Implications of an ATBI for Reserve Stewardship

Keith Langdon, Peter White, and Becky Nichols

Introduction

SINCE THE 1980S, CONSERVATION HAS FOCUSED INCREASINGLY ON BIOLOGICAL DIVERSITY as a fundamental goal. We can trace this focus to many causes. Interest in biological diversity has been heightened by the rapid loss of tropical rainforests, which are great centers of diversity. Also, we have become more aware of the permeation of human effects: for instance, the spread of air pollution and exotic species into otherwise pristine areas, and an increase in habitat loss and fragmentation. Our measure of successful conservation has become not only the preservation of wilderness, but also the survival of all the plants, animals, and other species that are present within protected areas. It is also clear that some species migrate long distances, giving us a renewed sense of the interconnections that biodiversity represents and the critical role that protected reserves play.

Above all, perhaps, we should be reminded that our knowledge has a bias towards larger organisms and we are profoundly ignorant about the vast numbers of species, some of which play vital ecological roles: metabolic roles in decomposition and nutrient cycling, and regulatory roles in pollination and trophic interactions. Perhaps it is our ignorance and the sheer wonder of discovery that has raised enthusiasm for large-scale, taxonomically integrated biological inventories. But also, the species we discover will help us understand and defend conservation areas against threats. In a larger context, biological diversity has a fundamental value to ecological function and to humans: diversity supports future options in terms of the ability for an ecosystem to evolve and to adapt to environmental change. Genetic diversity is the basis for evolution and adaptation, and species diversity underlies the range of functions and responses at an ecosystem level. Further, when species loss occurs, it is irreversible because each species is the product of a unique evolutionary history that can never be repeated. Many factors thus underlie the excitement behind All Taxa Biodiversity Inventories (ATBIs) and the increasing interest in carrying them out in national parks and other conservation areas.

Species data

From the beginning of the Smokies' ATBI, park staff insisted that we needed four things:

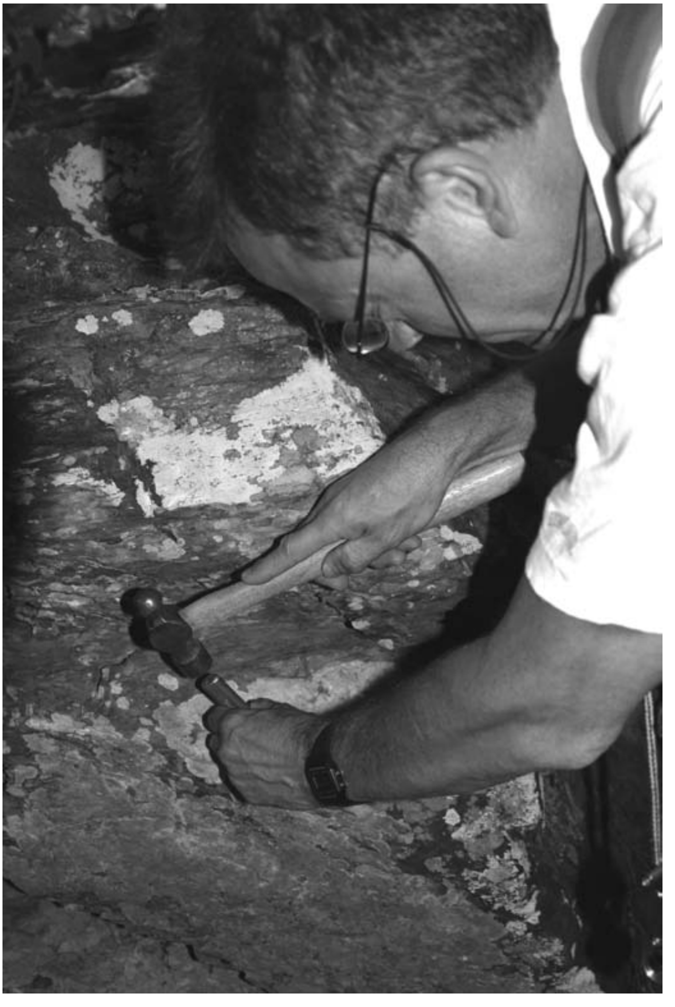
- A comprehensive list of species for each group, with valid names and an understanding of where species fit in taxonomic hierarchies.

