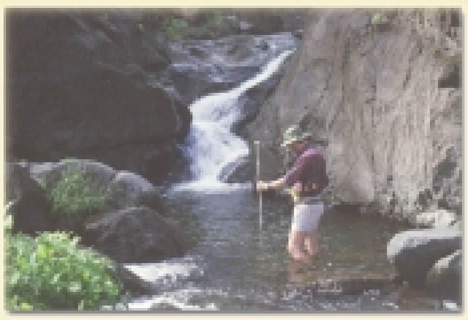
Report of the External Science Review Committee

The Nature Conservancy
May 2001



The Nature Conservancy®
Saving the Last Great Places

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EXECUTIVE SUMMARY

The Nature Conservancy promotes itself as an organization that is founded on "science-based conservation." The adoption of a new conservation framework by the Conservancy (Conservation by Design) and the rapidly changing face of ecological and conservation science both suggest that it is timely to examine how well the Conservancy lives up to the mantra of science-based conservation. Accordingly, in June, 2000, the Conservancy's Board of Governors' Conservation Committee commissioned an External Science Review of the use, role, and organization of science in The Nature Conservancy. To that end, an External Science Review Committee was established in September, 2000. Over the next five months, members of the Committee conducted interviews with a large number of scientists and other interested individuals, both within and outside of The Nature Conservancy. We visited Conservancy programs, field offices, workshops, and sites in all parts of the United States, interviewed many individuals involved in international programs, and conducted a mail survey of Conservancy science staff to solicit their views on how science is being done within the organization.

It is important at the outset to clarify what "science" means in the context of a conservation organization such as The Nature Conservancy. *We view science as the continual process of building understanding and reducing uncertainty by applying knowledge and critical thought to a problem, by objectively evaluating evidence, and by learning from experience.* Science is not characterized by its tools, but by the way of thinking about a problem, of marshaling knowledge and evaluating information, of developing and testing general predictive theory, and of applying reasoned skepticism to our knowledge. It is a process that is open to continual learning and improvement. Viewed in this way, there are no real impediments to the use of science in conservation action other than a lack of time, resources, understanding, or willingness.

Here we summarize the recommendations that have emerged from our assessment. We first highlight five general recommendations, and then list a number of more specific recommendations that deal with several distinct aspects of science in the Conservancy .

General Recommendations

1. ***To realize the goal of science-based conservation, science and science-based leadership should be strengthened and suffused throughout the organization.*** As the Conservancy moves beyond its past emphasis on dollars and acres to broad-scale, integrated conservation action, science and science-based stewardship should be front and center. Science and scientific thinking must become an integral part of Conservancy culture.
2. ***The Conservancy should enable their science staff to realize their scientific potential.*** "Doing science" should be part of their job descriptions. They should be given the guidance, training opportunities, encouragement, rewards, and time to achieve their potential. It is critical to the success of the Conservancy's conservation programs that science staff be able to maintain their skills and knowledge. There can be real costs of basing conservation decisions or practices on outdated expertise.
3. ***The Conservancy should move more vigorously to develop scientific partnerships and collaborations.*** Greater use should be made of the expertise that exists in universities, government laboratories, and other conservation organizations. Such partnerships should be founded on true scientific collaborations that go beyond seeking external expert opinion. To accomplish this will require that the Conservancy build internal scientific expertise in critical areas.

4. ***The Conservancy should adopt and promote an adaptive management approach.*** The philosophy of adaptive management, of learning from experience and using that knowledge to inform subsequent policies and actions, should be applied to both conservation action and organizational structure, in order to make the Conservancy a dynamic learning organization.

5. ***The Conservancy should strive to become a leader in applying science to conservation through sharing what it learns about science-based stewardship with other land managers, scientists, and government and conservation organizations.*** The elements contained in the framework of Conservation by Design—broad-scale planning, networking of sites, evaluating threat abatement, adaptive management, and a focus on functional landscapes—offer the potential for forging important new approaches to the conservation of biodiversity. The Nature Conservancy cannot work alone to preserve the plants, animals, and natural communities that represent the diversity of life on earth; the knowledge that comes from science-based conservation should be widely disseminated and shared.

Specific Recommendations:

1. Conservation by Design

- ***Conservancy staff at the site, state, national, and international levels need to be convinced of the strength and value of the philosophy and the action plan of Conservation by Design.*** Those who do not embrace the approach should be convinced that this represents the most effective way to manage and conserve (to borrow a phrase from earlier Conservancy days) "the last great places." The most effective way to bring doubters on board may be to demonstrate that science-based conservation implemented within this framework is doable, works, and is ultimately cost-effective.
- ***The administrative partitioning of the Conservancy structure and activities should be loosened to encourage greater collaboration and sharing of resources focused on entire ecoregions.*** The administrative boundaries that have served The Nature Conservancy well in the past, by tuning conservation activities to local, state, and national cultures and concerns, do not always mesh well with the need for broader scale ecoregional planning and implementation. The notion of "One Conservancy" contained in Conservation by Design must become more than words.
- ***Ecoregional plans must be periodically re-examined and revised, and the revisions implemented.*** Ecoregional plans provide a blueprint for conservation action, but they are not action in and of themselves. As circumstances change, the conservation values of a specified portfolio of conservation areas will also change, so modifications of plans and actions will be necessary. Conservation is a dynamic process.
- ***The expert opinion that is used in various stages of conservation planning should be validated, and greater effort should be made to base decisions on data rather than opinion.*** Expert opinion is an important source of information in conservation planning, but it does not replace other, data-based kinds of information. Good conservation planning requires that all available information be included in the process.
- ***Key concepts, such as "measures of success," "ecosystem viability," and "biodiversity health," must be made operational by increased rigor and quantification.*** Using relative terms such as "good," "fair," or "poor" to express such important measures leaves too much room for subjective evaluations (which may become self-serving), masks scientific uncertainty, and creates inconsistencies among programs. Quantitative measures can foster a rigorous evaluation of progress in meeting goals and of benefits and costs. If one is going to assess conservation success, it is important to do it right.
- ***Science should be part of conservation planning from the outset.*** Science should not be brought in to justify actions after the fact, but should be instrumental in planning actions from the beginning.
- ***Ecoregional and site conservation planning create the necessity of engaging other landowners, governments, communities, and organizations in developing a comprehensive understanding of the biodiversity assets and potentials of an area and crafting a shared vision of a desired future.*** Conservation at the landscape scale requires collaboration and coordinated monitoring and management. Ecoregional planning can be an excellent forum to collaborate with partners in assembling information and identifying information needs. In addition, building understanding of places can inspire actions to achieve a commonly desired set of future conditions.

2. Adaptive Management

- ***The Conservancy should embrace and practice adaptive management.*** The scientific elements of adaptive management should be incorporated into the Conservancy's conservation approach whenever possible. True experimental management, however, may not be possible or desirable in all situations. Adaptive management does not always need to be a highly formalized procedure, but the general approach is essential to good management and conservation.
- ***The Conservancy should create a safe environment in which to take risks.*** Adaptive management is based on accepting the possibility that current resource management actions may not work but can nonetheless provide a basis for learning. The "fear of failure" attitude that still exists at some levels within The Nature Conservancy should be purged. Conservation is learning as well as doing.
- ***Conservation goals must be clearly and explicitly stated.*** The process of adaptive management rests on a continuing evaluation of progress toward specified goals. If the goals are not specified, in measurable terms, it is impossible to determine when or if they have been reached. Cost-effective conservation requires a clear statement of desired endpoints.
- ***The expectation that Conservancy science staff should contribute to the development and testing of science-based conservation should be explicitly articulated.*** Science staff need to know that their role in implementing adaptive management is both expected and appreciated.
- ***Site networks should be used to conduct comparative experiments.*** The networks of sites identified within or among ecoregions as part of ecoregional planning provide exceptional opportunities for testing management methods and approaches through well-designed comparisons. Such approaches can be applied to many Conservancy actions, whether passive or active (e.g., restoration). There is a great potential to produce insights of lasting value to sustainable conservation. The Nature Conservancy needs to capitalize on these opportunities.
- ***The adaptive management approaches adopted by the Conservancy should be independently evaluated.*** Such independent evaluation can serve multiple purposes: drawing external scientists more fully into Conservancy activities (i.e., potential partnerships), making the conservation approaches of the Conservancy more widely known, and discovering ways to improve the process.

3. Partnerships and Collaborations

- ***More external scientists should be involved in Conservancy activities.*** For example, much could be gained by involving more scientists in Conservancy workshops. The possibility of developing sabbatical programs to enable external scientists to spend time working within the organization, at state, national, or international levels should be explored.
- ***The Conservancy should develop and actively promote programs to base Conservancy science staff in universities, government laboratories, and field sites.*** Some assignments, lasting from a few weeks to several months or even years, would have a clear focus and the expectation of a definite product. Others would be permanent posts, enabling Conservancy scientists to benefit from interactions with a critical mass of other scientists and practitioners concerned with applied conservation issues.
- ***The Smith Fellowship Program should be expanded.*** This program has proven to be extremely cost-effective. It is currently being enlarged to support sabbatical leaves for senior scientists. Possibilities of developing an international counterpart should be explored.
- ***A program to provide limited support to graduate students conducting research on Conservancy conservation areas should be developed.*** Because such a program could potentially become quite large, we suggest initial development as a small, tightly focused pilot program.
- ***The Conservancy should make greater use of web sites to engage potential partners.*** For example, a state program could develop a web site that provided detailed descriptions of conservation areas, along with listing of specified Conservancy information or research needs for those areas. Potential collaborators could search the web site for suitably compatible research opportunities, which could then be the foundation for developing a partnership.

4. Information Management

- ***The Conservancy should maintain a strong working relationship with the Association for Biodiversity Information (ABI).*** Although the Conservancy's information needs have expanded beyond the Heritage-based data that continue to be the focus of ABI, such information is still an essential ingredient of sound conservation planning. A continuing Conservancy commitment is needed to ensure the long-term viability of local Heritage programs and ABI.
- ***The Conservancy must build capacity in information management.*** Good planning and effective action require information. Indeed, information is power. It provides the leverage to influence the thinking, policies, and actions of others. To enhance its use of information, The Nature Conservancy must add staff with expertise in such areas as database design and management, decision science, programming, modeling, and environmental informatics at all organizational levels. Information management has entered a new era, and to capitalize on these advances—indeed, to invest in the future—the Conservancy needs staff who know how to meld these advances into the organizational structure of the Conservancy most effectively and efficiently.
- ***Standardized procedures for collecting and managing scientific data and information must be developed.*** Conservation action at the scales of landscapes or ecoregions requires information on a variety of topics that must be obtained from a variety of sources, yet integrated management requires also that such varied data sets be compatible. Information must be readily retrievable or else it is not really "information."
- ***Continuing efforts should be made to ensure that the computational and communication capacities within the Conservancy are current.*** Efficient information flow and sound business management both demand that all individuals and units within the organization be able to communicate rapidly and effectively.

