Gain for Effort is the ratio of *Convergence* to the sum of *Restoration Logistics* and *Stressor Removal Potential*. It provides a measure of the functional change needed to restore a site to either a natural condition or management goal for the amount of effort that would need to be expended.

To calculate *Site Value*, a numerical value is assigned to the categorical user input. Management goals may pertain to only one aspect of site value, so users must consider the score for *Site Value* with respect to their goals for the site.

Interpretive output

The *Site Profile* pertains to a single site and includes complete interpretive information for all seven indexes as well as tabular description of site value ratings, stressors that require removal and their associated difficulty ratings, and warnings related to stressors that are impossible to remove and the number of unknowns in the assessment.

In each *Site Profile*, a table lists the aspects of *Site Value* that the user evaluated and the categorical values assigned to each. A second table lists the user-selected *Stressors* that affect the site and the effort required to remove them. Any stressor deemed impossible to remove by the user is highlighted in red type and a warning advises users to carefully evaluate their ability to achieve their management goal if the stressor cannot be removed. A third table is included only if *Unknown* is selected for more than two indicators. This table lists the indicators for which *Unknown* was selected and a warning advises users to investigate the indicator(s) so that an appropriate response can be made.

A second form of output is a *Site Comparison* report. This report consists of index scores for a group of sites within one user-defined management group (see sidebar). For each group of sites selected, two reports are produced. One is based on comparison with natural conditions, the other on comparison with the management goal for each site. These reports lack the tabular and interpretive output contained in the *Site Profiles* but provide output scores sorted in various ways to facilitate comparison as well as graphic displays of the selected sites on four axes: *Ease of Restoration*, *Ecological Restoration Potential*, *Restoration Logistics*, and *Site Value* (see sidebar).

RRAT and its users' manual (Hiebert et al. 2009) can be downloaded from http://www.npwrc.usgs.gov/resource/methods/rrat/index.htm. The users' manual provides full definitions for each of the indicators and stressors, definitions for each of the seven output indexes, and details on the technical aspects of conducting an assessment. RRAT is formatted in a Microsoft Access database application programmed with Visual Basic. We encourage reviewers and users to provide comments to the first author so the tool can be made more efficient and effective.

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Acknowledgments

The authors acknowledge funding by the National Park Service (NPS) Recreational Fee Demonstration Program Fee Funds and project coordination by Linda Drees, manager of Program Development and New Initiatives for the NPS Biological Resource Management Division, Natural Resource Program Center. D. Johnson and M. Kuchenreuther provided helpful comments on an earlier version of this manuscript. We also acknowledge reviews and input from numerous colleagues and the cooperation of numerous parks in testing the tool.

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