- An estimation of each species' relative abundance. Sampling protocols for some groups (e.g., forest litter organisms) may provide much better abundance measurements than others, but the ability to assign relative abundance is a goal for all species.
- Documentation of specific locality information. Once many points are accumulated, we can then attempt to associate each species with various habitat parameters, thereby allowing creation of a first-iteration distribution map for each taxon.
- Wherever feasible, sample in such a way as to provide information on the life history of each organism. A beetle collected in a flight intercept trap is a valuable record, but a beetle collected off of its plant host is a more valuable record, because it then allows both species and their relationship to be associated in the database.

One of the major tasks of an ATBI is to obtain specimen identifications. This is a massive task and should not be underestimated. At the Smokies, it is estimated that there may be 75,000 (+/– 25,000) multi-cellular species of organisms. For micro-organisms, the tally is predicted to be much higher (Seán O'Connell, personal communication). Species lists alone are of limited value in direct stewardship; however, managers of individual reserves should use their species lists to look past their own boundaries to assess their reserves' overall value to conserving regional, national, and global biodiversity in each species group.

From a strictly scientific viewpoint, we are learning a tremendous amount about certain species' ranges, habitats, and relationships with other species. Geographic analysis of multiple distributions can be used for activities such as protecting sensitive sites, locating monitoring activities at the most cost-efficient locales, properly tim-

Isotomurus philfrancisi, one of the springtail species new to science found by the ATBI. Photo courtesy of Ernest Bernard / DLIA.



Dr. Tor Tønsberg searches for lichens in the park. Photo courtesy of Rebecca Shiflett / DLIA.