5. Empowering Conservancy Staff Scientists

- ***The value to individuals and to the Conservancy of publication and presentation at professional conferences should be recognized.*** While the expectations that Conservancy scientists publish and present their work are clearly different from those in academic institutions, it is nonetheless clear that this activity is extremely important and valuable. Publication and presentation help individuals maintain currency, establish contacts, and generate a feeling of fulfillment and closure in their application of science to conservation goals. The external peer review that is part of this process should become the *modus operandi* of scientific work and science-based management in the Conservancy. Publication and presentation are also a cost-effective way to publicize the scope and quality of the science that the Conservancy brings to bear on conservation issues. They enhance the scientific credibility of the Conservancy, which in turn enhances the capacity of the Conservancy to form partnerships and obtain support for its conservation programs.
- ***Conservancy scientists must be given enhanced training opportunities that are relevant to their work and the organization's mission.*** Science is advancing quickly. Focused workshops and training sessions can enable Conservancy scientists to maintain currency and self-confidence without unduly distracting them from their other responsibilities. Continuing training is also important in retaining skilled science staff within the organization. Such workshops should include a substantial representation of external scientists as well as Conservancy staff. The working-group approach of the National Center for Ecological Analysis and Synthesis may provide a useful model.
- ***Science staff and expertise must be added in key areas that are defined by the future directions of Conservation by Design.*** To address current and emerging conservation issues, and to forge effective partnerships and collaborations, the Conservancy needs internal expertise in critical areas. Conservancy staff in the field have identified such areas as GIS and remote sensing, forestry, aquatic and marine ecology, hydrology, landscape ecology, restoration, social science, and climate and land-use change as important priorities. Such additions should be made at international, national, and state levels as appropriate. The level of science awareness in staff at all levels and in all programs should also be increased.
- ***Scientists in small programs should be networked to reduce their isolation.*** Steps should be taken to enable scientists located at sites or in programs, states, or nations with little immediate contact with other scientists to engage in broader interactions with their peers. For example, conference calls and the Internet may provide opportunities for such individuals to act as members of scientific teams.

6. Promoting Science

- ***The Conservancy must recognize and promote the value of a science-based approach.*** In order to implement Conservation by Design, the approach and the science it entails must be widely accepted. This recognition must extend to include administrators, staff, and Governing Boards.
- ***The Conservancy must use science vigorously, innovatively, and accurately in its fund-raising efforts.*** Properly presented, science sells.

7. Future Challenges

- ***The Conservancy must expand its internal capacity to address future conservation threats.*** Expertise is particularly needed to evaluate the consequences to terrestrial, aquatic, and coastal marine environments of global climate change, economic globalization, and changing land use. These consequences are likely to be so extensive and profound that they cannot be dealt with after-the-fact, nor can they be addressed on a site-by-site basis. There is a clear need to anticipate threats and to "go to scale" in addressing these threats.
- ***The participation of stakeholders in Conservancy planning and actions should be encouraged from the outset.*** The importance to broad-scale landscape management of private lands and the "semi-natural matrix" that surrounds Conservancy conservation areas demands both the insights and the goodwill of local stakeholders.
- ***The level of involvement of the Conservancy in international land and marine conservation should be increased.*** Many of the greatest threats to the world's biodiversity lie outside of the United States. The Conservancy should go where the action is.

8. Science in The Nature Conservancy Infrastructure

- ***The Conservancy should become a learning organization.*** This means that it should explicitly develop organizational strategies that foster opportunities to question core values and goals based upon results, processes for evaluating expected against actual outcomes of conservation strategies, opportunities to learn from experience and literature, and processes for creating new knowledge through basic organizational work.
- ***Science as a process, as a way of knowing, must permeate all levels and activities of the Conservancy.*** "Science" cannot be sequestered in some units or programs and ignored elsewhere.
- ***Scientists and scientific thinking must be fully integrated into the leadership of the Conservancy.*** The expectation that Conservancy science staff should contribute to the development and testing of science-based conservation strategies and actions must be explicitly articulated. Those entrusted with administrative leadership should express a vision of "science-based conservation" that truly includes science.
- ***Alternative or complementary models for developing effective science leadership in the Conservancy should be reviewed.*** For example, developing career ladders for Conservancy science staff that lead to enhanced science positions rather than greater administrative responsibilities would improve both internal scientific expertise and scientific leadership. Greater use of scientists who serve on Governing Boards could also contribute to effective science leadership.

INTRODUCTION

The Nature Conservancy promotes itself and its programs as "science-based conservation." Its roots lie in science. The Nature Conservancy began as an offshoot of the Ecological Society of America initiated by scientists interested in applying ecological science to pressing conservation problems. As the Conservancy has grown in membership, funding, and scope, concerns have also grown that it may have drifted from its original foundation in strong science. To assess how science is actually being used to achieve the goals of The Nature Conservancy, in June, 2000, the Board of Governors' Conservation Committee commissioned an External Science Review of the Conservancy. The External Science Review Committee[1] was assembled in September, 2000. This is that Committee's report.

The Board of Governors posed seven questions for the Committee to address, all of which have to do with the central issue of how science is used (or can or should be used) to achieve the conservation goals of The Nature Conservancy, and how, in turn, conservation science can be enhanced in the process. The seven questions were:

- Does the Conservancy demonstrate an appropriate balance between an action orientation and a scientific approach?
- At what stages in the Conservancy's conservation process is science being used?
- Is the current conservation process (i.e., Conservation by Design) scientifically sound?
- How can the Conservancy best identify and incorporate current science into it practices and into landscape and site conservation actions?
- What are the key scientific problems that the Conservancy needs answers to but that are not now being addressed?
- Are adequate measures used to recruit, reward, and retain excellent science and stewardship staff?
- How can the Conservancy best engage the scientists on its boards in the Conservancy's efforts?

These seven questions set the tone for the Review Committee's fact-finding and thinking. Rather than address these questions individually, however, we have structured this report to emphasize the most important topics that emerged in our evaluation. Our recommendations, therefore, relate directly to these topics. We will return to address the Board of Governors' original questions at the conclusion of this report; the answers to those questions, however, are woven throughout the report.

1 Background information on the Review Committee members is provided in Appendix A.
2 A summary of these activities is provided in Appendix B.
3 The survey results are presented in Appendix C.

We must also emphasize at the outset that The Nature Conservancy is a large and diverse organization with a generally decentralized organizational structure. As a result, it is difficult or impossible to derive generalizations that will hold true in all programs at all places. Although there are undoubtedly exceptions to the statements we will make, we believe that our observations are accurate and our conclusions well-founded. It is our intent that these recommendations point directions for the future strengthening of science-based conservation in the Conservancy rather than be taken as criticisms of what has been done in the past.

Procedures

The Committee first met at the Conservancy's Trustee's meeting in Tucson, Arizona, in late September, 2000. At that time we discussed the charge from the Board of Governors and developed a plan for addressing the issues. Over the following five months, committee members individually conducted interviews with a large number of scientists and other interested individuals, both within and outside of the Conservancy. We visited Conservancy programs, field offices, and sites in all parts of the United States and interviewed many individuals involved in international programs[2] . We requested or were given large quantities of papers, reports, and conservation plans to read and digest. We attended Conservancy workshops. And we developed, distributed, and analyzed a mail survey of Conservancy science staff to solicit their views on how science is done within the Conservancy[3].

The Review Committee then met for two days in mid-February, 2001, in Santa Barbara, California, to present and discuss their findings and thoughts. It was immediately apparent that, despite the differences in our backgrounds and approaches and in the interviews we had conducted, there was remarkable unanimity in our opinions. All of us were impressed and excited by the great potential of the Conservancy to chart new directions in conservation. The Conservancy clearly has a valuable asset in its current science staff and highly educated and enthusiastic work force that can be brought forward to address new challenges in conservation. The framework of Conservation by Design, together with the extensive network of Conservancy sites and a broad perspective on conservation in land, freshwater, and marine ecosystems, can provide an extraordinary opportunity for implementing broad-scale landscape conservation. These factors combine to create a setting in which the Conservancy could establish a strong leadership role in forward-looking, integrated, science-based conservation planning and action. Whether the Conservancy will be able to realize that potential, however, will depend on how effectively the organization deals with the topics we discuss in this report. These topics reflect a series of general concerns:

- Often, Conservancy science staff are not provided with adequate opportunities or encouragement to conduct conservation that is truly science-based; the organizational infrastructure provides neither time nor rewards for doing science.
- The benefits of a science-based approach to conservation are not promoted adequately, either within the Conservancy or externally, to the general public and to potential donors.
- The organization generally lacks sufficient in-house expertise to anticipate or address major future conservation threats, such as climate change, economic globalization, changing land use, or the social dimensions of these forces.
- The Conservancy is not meeting its potential as a learning organization because a "science culture" does not permeate the organization.
- The approach of Conservation by Design and the broader conservation philosophy that it embodies are unevenly embraced and applied within the organization.
- There is some reluctance to take risks, to learn from experience, and to apply this knowledge to a continuing assessment of conservation practices and policies—the basic elements of adaptive management.
- There is a tendency not to take full advantage of opportunities for forming partnership and collaborations with scientists outside of the Conservancy.
- There is inadequate exchange of information, both within the Conservancy and with the broader community of scientists, resource managers, and policy makers.

These statements are oversimplifications, to be sure, and there are certainly individuals, sites, and programs to which they do not all apply. They are concerns that surfaced repeatedly during our review, however, and they provide a useful framework for discussing our findings and presenting our recommendations.

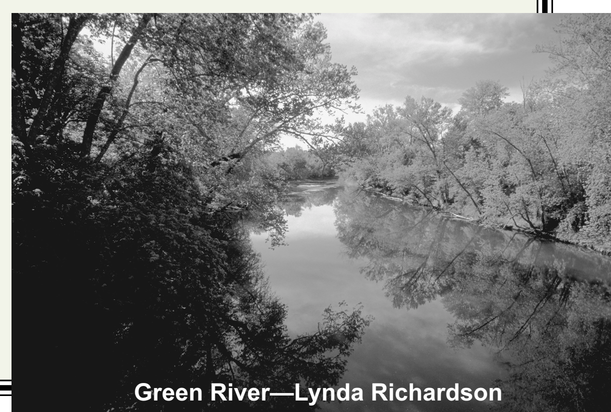
Everything we say, of course, relates to science and its applications. The basic premise of our review, and indeed of any science-based conservation efforts, is that conservation action and management that is grounded in science is better, in the long run, than conservation that is not based on science. To reinforce this point and to illustrate the benefits of incorporating science into conservation planning and action, we showcase several examples in sidebars that are interspersed throughout this report.

One difficulty in assessing science-based conservation, however, is that "science" means different things to different people. Because these differences affect perceptions of how science can contribute to the goals of the Conservancy, we have considered how "science" should be viewed in the context of a conservation organization such as the Conservancy. Our thoughts are summarized in Box 1 (see page 8).

We address the issues raised by the concerns listed above in the body of this report. Before doing that, however, it is appropriate to state the five general recommendations that have emerged from our assessment. Following that, we will briefly describe how conservation and science are both changing; these changes underlie the importance of evaluating how science enters into Conservancy conservation planning and action.

Let it Flow

The Green River in Kentucky is not just another pretty place -- it is a priority aquatic ecosystem for conservation. It has high native fish and aquatic mussel diversity, and several of these species are federally listed as threatened or endangered species. The most significant threat to aquatic diversity on the Green River is an altered hydrological regime caused by a U.S. Army Corps of Engineers dam in the upper reaches of the river. The Conservancy project director for the Green River, who has a Ph.D. in aquatic ecology, has worked with the Corps to change dam operations so as to mimic a more natural flow regime for the river. These changes are being implemented on an experimental basis. As a result of this project, the Conservancy is preparing to sign a national Cooperative Agreement with the Corps that can lead to the Conservancy working with the Corps at other dam sites affecting priority aquatic systems. Other Conservancy work on the Roanoke River in North Carolina and the Mattaponi and Pamunkey rivers in Virginia has shown how flow rates from regulated rivers affect downstream forests and wetlands. These results are also being used as a basis for developing new water-use policies.



Green River—Lynda Richardson

Box 1: What is "Science?"

It is important to clarify what "science" means in the context of a conservation organization such as The Nature Conservancy. Reading a paper in the mainstream scientific literature, one might easily conclude that science consists of abstract mathematical theories, experiments with multiple replicates and controls, statistics, computer models, and dry writing. Perhaps it is this image of science that leads some conservation managers and directors to conclude that science is a luxury they cannot afford. The threats in conservation are too pressing, the demands for quick decisions too immediate, and the funds too limited to engage in lengthy and expensive scientific investigations that may or may not bear on the problem at hand. In this context, science may come to be viewed as an impediment to action, something that stops progress until there is sufficient understanding to permit action (by which time it may be too late). The perception is that science seeks "the answer" to a question and forestalls action until that answer is found.

Alternatively, science is sometimes viewed as the collection and management of data, or as the information itself. This leads to the belief that the contribution of science to conservation goals might be calibrated in a manner similar to dollars, acres, or new programs generated. In this view, science is a commodity, something that one needs to acquire, as quickly and cheaply as possible, before moving on to other important aspects of a project.

Neither of these views accurately represents what "science" really means. Of course science involves theories, experiments, statistics, and models, and it generates lots of data. But these are the tools and products of science, not science itself. Science is the *continual process of building understanding and reducing uncertainty by applying knowledge and critical thought to a problem, by objectively evaluating evidence, and by learning from experience*. It requires that questions, goals, or hypotheses be clearly and logically stated, but it does not require that experiments be done or models constructed, or hypotheses truly "tested," in order to qualify as objective and rigorous—i.e., *science-based*. Science is not characterized by its tools, but by the way of thinking about a problem, of marshaling knowledge and evaluating information. Science rarely produces "the answer," particularly to complex problems such as those at the heart of conservation; it is an ongoing process, a continual building of knowledge and applying it to problems. It is characterized by reasoned skepticism about what we think we know about how a system works or what will happen in response to some action. This skepticism keeps science open to continual learning and improvement.

This way of thinking about "science" may strip away some of its mystique and foster the realization that there are really no impediments to its use in conservation action other than a lack of time, resources, understanding, or willingness. The perceived problem, of course, is that science dictates a need for "more information," yet the immediacy of conservation problems dictates that the science applied in conservation must be carried out "on the fly" and will consequently be inadequate. Good stewardship, for example, is applied science, but it is often conducted from a foundation of limited information (as is all science) and must evolve rapidly in situations that include endless uncontrolled variables. It can be experimental (staff formulate hypotheses, test them, evaluate the results, and revise the hypotheses as necessary) even though it usually does not conform to traditional definitions of a "scientific experiment" (too many uncontrolled variables, hard to replicate because no two sites are truly identical, limited predictive capacity). Thus, it is possible both to take action and to increase understanding at the same time, and to use that increased understanding to inform subsequent actions.

General Recommendations

The five general recommendations are:

1. ***To realize the goal of science-based conservation, science and science-based leadership should be strengthened and suffused throughout the organization.*** As The Nature Conservancy moves beyond its past emphasis on dollars and acres to broad-scale, integrated conservation action, science and science-based stewardship should be front and center. Science and scientific thinking must become an integral part of Conservancy culture.

2. ***The Conservancy should enable their science staff to realize their scientific potential.*** "Doing science" should be part of their job descriptions. They should be given the guidance, training opportunities, encouragement, rewards, and time to achieve their potential. It is critical to the success of the Conservancy's conservation programs that science staff be able to maintain their skills and knowledge. There can be real costs of basing conservation decisions or practices on outdated expertise.

3. ***The Conservancy should move more vigorously to develop scientific partnerships and collaborations.*** Greater use should be made of the expertise that exists in universities, government laboratories, and other conservation organizations. Such partnerships should be founded on true scientific collaborations that go beyond seeking external expert opinion. To accomplish this will require that the Conservancy build internal scientific expertise in critical areas.

4. ***The Conservancy should adopt and promote an adaptive management approach.*** The philosophy of adaptive management, of learning from experience and using that knowledge to inform subsequent policies and actions, should be applied to both conservation action and organizational structure, in order to make the Conservancy a dynamic learning organization.

5. ***The Conservancy should strive to become a leader in applying science to conservation through sharing what it learns about science-based stewardship with other and managers, scientists, and government and conservation organizations.*** The elements contained in the framework of Conservation by Design—broad-scale planning, networking of sites, evaluating threat abatement, adaptive management, and a focus on functional landscapes—offer the potential for forging important new approaches to the conservation of biodiversity. The Conservancy cannot work alone to preserve the plants, animals, and natural communities that represent the diversity of life on earth; the knowledge that comes from science-based conservation should be widely disseminated and shared.

THE CHALLENGE OF CHANGING CONSERVATION AND CHANGING SCIENCE

The need for an assessment of the role of science in The Nature Conservancy is driven by two factors. First, conservation is changing. For decades, the primary focus of conservation efforts was on individual species (usually rare, declining, charismatic, or some combination of these traits) and on pretty places (e.g., National Parks). These priorities dominated Conservancy activities for many years—sites were collected like postage stamps, emphasizing value, variety, beauty, and the size of the collection with little overall pattern or plan except to fill spaces in the album. In recent years, conservation biologists and conservation organization have become increasingly concerned about the broader issue of biodiversity loss, and the emphasis has shifted toward multiple species and multiple sites over multiple scales ("ecosystem conservation"). Within the Conservancy, this shift evolved into Conservation by Design, which has set forth a vision of conservation planning and action based on functional landscapes and ecoregions. To continue the stamp analogy, the shift parallels what stamp collectors often do as they mature—they begin to focus the collection, to group together similar stamps (i.e., sites) into topical folders (i.e., ecoregions) that contain not just rarities but many stamps that collectively represent the topic. The collection is then judiciously supplemented (often through trading of stamps of lesser importance to the topical collections), but more effort is devoted to maintenance and curation (i.e., stewardship) of the collection.

A second factor is the changing face of ecological and conservation science. For decades, ecology was dominated by a focus on population dynamics, community structure, and ecosystem processes. Although these areas were clearly relevant to conservation issues and were incorporated into conservation practices (including those of the Conservancy), there was a continuing separation of basic and applied ecology. In recent years this distinction has progressively faded. At the same time, ecologists have shifted their focus to embrace the greater complexity of entire landscapes and of systems composed of multiple species interacting in multiple ways over multiple scales.

Clearly, the changes in conservation and the changes in science are concordant. The justification for strengthening the role of science in Conservancy conservation activities, however, rests on more than this coincidence in timing. As a consequence of changing its focus from species and sites to landscapes, ecoregions, and biodiversity, the Conservancy must now deal with a new set of challenges. Specifically:

- The complexity of landscape-scale ecosystems and the role of disturbances must be recognized. Sites set aside because they possess certain conservation values will change over time. Consequently, the long-term viability of these ecosystems and the biodiversity they contain becomes a central concern. Sustainable conservation becomes the mantra.
- The scale of conservation efforts has changed. When conservation efforts were directed toward individual (usually small) sites, the data that were collected were usually "snapshots" used to typify the sites. Now the focus has shifted to assessing dynamics and trends, to documenting ecological processes rather than patterns alone, and to doing this over the broader scales of entire landscapes or ecoregions. The demands for information, and for synthesis of information, have become far greater.
- The rate of environmental change is faster now than in historic times. Global climate change, species introductions and invasions, land-use changes and their links to declining coastal marine systems, and habitat fragmentation are all happening at accelerating rates. As a result, science-based stewardship requires some degree of "bet-hedging," by building buffers into conservation plans and stewardship approaches and placing greater emphasis on multiple-ownership systems of conservation lands and regional networks.
- The role of humans in altering landscapes has become a major focus. Consequently, both conservation planning and implementation must include an understanding, not just of the biological and ecological sciences, but of environmentally oriented social sciences as well. Conservation action is inevitably undertaken in a social context.
- Conservation sites take on added value when they are considered as parts of a broader network of sites, linking together not only land areas but freshwater and marine environments as well. Collectively, a network of sites can make larger contributions to conservation goals, and to conservation science, than is possible when the sites are considered individually. Networking sites involves more than listing them together as elements of an ecoregional plan, however. It requires that they be considered as an integrated set of sites that are complementary to one another. This requires integrated management, which in turn requires integrated information about the sites and the site network.

All of these challenges embody greater complexity. Dealing with this complexity is inevitable if conservation challenges and goals are to be met successfully. The changing nature of conservation demands that greater use be made of the tools and insights that can be provided by evolving science. Because both conservation and science are changing in parallel directions, they should be mutually reinforcing. Science should inform conservation practices, but conservation application can also provide insights that advance scientific understanding.

CONSERVATION BY DESIGN

Conservation by Design is the centerpiece of current Conservancy priorities and practices. The development of this approach represents a dramatic step for a conservation organization. It involves a recognition not just of the value of biodiversity (which everyone talks about), but of the need for a broad-based, integrated conservation approach that is based upon setting priorities for the terrestrial, freshwater, and marine areas that must ultimately support biodiversity—the landscapes.

There is more to Conservation by Design than its breadth and scale, of course. It is founded on a conservation approach that involves setting priorities, developing strategies, taking action, measuring success, and using that information to revise priorities as necessary (Fig. 1). Setting priorities involves the design of portfolios of conservation areas within and across ecoregions—ecoregional planning. Developing strategies involves defining conservation targets, evaluating potential stresses or threats and their sources, developing strategies to mitigate these stresses, and monitoring the condition of an area (the "5-S framework" for site conservation planning). Taking action involves the implementation of strategies to achieve conservation objectives, and success is measured by the abatement of threats or improvement in the biodiversity health of a portfolio of sites.