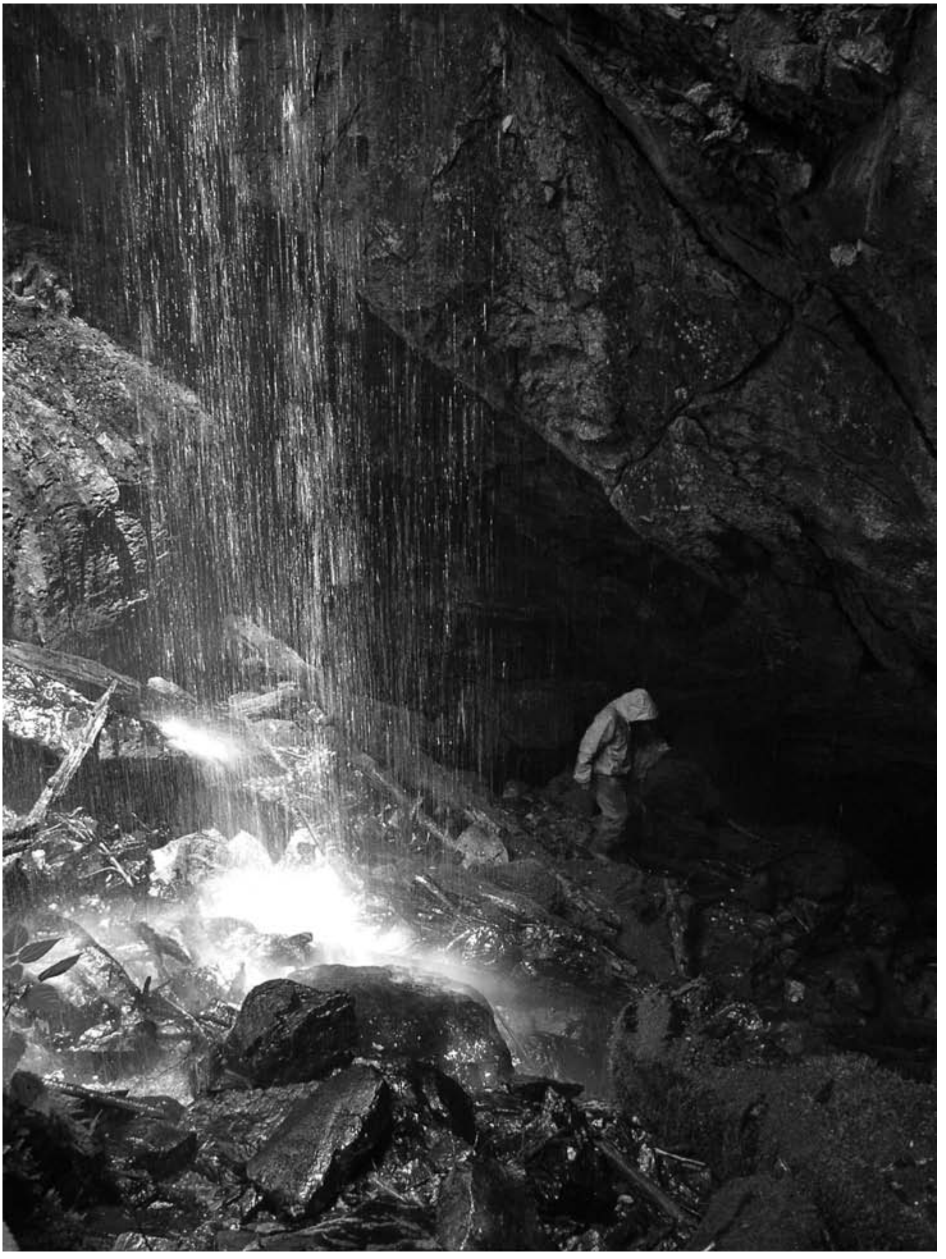
ing control actions for pest species, displaying the varying intensities of ecological stressors across landscapes, and many other investigations. All of these activities are of value to park managers, heralding a new level of more intelligent stewardship of natural reserves. These data will also give the Smokies a strong foundation for advanced ecological research well after the ATBI project is completed.

Discovering exotics. Conducting an ATBI means sampling in every habitat and bringing in taxonomic experts who have wide experience in many other regions. A number of new exotics have been discovered this way during the Smokies ATBI, including, but not limited to, red imported fire ants *(Solenopsis invicta x richteri),* which are now being controlled but will affect many open-land native species; pear thrips *(Taeniothrips inconsequens),* a European insect that feeds on many North American trees, but in the last 20 years has devastated sugar maples in New England; giant resin bee *(Megachile sculpturalis),* which is a primary pollinator of kudzu in its native region in Asia; Klamath weed beetles *(Chrysolina quadrigemina),* which have suppressed introduced St. Johns worts *(Hypericum* spp.) in the West, but may affect two rare narrow endemics, *Hypericum mitchellianum* and *H. graveolens*, in the park; and Chinese jumping worms *(Amynthas hilgendorfi),* which are devouring forest duff in an area with concentrations of rare plants. Each of these ATBI discoveries has resulted in some monitoring, management, or research action. ATBIs will lengthen the list of known species-specific threats by exotics in each reserve, but we are better off finding them in their incipient stage of invasion, rather than later when fewer control options are available.

"Spin-off" science

No one can predict the number or type of threats that will be faced by a park or

Collecting a soil sample under the falls during a 2006 beetle blitz at White Oak Sink. Photo courtesy of Charles Wilder / DLIA.



reserve in the future. Although not a goal of the inventory, monitoring of biological resources from a well-documented ATBI baseline is not only possible, but is virtually assured in future years as changing circumstances require re-measurements of specific resources. The excellent long-term monitoring program currently being established agency-wide by the National Park Service (www1.nature.nps.gov/protectingrestoring/IM/vitalsignsnetworks.cfm) is well conceived, peer reviewed, and necessarily expensive. The biological monitoring components that are quantitatively monitored are therefore a very narrow selection of park "vital signs." These park "vital signs" usually include at least some species- or population-level monitoring in park units, but expense keeps the number of species and sites monitored very low relative to the number of total species in the park or reserve.