Clearly, each of these steps should involve a science-based approach, as we have defined it here. But there are also substantial scientific opportunities implicit in an enterprise of this scope. The network of functional landscapes envisioned in this approach is a potential national resource for understanding human influences on the structure and functioning of landscapes. The relatively fine-grained network of sites of the Conservancy's network can be used for detailed observations and even manipulative experiments on ecosystem and landscape disturbances and management, indicators of change, and measures of conservation and management success. Conservation by Design provides a framework not only for research that is targeted to the specific conservation goals of the Conservancy, but for research conducted by partners outside of the Conservancy that can have unanticipated conservation benefits.

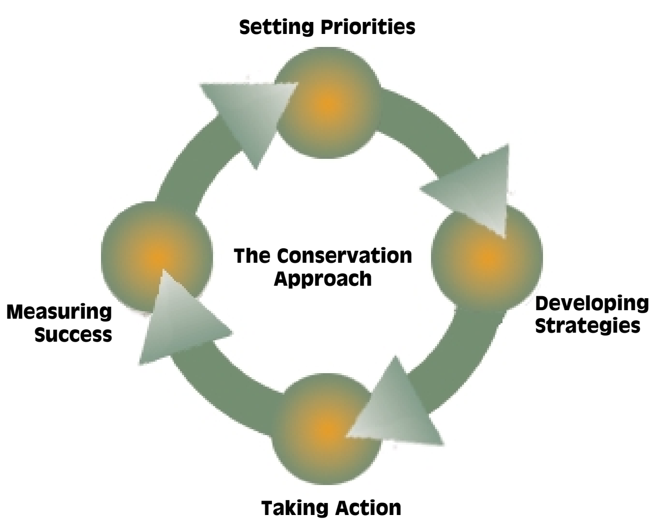


Figure 1. The elements of Conservation by Design

We believe that the approach to conservation embodied in Conservation by Design can lead to conservation planning and action that effectively marshal scientific information, provide opportunities for critical evaluation, foster learning and its application to practices, integrate the perspectives of ecological science with those of social sciences, and consider conservation issues at broad spatial and temporal scales. Whether Conservation by Design currently meets these expectations, however, is another matter. Much of the remainder of this report will deal with what we view as impediments to the realization of the vision of Conservation by Design. Here, however, we offer the following observations:

- The framework and its underlying philosophy are not embraced throughout the organization. At some sites and in some programs conservation is conducted as "business as usual"—i.e., collect more sites and implement site stewardship, sometimes with more of an eye toward community relations than toward the ecological dynamics of the site. This is reflected in a continuing use of "dollars and acres" as measures of organizational success. Ecoregional planning, much less its implementation, is difficult when such attitudes prevail.
- Ecoregions represent areas or zones that are defined by environmental gradients or thresholds rather than political boundaries. As a consequence, most ecoregions encompass more than one state and some cross national boundaries. Developing an ecoregional plan under these conditions requires close collaboration and cooperation among programs. In the past, this has not been a conspicuous element of the Conservancy culture. The development of ecoregional plans in some areas is being delayed because of an inability (or an unwillingness) of programs to collaborate.
- In some instances, once ecoregional plans are developed the process is thought to be finished, when in fact it has just begun. Good plans may become "shelf art" rather than periodically subjected to fresh appraisal, revision,

and action. Only the first stage of the conservation approach shown in Figure 1 has been achieved. Conservation by Design requires action, not just words.

- There is too much reliance on untested expert opinion in the development of ecoregional plans. There are obvious reasons for including expert opinion in conservation planning: data and information are often limited or not readily available, and who better to offer advice than one considered to be expert in a field? Yet "expertise" can vary widely in competence or relevance to a particular problem, and can be biased in various ways. Although there is often an intent to test or validate expert opinion in ecoregional planning, in practice this is rarely done. Overreliance on expert opinion may lead to the substitution of opinion, local dogma, and hearsay for actual data in reaching conservation decisions, producing a false sense of certainty in the basis for the decisions. Once decisions are made, there may be little impetus to look further for additional data sources, or to revisit the decision at some later time.
- Conservation by Design is founded on the idea of identifying targets that can reflect biodiversity and ecosystem health, determining the stresses or threats that are most important, and measuring the success of actions taken to alleviate the threats. Concepts such as "ecosystem viability," "biodiversity health," and "measures of success" (or, for that matter, "functional landscapes" and "sustainability") contain a substantial amount of scientific uncertainty that is masked by vague and subjective assessments such as "good," "fair'" etc. Unless such concepts are defined in ways that allow them to be measured quantitatively, it will be difficult to determine whether Conservation by Design is working as it should, and whether the Conservancy is really achieving its goal of sustainable conservation.
- To be effective, science should be brought into the conservation process at all stages, especially as part of the planning and strategy-setting process. We heard time and again that the most effective ecoregional planning processes were those that involved science from the outset.
- The scope of Conservation by Design is broad, and the need for information is correspondingly broad. This means that it is essential that information about one aspect of the ecological system be related to information about other aspects of the system, that information about one site in an ecoregional portfolio be related to information about other sites, and that information relevant to one disciplinary approach be communicated to individuals from other disciplines who are involved in the conservation planning or action. Inadequate information flow within the Conservancy or between the Conservancy and external partners may impede the realization of Conservation by Design.

Recommendations

Several recommendations follow directly from these observations. Here, as elsewhere in this report, recommendations are presented with differing levels of detail. We use words such as "can," "should," and "must" to express the strength and importance we attach to the recommendations in meeting The Nature Conservancy's science-based conservation goals.

- ***Science should be part of conservation planning from the outset.*** Science should not be brought in to justify actions after the fact, but should be instrumental in planning actions from the beginning.
- ***Key concepts, such as "measures of success," "ecosystem viability," and "biodiversity health," must be made operational by increased rigor and quantification.*** Using relative terms such as "good," "fair," or "poor" to express such important measures leaves too much room for subjective evaluations (which may become self-serving), masks scientific uncertainty, and creates inconsistencies among programs. Quantitative measures can foster a rigorous evaluation of progress in meeting goals and of benefits and costs. If one is going to assess conservation success, it is important to do it right.
- ***The expert opinion that is used in various stages of conservation planning should be validated, and greater effort should be made to base decisions on data rather than opinion.*** Expert opinion is an important source of information in conservation planning, but it does not replace other, data-based kinds of information. Good conservation planning requires that all available information be included in the process.
- ***Ecoregional plans must be periodically reexamined and revised, and the revisions implemented.*** Ecoregional plans provide a blueprint for conservation action, but they are not action in and of themselves. As circumstances change, the conservation values of a specified portfolio of conservation areas will also change, so modifications of plans and actions will be necessary. Conservation is a dynamic process.
- ***Ecoregional and site conservation planning create the necessity of engaging other landowners, governments, communities, and organizations in developing a comprehensive understanding of the biodiversity assets and potentials of an area and crafting a shared vision of a desired future.*** Conservation at the landscape scale requires collaboration and coordinated monitoring and management. Ecoregional planning can be an excellent forum to collaborate with partners in assembling information and identifying information needs. In addition, building understanding of places can inspire actions to achieve a commonly desired set of future conditions.

- ***The administrative partitioning of the Conservancy's structure and activities should be loosened to encourage greater collaboration and sharing of resources focused on entire ecoregions.*** The administrative boundaries that have served the Conservancy well in the past, by tuning conservation activities to local, state, and national cultures and concerns, do not always mesh well with the need for broader scale ecoregional planning and implementation. The notion of "One Conservancy" contained in Conservation by Design must become more than words.
- ***Conservancy staff at the site, state, national, and international levels need to be convinced of the strength and value of the philosophy and the action plan of Conservation by Design.*** Those who do not embrace the approach should be convinced that this represents the most effective way to manage and conserve (to borrow a phrase) "the last great places." The most effective way to bring doubters on board may be to demonstrate that science-based conservation implemented within this framework is doable, works, and is ultimately cost-effective.

Managing Military Lands

The relationship between the Department of Defense (DoD) and The Nature Conservancy serves as an excellent example of collaboration. Several years ago the Conservancy recognized the high biodiversity value of DoD lands. Today, there are several military installations that house Conservancy staff so that the expertise and approaches of the Conservancy can be directly applied to management and conservation. The Conservancy benefits by adding such extensive and diverse lands to its conservation portfolio. In addition, DoD is supplying funds so that some of the scientific ideas developed on DoD lands can be published in the scientific literature. Conservancy scientists work with natural resource staff at the military bases in three capacities. First, they establish an adaptive management process whereby base personnel routinely consult with scientific experts around the country on a variety of science issues, usually in an expert workshop format. The expert workshops define issues and make recommendations, many of which involve the use of models to help natural resource staff do a better job of restoring the ecosystem. Second, they have developed and run a research program aimed at testing different land-management regimes in an experimental design, with the goal of restoring a functional ecosystems. Third, they assist base personnel in preparing an integrated resource management plan for a base by using a site conservation planning approach. Through this effort, additional data are collected in the field on priority conservation targets that will contribute to defining desired future conditions for these targets.

Cowbird Tracking—Terry Cook

ADAPTIVE MANAGEMENT

Adaptive management is a process that considers planning and policy decisions and their implementation in management actions as hypotheses that are subject to testing, analysis, and revision. The approach can be used to evaluate the impacts of management actions on natural resources and to modify management actions to protect those resources and enhance the likelihood of meeting conservation goals. Adaptive management emphasizes decision-making as a continuing process, not a discrete end point. It views management actions as "experiments" and accumulates knowledge to foster continual learning. It is an explicit way to address the uncertainty in management decisions and, by applying what is learned, reduce future uncertainties. The incorporation of uncertainty in the formulation of management strategies sets adaptive management apart from other, more traditional approaches to decision-making.

Adaptive management involves six critical elements:

- defining the ecosystem and the conservation problems based on a review and synthesis of available information;
- identifying goals based on scientific predictions and conservation values;
- developing a peer-reviewed management system;
- implementing management actions that meet stated goals within the parameters of the social, political, and ecological acceptability of risks and consequences;
- conducting applied research and monitoring to reduce uncertainties and evaluate management actions; and
- using the results and knowledge gained from those activities to reassess goals, procedures, and policies.

Adaptive management assumes an ongoing, iterative process that can adjust to new information, changing goals, and changes in environmental conditions that may occur over a broad scale or over a long time.