It is assumed that the confidence placed in monitoring results can be increased with the number of years of data collected. However, stressors that were targeted 10 or 15 years beforehand when a monitoring program was planned may not have the flexibility to be decisive or even minimally inform managers confronted with a new threat. A completed ATBI means the broadest possible palette of baseline species data is available for special or periodic re-sampling, when needed. Having a known status for a species, or group of species, or site in a reserve at a known period in the past, is invaluable when a future exotic invasion, proposed project impact, or other disturbance occurs. This makes a well-designed monitoring program based on "vital signs" and an ATBI complementary—a data "hedge" against the many unknowns parks and reserves are facing and will continue to confront in the foreseeable future.

Another example of "spin-off" science is that over 1,000 species of moths and butterflies in the Smokies have had their mitochondrial DNA sequenced and indexed as part of the ATBI. The other 600 known species of Lepidoptera will be added to this database in the near future. Now the park can identify most larvae, making a number of important and previously impossible ecological studies possible. These include plant host–herbivore studies, pollinator studies, bird diet studies, etc. If researchers writing proposals can come to a protected reserve where these data are available already, the reserve becomes much more attractive, and ATBIs become a springboard for advanced research projects in the future, which in turn will benefit the reserve's stewardship.

Next steps

In our "sound bite," scorecard-oriented society, we usually get asked how many new species we have found, but even if not a single new species or new record would have been found, the discovery of hundreds of thousands of known points for known species would make the ATBI a worthwhile endeavor for stewardship and protection purposes. One of the next hurdles in the Smokies ATBI is to develop probability distribution maps of park species. Most threats to natural resources are not uniformly distributed over a reserve of any size, and neither are the resources that are jeopardized. This is one reason that a priority for many resource stewards is to obtain high-resolution species distribution maps in a GIS where they can be overlain with many other data themes. When distributions are mapped, analysis with a GIS can be used to

A syrphid fly lands on a turtlehead bloom growing along the Appalachian Trail between Clingman's Dome and Newfound Gap. Photo courtesy of Charles Wilder / DLIA.

determine which environmental factors they are associated with, such as temperature, geochemistry, solar aspect, moisture, etc. To start, rare, listed, commercially collectable, and endemic species in the Smokies will be targeted, but eventually all species for which we have enough point locations will be included. This will then allow us to develop predictive models of the responses of individual species, guilds, or communities of species to threats (e.g., global warming, invading exotics, loss of integral habitat along boundary, etc.) or management activities (e.g., prescribed fire). This will be a major step forward for stewardship.

Summary

Every discovery in an ATBI immediately results in value to stewards of the reserve. Not just species new to science and new records for the reserve, but even new locations for common species help in the development of more accurate phenological, geographic, and ecological data products of those species. These values accrue as the project proceeds to completion with comprehensive public involvement in real scientific discovery, "spin-off" scientific activities, and a superior understanding of the complex ecological processes that drive and sustain every nature preserve.

Several units of the U.S. National Park System, as well as some private and state natural areas, have either started ATBIs, or are planning to do so (see Langdon, Parker, and Nichols, this volume). All of these reserves share an interest in science and education, but they also recognize that they need much more detailed information about their natural resources—even if the reserves were established over a century ago. Because reserve staffs constantly have to make decisions about how to assess the impacts of various operations (e.g., development proposals, site modifications, prescribed burning, pesticide applications, recreational uses, etc.), information about where species occur, how rare or abundant each is, and basic information about the species' life history is of the utmost importance.

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