Although it is not always stated as such, adaptive management is in fact the central guiding philosophy of the Conservation Approach embodied in Conservation by Design (Fig. 1, page 12). To complete the adaptive management circle of the Conservancy's conservation approach requires science. A scientific perspective is needed to define the ecosystem, identify goals, and monitor and evaluate the results in a learning mode. Adaptive management requires acceptance of the idea that "there are no failures, only failures to learn." The need for adaptive management is currently recognized within the Conservancy, although its use is not widespread. Our survey of Conservancy staff scientists (Appendix C) indicated that adaptive management approaches were not employed in the majority of projects, even though most of these projects could benefit from it. When adaptive management was used, it generally involved trial-and-error
approaches or passive rather than active management. When unanticipated outcomes emerged, the usual response was to seek expert opinion to decide what to do next.

Although half of the respondents felt that there were adequate mechanisms available to use information on the results of an action to reassess the data or reasoning underlying that action, such mechanisms seem to be infrequently used, usually due to a lack of sufficient time. To a considerable extent, then, "adaptive management" within the Conservancy appears to be more talk than application. Too often, the initial management actions are not carefully thought through and are inadequately documented, and there is little follow-up investigation or monitoring to see what happened. This problem, of course, is widespread in conservation and ecosystem management outside of the Conservancy as well. The conservation missions of government agencies and other land-management organizations could greatly benefit if the Conservancy were to lead by example in the application of adaptive management.

Recommendations

- ***The Conservancy should embrace and practice adaptive management.*** The scientific elements of adaptive management should be incorporated into the Conservancy's conservation approach whenever possible. True experimental management, however, may not be possible or desirable in all situations. Adaptive management does not always need to be a highly formalized procedure, but the general approach is essential to good management and conservation.
- ***The Conservancy should create a safe environment in which to take risks.*** Adaptive management is based on accepting the possibility that current resource management actions may not work but can nonetheless provide a basis for learning. The "fear of failure" attitude that still exists at some levels within the Conservancy should be purged. Conservation is learning as well as doing.
- ***Conservation goals must be clearly and explicitly stated.*** The process of adaptive management rests on a continuing evaluation of progress toward specified goals. If the goals are not specified, in measurable terms, it is impossible to determine when or if they have been reached. Cost-effective conservation requires a clear

statement of desired endpoints.

- ***The expectation that Conservancy science staff should contribute to the development and testing of science-based conservation should be explicitly articulated.*** Science staff need to know that their role in implementing adaptive management is both expected and appreciated.
- ***Site networks should be used to conduct comparative experiments.*** The networks of sites identified within or among ecoregions as part of ecoregional planning provide exceptional opportunities for testing management methods and approaches through well-designed comparisons. Such approaches can be applied to many Conservancy actions, whether passive or active (e.g., restoration). There is a great potential to produce insights of lasting value to sustainable conservation. The Nature Conservancy needs to capitalize on these opportunities.
- ***The adaptive management approaches adopted by the Conservancy should be independently evaluated.*** Such independent evaluation can serve multiple purposes: drawing external scientists more fully into Conservancy activities (i.e., potential partnerships), making the conservation approaches of the Conservancy more widely known, and discovering ways to improve the process.

Water in the Desert

In Arizona, the San Pedro River riparian woodlands and adjacent desert support what is arguably one of the most diverse ecosystems in the United States. Studies conducted by scientists at Arizona State University in partnership with the Conservancy revealed that the riparian trees required certain levels of groundwater, leading to the prediction that further groundwater reductions due to pumping for agriculture would result in reduced establishment of native forests, as well as reductions in native herbaceous species associated with the fine-textured soils and shady conditions of floodplain terraces. This vegetation comprises critical habitat for the endangered Willow Flycatcher. This research has had significant impacts on the Conservancy's work in Arizona. Following from the prediction that retiring agriculture and the associated water pumping should restore the river's flow and raise the water table, Conservancy staff developed a hydrological model to help guide decisions. As a result, a large tract of land is being purchased to reduce agricultural pumping. Continued monitoring is in place to determine whether additional actions are required to restore natural ecosystem functioning.

San Pedro—Adriel Heisey

PARTNERSHIPS AND COLLABORATIONS

Collaborations with agencies, universities, and other non-governmental organizations have contributed to many of The Nature Conservancy's accomplishments by helping to bring the best science into conservation. The Conservancy's programs could benefit from substantially more collaboration, however. As the scope and complexity of conservation and the science it entails have grown, the demands for science expertise have far exceeded the capacity of the Conservancy to meet these demands using their own staff. Furthermore, although increased science staffing is clearly needed in critical areas, the solution does not lie simply in adding more staff to address these needs. The Conservancy is relatively strong in pattern-based conservation science, but it is relatively weak in process-based sciences, even though the need for such expertise is emerging with the increased focus on ecoregional planning and stewardship of areas that are less than pristine. The Conservancy is not likely to build major internal strength in disciplines such as modeling, climatology, geology, forestry, or the social sciences by adding the necessary staff, but it can gain access to such expertise through partnerships. The Conservancy cannot address the challenges of Conservation by Design, especially those posed by future environmental changes, by adding a little expertise here, a little there. At the same time the Conservancy must have sufficient in-house expertise in critical areas to be able to attract the best partners, to be able to communicate effectively with them, and to translate the resulting knowledge into conservation action.

The Nature Conservancy cannot do it alone. More and better partnerships are needed. Building partnerships with external scientists in academia and government is probably the most cost-effective way to infuse new and emerging science directly into Conservancy programs. The payoff per unit investment in partnerships can be extremely high, so increased investment in collaborative science is warranted. Productive partnerships enhance, and are enhanced by, the credibility of the Conservancy as a science-based conservation organization.

Partnerships and collaborations can be built in a number of ways, by:

- basing Conservancy scientists on university campuses or in agency laboratories;
- providing limited support for graduate student or faculty research that meets the needs of the Conservancy;
- co-authoring grant proposals to fund science of mutual interest and importance;
- jointly supporting scientist (or shorter term postdoctoral) positions;
- facilitating use by external scientists of Conservancy conservation areas as venues for research;
- co-sponsoring symposia or scientific meetings (such as the highly visible and successful joint The Nature Conservancy-Ecological Society of America meeting of 1999);
- developing and leading multidisciplinary workshops to link Conservancy scientists and non-science staff with experts in areas relevant to a particular conservation concern or goal; and
- sharing information and data.

What are some of the likely payoffs to the Conservancy from further investment in science partnerships? The benefits accrue in three areas: expertise, training, and research. Partnerships can increase both the quality and the breadth of expertise that can be tapped by the Conservancy. Close collaboration, for example, is one way to enhance confidence in the expert opinion that is sought to guide planning, protection, and stewardship. Partnerships provide access to much better science than the Conservancy can possibly afford to employ independently.

An important benefit of locating Conservancy scientists at universities or agency laboratories is in enhancing the level of their scientific knowledge through their immediate access to a larger scientific community. Often, Conservancy scientists operate in near isolation from their scientific peers. One result of this isolation is that their knowledge may become outmoded and stagnant. A scientist immersed in a group of peers is stimulated and better informed, thereby keeping the Conservancy closer to the leading edge of conservation science. Personal contacts are an important way for Conservancy scientists who may be new to a particular area of inquiry to access outside scientists. They can initiate a network of contacts that can provide training opportunities and may initiate long-term collaborations, by nurturing the interest of academic or agency scientists in the Conservancy and its programs.

The Nature Conservancy can also reap benefits by building relationships with graduate students, postdoctoral investigators, and established scientists who can conduct research on Conservancy sites in collaboration with Conservancy staff. Such partnerships can add substantially to the body of expertise available to focus on research problems of common interest with the Conservancy. Their commitment of time and effort may be critical to helping the Conservancy understand and predict the consequences of site management decisions or of broader policies. Moreover, a scientist who works on Conservancy lands becomes a friend of the

Conservancy. This is evident already among the first cohort of Smith Postdoctoral Fellows. This program is producing a cadre of young researchers who feel a bond with each other and with the Conservancy, and it is expressed in their commitment to the types of environmental research that address the conservation needs of the organization.

Partnerships can also facilitate communication with the community at large, a process certain to increase in importance as Conservation by Design is fully implemented. Strong partners can help the Conservancy speak effectively and convincingly to the need for regional perspectives in conservation planning: multiple voices often speak more convincingly than soloists.

Of course, engaging in partnerships and collaborations takes time—the process of setting shared goals, communicating effectively, and establishing working personal relationships all require that the Conservancy participants devote some time and energy to managing the partnership. The broader the partnership, the greater the management demands. This is one more factor that can draw Conservancy science staff away from what they do best, so this managerial role in partnerships must be carefully balanced with other demands.

It is clear that the Conservancy can benefit greatly from partnerships and collaborations. Can the relationship be reciprocal? Will partners see sufficient benefits in forming strong collaborations to make the formation of partnerships with the Conservancy worthwhile? Properly implemented, the answer is clearly and emphatically yes. The Conservancy's reputation as a global leader in conservation makes it an attractive partner for organizations (e.g., some federal agencies) whose own conservation reputation is less than robust. The Conservancy can also provide access to a scientifically valuable resource base in which partners can conduct research. Many protected areas under Federal or State jurisdiction (e.g., Wildlife Refuges, National Forests, National Marine Sanctuaries, marine protected areas, Natural Area Reserves, protected research reserves of universities, National Parks) serve multiple and often conflicting purposes. In contrast, the conservation areas that form the foundation of the Conservancy's ecoregional planning have been targeted for protection and management because of their inherent value to biodiversity. Some of these areas have been subjected to reasonably long-term adaptive management in which stewardship practices have been accompanied by monitoring. These practices, and the data resulting from monitoring their impacts, provide a valuable and attractive resource, especially to scientists interested in developing a stronger scientific foundation for conservation.

It is important to emphasize that, while partnerships and collaborations may be an effective and cost-efficient way for the Conservancy to increase the breadth and depth of available expertise to address conservation issues, partners can't do it alone. It is imperative that the Conservancy develop a sufficient level of in-house scientific expertise in critical areas to serve as a foundation for these essential partnerships. There are two reasons why this is important. First, the partners who have the greatest expertise to offer are not likely to be interested in collaborating with Conservancy staff or programs unless there is some degree of expertise in an area in the Conservancy as well. Otherwise, they become little more than a consultant, not a true partner. Second, in order to take advantage of what external partners have to offer, it is essential that there be people within the Conservancy who have sufficient understanding not only to carry on intelligent collaborations with the partners, but to be able to convert the results of the collaboration into information that can be applied directly to Conservancy actions. Translating important knowledge is not possible unless one knows the language.

Curiously, The Nature Conservancy may have a stronger reputation for partnering and collaborating in international conservation science than it does in the United States. Perhaps this is because the mutual benefits change in the international arena. Here the situation is not usually one of the Conservancy scientists immersing themselves into a larger critical mass of scientists (although this can happen in some instances), but rather the Conservancy serving as trainer and mentor of staffs of local governmental and non-governmental conservation organizations as they strive for self sufficiency. The Conservancy is their pathway to the knowledge and tools of conservation science. The relationship is equally essential for the Conservancy, for it is the local partners who provide links to the socio-political environment and facilitate in-country support for conservation. In some cases, the Conservancy plays a role as catalyst among many players; in others, the Conservancy's role is one of front-line leadership. In both, however, success can only be achieved when the Conservancy engages in strong collaborative efforts, a point clearly recognized by the Conservancy's international programs.

Of course, partnerships do not always work out well. In our interviews with Conservancy staff, two messages about partnering emerged clearly. First, when partnerships work, they are great. Second, they sometimes don't work, usually because the partner (often an academic scientist) does not deliver needed information on time, does not conduct research relevant to the Conservancy's needs, or proves to be difficult to work with. Clearly, good partnerships require a shared understanding of goals, a clear statement of what the Conservancy needs and expects from the collaboration, continual attention from Conservancy staff to keep the partnership focused, communication, and mutual trust and respect.

Recommendations

- ***More external scientists should be involved in Conservancy activities.*** For example, much could be gained by involving more scientists in Conservancy workshops. The possibility of developing sabbatical programs to enable external scientists to spend time working within the organization, at state, national, or international levels should be explored.
- ***The Conservancy should develop and actively promote programs to base Conservancy science staff in universities, government laboratories, and field sites.*** Some assignments, lasting from a few weeks to several months or even years, would have a clear focus and the expectation of a definite product. Others would be permanent posts, enabling Conservancy scientists to benefit from interactions with a critical mass of other scientists and practitioners concerned with applied conservation issues.
- ***The Smith Fellowship Program should be expanded.*** This program has proven to be extremely cost-effective. It is currently being enlarged to support sabbatical leaves for senior scientists. Possibilities of developing an international counterpart should be explored.
- ***A program to provide limited support to graduate students conducting research on Conservancy conservation areas should be developed.*** Because such a program could potentially become quite large, we suggest initial development as a small, tightly focused pilot program.
- ***The Conservancy should make greater use of web sites to engage potential partners.*** For example, a state program could develop a web site that provided detailed descriptions of conservation areas, along with listing of specified Conservancy information or research needs for those areas. Potential collaborators could search the web site for suitably compatible research opportunities, which could then be the foundation for developing a partnership.

INFORMATION MANAGEMENT

Effectively gathering and managing biodiversity data and information have been keys to The Nature Conservancy's success as a conservation organization. Over the past quarter-century, the Conservancy has invested considerable resources into collecting, organizing, archiving, and distributing information about the distribution and status of native species and communities. The resulting network of Heritage databases managed by some 85 Heritage Data Centers is a remarkable achievement that set an international standard for biodiversity databases. The Conservancy has also been a leader in developing and promoting other components of systematic biodiversity inventory and monitoring, such as a national vegetation classification system and vegetation plot database.

We did not undertake a detailed analysis of Conservancy information management across all levels of the organization. However, we did try to gain a general sense of the Conservancy's human and technological capacity for managing scientific data and information to answer two questions:

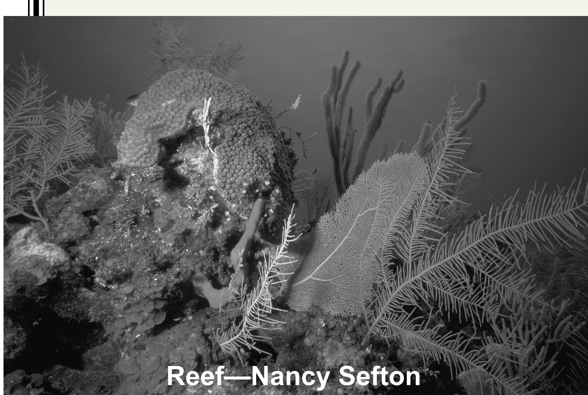
1. *How has institutional separation from the Association for Biodiversity Information (ABI) and the Heritage Database Programs impacted information management in the Conservancy?*

   With the separation from ABI, the Conservancy has retained little internal capacity for maintaining or analyzing the regional biogeographic, socioeconomic, and environmental data that will continue to inform ecoregional planning and provide the larger context for local and landscape conservation efforts. ABI is now modernizing the Biological and Conservation Data System into the Heritage Data Management System (HDMS). At the same time, the Conservancy is developing a suite of new software tools to complement HDMS. Examples include the Conservation Lands System, which will be used to manage information related to land transactions, the Conservation Planning Tool, which will store site-based and ecoregional-based scientific information, and BIOTICS, a GIS tool built on ArcView to facilitate mapping and display of Heritage data and other geospatial information. In view of the Conservancy's continuing need for technical and scientific information for ecoregional analysis, these developments indicate the need for the two organizations to maintain strong and ongoing working relationships.

   We encountered some concern among Conservancy and ABI staff that institutional separation, although sensible in many ways, may over the long run undermine the Conservancy's commitment to collecting and using Heritage data and information, as well as ABI's ability to tap Conservancy experience on information needs and applications. While the Conservancy currently provides major funding to ABI and has a seat on the ABI Advisory Board, there is no formal arrangement for maintaining scientific collaboration between the two organizations. Furthermore, the interest among local Conservancy personnel in supporting state Heritage databases appears to be declining as emphasis shifts to community collaboration and local stewardship.

The Key to Conservation

The Nature Conservancy through its Florida Keys Office was instrumental in the 1990 legislation that created the 2800 nmi^2 Florida Keys National Marine Sanctuary and it was actively involved in over six years of public debate leading to implementation of its management plan in 1997. Research supported by the Conservancy showed that runoff of untreated sewage from thousands of cesspits and septic tanks caused nearshore water quality to decline below state minimum standards. Conservancy-sponsored volunteer groups continue a monitoring effort that informs the water quality action plan. The management plan calls for the implementation of a zoning action plan including marine reserves, where fishing and extractive use are prohibited. By effectively gathering existing scientific information and surmounting public skepticism with facts, the Conservancy was influential in establishing and monitoring the nation's first network of marine reserves. This early experience in marine conservation in the Keys Sanctuary will be a model for the Conservancy's future efforts in its current 60 coastal and marine sites.



Reef—Nancy Sefton

Currently, Conservancy chapters in many states provide important political support and collaboration to maintain healthy local Heritage programs. A weakening of the Conservancy's commitment could threaten the long-term viability of those programs.

In separating from ABI, the Conservancy divested itself of its most of its technical expertise and personnel in biodiversity information management at a time when its information management needs are growing exponentially. The Conservancy does not appear to be committed to significant new technical staffing. Of 206 job announcements this year, only six have been for technical specialists, and half of those were for GIS specialists. We believe that programmers, modelers, and environmental informatics specialists are also needed to meet some critical information management and analytical demands, which are described in more detail in the next section.

2. *Is the Conservancy's current and planned information management capacity adequate for the scientific challenges of Conservation by Design?*

Scientifically based conservation requires data and information that have not traditionally been considered by the Heritage Data Programs. For example, ecoregional and site planning uses satellite imagery and digital environmental maps; static models for predictive mapping of species' distributions; socioeconomic information such as census data and county general plans; and dynamic models to help project future changes in land use and biological distributions. Similarly, stewardship and adaptive management require a variety of scientific information, ranging from water chemistry or vegetation structure and composition to animal telemetry data or livestock grazing records. In moving "beyond Heritage," is the Conservancy also developing the capacity to coordinate these kinds of measurements across landscape project areas and to manage and analyze such a variety of data?

Although the Conservancy has some excellent individuals in informatics and scientific computing, we believe the organization has a shortage of trained personnel in these areas, especially in database design and management, decision science, quantitative geographic information analysis, integrated assessment and modeling, and dynamic modeling of ecological processes. These capabilities are important to site, landscape, and ecoregional monitoring, assessment, adaptive management, and planning.

The Conservancy currently has no policies governing the collection and management of scientific data and information. Not surprisingly, data management practices are uneven across the organization, especially for site-level stewardship and research. This situation does not bode well for the Conservancy's goal of adaptive management over large landscapes. For example, based on survey responses, two-thirds of the individuals who generate original data do not use a formal archiving procedure to store those data. A small fraction of Conservancy site information is readily accessible, even to other Conservancy employees. There is presently no information storage or retrieval system for stewardship-related information and data generated at sites, and we are not aware of any plans to develop such a system. This compromises attempts to measure conservation success.

Although many Conservancy scientists and other personnel appreciate the importance of good information management practices, most lack the technical training, time, and/or interest to carry out those practices. Achieving some level of standardization in sampling and measurement techniques, data documentation, archiving, and sharing over the network is now both reasonable and practical. For starters, organizations such as the Federal Geographic Data Committee (www.fgdc.gov/), the Long Term Ecological Research Network (www.lternet.edu), and the Knowledge Network for Biocomplexity (http://knb.ecoinformatics.org/) provide technical literature and public software tools to promote better management and sharing of scientific data by individual scientists as well as organizations. Improved information management is just one part of the Conservancy's larger challenge to maintain internal and external scientific communication. There is also the ongoing need to invest in scientific computing systems, fast and reliable Internet service, and convenient Web and e-mail services. We would highlight the recently established ConserveOnline (www.conserveonline.org) as a positive example of the Conservancy's investment in Web-based service to promote communication among Conservancy scientists and stewards.

Recommendations

- ***The Conservancy should maintain a strong working relationship with the Association for Biodiversity Information (ABI).*** Although the Conservancy's information needs have expanded beyond the Heritage-based data that continue to be the focus of ABI, such information is still an essential ingredient of sound conservation planning. A continuing Conservancy commitment is needed to ensure the long-term viability of local Heritage programs and ABI.
- ***The Conservancy must build capacity in information management.*** Good planning and effective action require information. Indeed, information is power. It provides the leverage to influence the thinking, policies, and actions of others. To enhance its use of information, the Conservancy must add staff with expertise in such areas as database design and management, decision science, programming, modeling, and environmental informatics at all organizational levels. Information management has entered a new era, and to capitalize on these advances—indeed, *to invest in the future*—the Conservancy needs staff who know how to meld these advances into the organizational structure of the Conservancy most effectively and efficiently.
- ***Standardized procedures for collecting and managing scientific data and information must be developed.*** Conservation action at the scales of landscapes or ecoregions requires information on a variety of topics that must be obtained from a variety of sources, yet integrated management requires also that such varied data sets be compatible. Information must be readily retrievable or else it is not really "information."
- ***Continuing efforts should be made to ensure that the computational and communication capacities within the Conservancy are current.*** Efficient information flow and sound business management both demand that all individuals and units within the organization be able to communicate rapidly and effectively.

Too Few Ungulates

In collaboration with scientists at several universities and government laboratories, Conservancy scientists initiated a broad study of the role and consequences of spatial and temporal disturbances in grassland ecosytems. Working on Conservancy sites in North Dakota, Nebraska, Kansas, and Oklahoma, the study evaluated how fire and grazing interact in their effects on plant species diversity and on the physical and chemical environment at several spatial scales. The results indicated that reintroducing large ungulate (i.e., bison) grazing is just as important as reintroducing fire to sustain biodiversity in large tracts of tallgrass prairie. Funding from the Conservancy's Ecosystem Research Program catalyzed the development of scientific collaborations between the Conservancy and academic scientists and served as a foundation for obtaining additional funding from other sources to support ongoing investigations into the design of large-scale management practices for these and other Great Plains grassland sites.

Bison—Harvey Payne

EMPOWERING CONSERVANCY STAFF SCIENTISTS

The strengths of The Nature Conservancy are in its vision, its places, and its people. The Conservancy's vision has been crystalized in the bold framework of Conservation by Design. The value of its places is the essence of Conservancy history and what places it in an extraordinary position to lead biodiversity conservation by example rather than words. Vision and places figure importantly in the Conservancy's promotions. But what about people? People are, ultimately, the heart and soul of an organization. They are its most valuable resource.

During the course of our review, two impressions emerged repeatedly. On the one hand, the Conservancy science staff, at all levels, contains many good scientists, and some truly outstanding ones. All are exceptionally dedicated to the Conservancy and its mission and are highly motivated to achieve its conservation goals. They believe in the Conservancy. On the other hand, many of them (including some of the best) express a disturbing level of concern and frustration. They feel that they are burdened with increasing responsibilities and demands without commensurate additional support. They are stretched too thin; they have no time (a point that emerged frequently in the Survey results; Appendixes C and D). In short, they often feel that the Conservancy does not empower them to be all that they can be.

Several circumstances contribute to this situation:

- Conservancy scientists find that they do not have the time to keep up with advances in their field. They fall farther and farther behind, and they begin to lose self-confidence as scientists. At the extreme, this may lead to a reluctance to interact with external peers because they no longer feel that they are really scientists.
- There is a perception among some Conservancy staff scientists that science, and their own scientific efforts, are not valued by supervisors and administrators. This is reflected in a general lack of encouragement or rewards for activities such as publishing papers in peer-reviewed journals or presenting papers at professional meetings. These are essential ingredients of "staying alive," professionally. They sharpen the scientific skills of staff scientists by exposing them to external peer review. They are also extraordinarily valuable and effective ways of spreading the word about Conservancy activities, thereby enhancing the credibility of the Conservancy as a science-based conservation organization. While the expectations that Conservancy scientists publish and present their work should not be the same as for academic scientists, they should not be neglected altogether.
- Career-advancement opportunities for science staff are limited, at least if they want to continue doing science. The normal "career ladder" for a staff scientist leads into an administrative position, which may contribute to the Conservancy's organizational needs but does not enhance the level of science being done by the scientist. Consequently, the incentives and opportunities for doing good science are diminished.
- Overall, Conservancy staffing in science is not keeping pace with the demands placed on science by the new initiatives. As a consequence, more and more is expected of scientists who have less time to think through what they are doing and must address too many disparate issues. The science staff needs to be bolstered, particularly in areas that are critical to current and future Conservancy programs. In the survey, Conservancy field scientists identified aquatic ecology and hydrology; monitoring, restoration, and stewardship; and GIS and remote sensing as areas in which additional staffing was needed. Based on our own review of Conservancy programs, we would suggest adding additional staffing in landscape ecology, modeling (especially spatial modeling), forestry, and climate and land-use change to this list. Bolstering internal expertise in ecologically informed social sciences is especially critical. Other staff needs have been mentioned in the section on information management.
- Staff that are added at sites (e.g., site stewards) often have little or no training in any science, but rather are hired on the basis of their managerial or community relations skills. Those scientists who do take positions at sites often feel isolated from their peers.

Collectively, these issues threaten to erode the "science-based" mantra of the Conservancy, by compromising the skill and knowledge base necessary to make Conservation by Design a reality. The credibility of this approach will ultimately rest on the quality of science that underpins the efforts. There is good science being done within the Conservancy, but its value is often not fully recognized within the organization, and it is usually not promoted (or even communicated) externally.

Recommendations

- ***The value to individuals and to the Conservancy of publication and presentation at professional conferences should be recognized.*** While the expectations that Conservancy scientists publish and present their work are clearly different from those in academic institutions, it is nonetheless clear that this activity is extremely important and valuable. Publication and presentation help individuals maintain currency, establish contacts, and generate a feeling of fulfillment and closure in their application of science to conservation goals. The external peer review that is part of this process should become the modus operandi of scientific work and science-based management in the Conservancy. Publication and presentation are also a cost-effective way to publicize the scope and quality of the science that the Conservancy brings to bear on conservation issues. They enhance the scientific credibility of the Conservancy, which in turn enhances the capacity of the Conservancy to form partnerships and obtain support for its conservation programs.
- ***Conservancy scientists must be given enhanced training opportunities that are relevant to their work and the Conservancy mission.*** Science is advancing quickly. Focused workshops and training sessions can enable Conservancy scientists to maintain currency and self-confidence without unduly distracting them from their other responsibilities. Continuing training is also important in retaining skilled science staff within the organization. Such workshops should include a substantial representation of external scientists as well as Conservancy staff. The working-group approach of the National Center for Ecological Analysis and Synthesis may provide a useful model.
- ***Science staff and expertise must be added in key areas that are defined by the future directions of Conservation by Design.*** To address current and emerging conservation issues, and to forge effective partnerships and collaborations, the Conservancy needs internal expertise in critical areas. Conservancy staff in the field have identified such areas as GIS and remote sensing, forestry, aquatic and marine ecology, hydrology, landscape ecology, restoration, social science, and climate and land-use change as important priorities. Such additions should be made at international, national, and state levels as appropriate. The level of science awareness in staff at all levels and in all programs should also be increased.
- ***Scientists in small programs should be networked to reduce their isolation.*** Steps should be taken to enable scientists located at sites or in programs, states, or nations with little immediate contact with other scientists to engage in broader interactions with their peers. For example, conference calls and the internet may provide opportunities for such individuals to act as members of scientific teams.

Too Many Ungulates

Stewards faced with abating the threat of non-native pigs, goats and other feral ungulates in Hawaii's rainforests are guided today by the science of ungulate management pioneered by Chuck Stones of the National Park Service, Reg Barrett of U.C. Berkely, and their colleagues. These researchers demonstrated the importance of focusing on removal of the last few ungulates in a problem population, and keeping numbers very low to prevent rapid reproduction and repeated damage to native vegetation. They also field tested a range of practical control methods, documenting their relative costs and effectiveness, and giving managers practical methods for measuring the impact of their work. Thanks to these scientists, the impossible—removing free-ranging pigs and goats from dense tropical forest—became the commonplace, and Hawaiian forests have rebounded where their methods are employed.

Feral Pig—The Nature Conservancy, Hawai'i

SELLING SCIENCE

Conservation by Design is a bold initiative, and it places the Conservancy in an extraordinary position. No other conservation organization has the foundation, in land holdings and perspective, and the potential to implement conservation that emphasizes the sustainability of broad-scale networks of sites integrating public and private land-use interests. Because it is not bureaucratically overly sensitive to political winds, it can do what many government agencies charged with conservation responsibilities cannot, and because it adopts a non-confrontational approach to dealing with private stakeholders, it can do what many other environmental organizations cannot. The Conservancy is well-positioned to make a difference.

Despite all of this, the contributions of science to the Conservancy's conservation practices and policies are by and large well-kept secrets. Other conservation organizations do much more to publicize the results of their science - chiefly through publications - and they reap the benefits of this publicity. The bottom line is that *the Conservancy needs to do a much better job of selling its science*.

There are three target audiences to whom science-based conservation needs to be sold. One is within the Conservancy: the State Directors, Home Office administrators, Boards of Governors, and other staff who are not yet convinced that "science" is worth the effort (perhaps because they have an overly restrictive view of what constitutes "science"; see Box 1). The second audience is potential collaborators and partners. Promoting a highly visible, high quality, and well-supported science presence in the Conservancy will make it easier for Conservancy scientists to attract excellent non-Conservancy collaborators and will help in the development of relationships with resource management agencies and other organizations. The third audience is potential donors, especially those who are attuned to science and technology and their uses. Properly presented, science can be a tremendously effective fund-raising tool. The heightened awareness of the biodiversity crisis makes it opportune to promote the Conservancy's Conservation Approach and the central role of science in giving that approach rigor and substance. Many potential donors would welcome the opportunity to talk about the Conservancy's approach to biodiversity conservation with scientifically literate people who can also communicate well, and this should become a central feature of the Conservancy's development and fund-raising strategies. Pretty places and charismatic species sell conservation, but so also can science.

Selling science requires more than the rough outlines of a science-based approach, however. Both Conservancy administrators and potential donors are likely to respond to concrete evidence that "science works" (see the sidebars); they need examples. The best people to supply such examples are the Conservancy scientists and their partners who have been directly involved in the conservation efforts. The information to sell science ultimately must come from the scientists. Once again, the importance of current limitations in time allocation and information flow becomes obvious. Conservancy administrators and potential donors may also respond well if the use of science in Conservancy programs is presented in a business context: What does science produce? What are the costs and benefits? Does science facilitate making the right decisions in a timely and cost-effective manner?

Recommendations

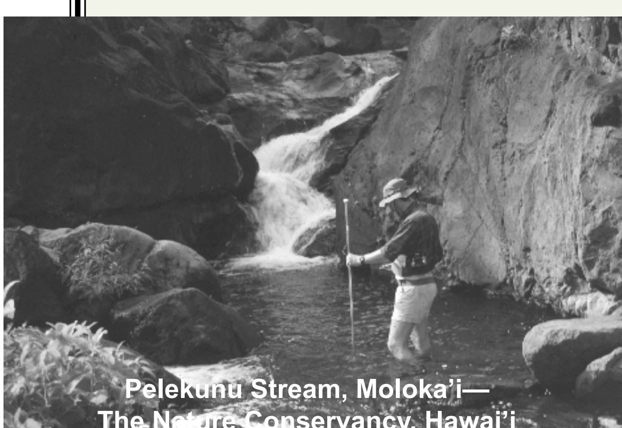
- ***The Conservancy must recognize and promote the value of a science-based approach.*** In order to implement Conservation by Design, the approach and the science it entails must be widely accepted. This recognition must extend to include administrators, staff, and Governing Boards.
- ***The Conservancy must use science vigorously, innovatively, and accurately in its fund-raising efforts.*** Properly presented, science sells.

FUTURE CHALLENGES

The number and variety of conservation threats that conservation organizations must deal with is increasing dramatically. This means that The Nature Conservancy must have the organizational capacity and flexibility to recognize and anticipate emerging threats and to develop new response and management strategies to deal with them (see the section on Science in the Conservancy Infrastructure). Some current threats are obvious. Respondents to our survey, for example, identified conversion of landscapes to human habitation (e.g., housing and urban development), invasive or exotic species, agricultural practices, fire suppression and wildfires, and alterations of hydrologic regimes as the most urgent conservation threats. To varying degrees, the Conservancy is beginning (but often just beginning) to consider these threats in its conservation action plans.

It's the Headwaters, Stupid

Scientists John Ford and Andy Yuen, then of the U.S. Fish and Wildlife Service, revolutionized the Conservancy's view of Hawaiian streams and helped avert what would have been a disastrous miscalculation of how to protect one of Hawaii's last pristine river systems—Pelekunu stream on the island of Molokai. Water developers proposed the diversion of Pelekunu stream flows above the 1100 foot elevation contour. These valley headwall streams were believed to be less important than the main stem to five endemic fishes. By studying the geomorphology of the catastrophic landslides that periodically scour Hawaiian streams and the subsequent recruitment of endemic fishes and other stream macrofauna, Ford and Yuen discovered that the stream's main stem is repopulated following these slides by populations from the very headwater streams that were proposed for diversion. This discovery strengthened the Conservancy's case for keeping Pelekunu free of all diversions.



Pelekunu Stream, Moloka'i—
The Nature Conservancy, Hawai'i

Of greater concern are the long-term threats that have the potential to undermine all current conservation efforts unless they are adequately anticipated. Three areas are especially critical:

1. *Global change.* The environmental and social consequences of global environmental change are becoming more and more evident. These changes are diverse. They include: climate warming; changes in precipitation regimes; increases in atmospheric concentrations of CO_2 ; conversion of natural landscapes and coastal marine ecosystems to human uses; intensification and disruption of nutrient cycles; changes in the hydrological cycle; changes in disturbance regimes; and a widespread mixing of biotas associated with the introduction of nonnative species and the loss of other species. We are seeing the difficulties of developing and implementing international policy decisions to manage the emission of greenhouse gases, to restore damaged environments, to preserve protected areas, and to reduce impacts on ecological resources. Concern with the oceans will increase, driven by coastal pollution, over-exploitation of marine resources, and increases in sea-surface temperatures and rising sea levels linked to global climate change.

2. *Economic globalization.* The development of new, consolidated trade partnerships, of increasingly linked stock markets and investments, and of electronic business transactions means that economic events in one part of the world can have immediate and widespread ripple effects. Conservation is closely tied to economics, both through the funding base that enables organizations to implement conservation planning and action and through the broader economic forces that alter land values and land uses.

3. *Changing land use.* Land and water are ultimately the commodities through which conservation objectives must be realized. One can talk forever about population viability, biodiversity health, landscape function, or ecosystem sustainability, but without land and water it all comes to naught. Increasing human populations, expanding agricultural needs, economic globalization, and regional and global climate change will all change human land use dramatically over the next few decades. The consequences of changing land use may in fact be more immediate and more pervasive than those of climate change—by the time climate change really affects broad-scale biotic systems, land change may have already had major effects on biodiversity.

Conservation activities on land and ocean will of necessity continue to be "place-based," incorporating the needs and concerns of local human societies. Although most land-use planning is local, the emerging direction of ocean policy suggests that "ocean-use plans" and marine ecoregional planning are likely to be applied within the Exclusive Economic Zone, as is being done in the Meso-American reef countries of Mexico, Belize, Guatemala, and Honduras and in the island republics of Micronesia. Preservation and management of private land are becoming key elements of long-term maintenance of biodiversity and many ecosystem services. It is also becoming increasingly evident that the effectiveness of place-based conservation, including that using logically structured portfolios of areas linked into conservation networks, can be increased substantially by including the surrounding lands (the "semi-natural matrix") as part of the overall conservation and management plans. Most government-funded research and management is focused on public land. The Conservancy holds a unique place in the world of science-based organizations (both NGOs and government agencies) in that its focus is on private lands—much of which it owns. The Conservancy's record of working *with* local communities and stakeholders to achieve conservation objectives also enhances its capability to forge broad-based conservation initiatives. The Conservancy is admirably positioned to become a leader in integrating ecological and social sciences into conservation-based management of private lands and the freshwater and marine environments associated with those lands. Developing this new science of integrated land-conservation management is not just an opportunity for the Conservancy, but a necessity. No other organization is coming forward to deal with the pressing issues of private land management in a world that is undergoing rapid changes. If this need is not met, it is possible that past efforts to protect biodiversity will be ineffective.

Although the Conservancy is expanding (judiciously) into more vigorous international conservation programs, its history and most of its effort are largely centered on the United States. The need for conservation action, however, may be greatest in other parts of the world, where the combined forces of population and economics (both local and global) are driving massive changes in landscapes. Such regions are, quite literally, on the cusp of ecological disaster. While it is clear that the Conservancy should not diminish its conservation programs in the United States, there is an obligation, under the Conservancy's overall mission, to "go where the action is." Some of the Conservancy's current international programs are exemplars of how to integrate conservation science with local cultures and expertise, and this "polycultural" implementation of Conservation by Design should be extended elsewhere. It would be appropriate to convince potential donors that the Conservancy can be extraordinarily effective in implementing land-based, science-based international conservation. Donors will also go where the action is.

Anticipating future threats and needs by listing them is one thing; undertaking action to deal with them proactively is another. This requires *capacity*. Currently, the Conservancy is woefully understaffed in areas dealing with the regional and global forces we have identified above: global climate change, economic globalization, and changing land use. A mixture of skills and expertise is required to think ahead. The need for social scientists who look beyond human behavior to consider human-ecosystem interactions and their consequences is especially critical. In a similar vein, attempts to develop "cost-effective" conservation approaches requires expertise in cost-benefit analysis, cost-effectiveness analysis, and the valuation of ecological "goods and services," areas in which the Conservancy has practically no scientific capacity. At least some of these skills should be contained within the Conservancy. As in other areas, however, the Conservancy cannot do it alone. Anticipating future threats and developing conservation strategies to deal with them can be facilitated by two activities: sharply focused workshops and partnerships, and clever use of computer modeling of future scenarios. Both activities provide opportunities to increase the linkages between Conservancy scientists and external scientists, economists, demographers, and planners.

Recommendations

- ***The Conservancy must expand its internal capacity to address future conservation threats.*** Expertise is particularly needed to evaluate the consequences to terrestrial, aquatic, and coastal marine environments of global climate change, economic globalization, and changing land use. These consequences are likely to be so extensive and profound that they cannot be dealt with after-the-fact, nor can they be addressed on a site-by-site basis. There is a clear need to anticipate threats and to "go to scale" in addressing these threats.
- ***The participation of stakeholders in Conservancy planning and actions should be encouraged from the outset.*** The importance to broad-scale landscape management of private lands and the "semi-natural matrix" that surrounds Conservancy conservation areas demands both the insights and the goodwill of local stakeholders.
- ***The level of involvement of the Conservancy in international land and marine conservation should be increased.*** Many of the greatest threats to the world's biodiversity lie outside of the United States. The Conservancy should go where the action is.

SCIENCE IN THE CONSERVANCY INFRASTRUCTURE

The Nature Conservancy was founded by scientists and continues to be dedicated to science-based conservation. At the same time, the organizational structure of the Conservancy divides responsibilities, including those for "science." For the Conservancy to realize the full potential of a science-based conservation approach, it needs not only the vision and the people and the places, but the organizational structure and culture to make the most of these resources.

It is not our role to delve into the specifics of the organizational structure and culture of the Conservancy. However, because the organizational structure and culture affect how science is brought to bear on conservation issues within the Conservancy, we will comment here on several broad aspects of organization that merit attention. Collectively, they point to the development of an organizational structure and culture that is founded on principles of learning, integration, and leadership.

The Conservancy as a Learning Organization
If science is a learning process (Box 1), then integrating science into the core goals and processes of the Conservancy requires that it adopt strategies of organizational learning. Organizational learning strategies include opportunities to question core values and goals based upon results (double-loop learning), processes for evaluating expected against actual outcomes of conservation strategies (single-loop learning), opportunities to learn from experience and literature, and processes for creating new knowledge through basic organizational work.

The Conservancy can become a strong learning organization. The Conservation by Design strategy, the use of ecoregional and conservation site planning, and commitments to undertake broad-scale conservation across private lands all emerged through a process of "double-loop" learning. Questioning core premises that had characterized the organization, such as measuring success by acres owned and dollars earned or setting conservation goals based upon rarity of certain species, led to the new conservation pathway that the Conservancy has embraced.

Adaptive management processes provide for "single-loop" learning, holding expected outcomes up against actual ones. Effective adaptive management requires two critical organizational capacities: culture and process. First, a culture of scientific inquiry needs to permeate the organization; opportunities to learn need to become institutionalized into the organization's "memory." Too often, individuals experience or learn things that are never incorporated into the broader body of organizational knowledge. A culture of inquiry means that staff are actively encouraged to seek out new knowledge, use it, record what they have learned, and communicate new understandings. "Science," after all, is in its essence a way of systematically learning about the world, remembering what was learned, and continuously adding to this body of knowledge (Box 1).

Today's technology, especially internet-based information management tools, means that individual learning can become organizational learning. For example, conservation stewards represent a tremendous scientific resource to the Conservancy: they are in tune with changes on the land but are also connected to the communities and people who use and work to conserve those lands. They can provide a wealth of information about environmental conditions, changes, responses to treatment programs, and key members of communities who support conservation work. What is missing is a way to link this information into the "institutional memory" of the organization so that it can be accessed by others, used for comparisons, and drawn on to inform decisions. An internet-based information management system could make the sharing of such insights a natural part of the daily work for every steward, every day. Their work and experience do not lie outside of the science work of the organization, but rather can form the basic descriptive foundation necessary to informed conservation action.

Second, adaptive management as a process applies to organizational learning just as much as it does to on-the-ground conservation action. Adaptive management can therefore be an organizational process for creating teams, incorporating diverse perspectives, and creating new partnerships. Teams built from all parts of an organization, for example, can bring a wide array of information and perspectives to a discussion, strengthening the commitment of the staff to the core principles of the Conservancy by fostering a broader understanding of its conservation work. More importantly, participants can take what they have learned and apply it to subsequent organizational activities. Adaptive management can produce an organization that is highly flexible, problem-oriented, and capable of rapidly responding to new information.

Integrating Science throughout the Organization
Conservation science within the Conservancy is often located in particular organizational units—science directors, science programs, science divisions, and the like. There are clear advantages to such an organizational structure: it is easier to assemble a "critical mass" of scientists in one place, it is easy to identify the source of "science" or scientific information within the organization, and it facilitates vertical information flow among levels in the organization. If "science" is simply information to be passed on to planning

teams, conservation stewards, and real estate negotiators, then having a separate science staff is not unreasonable. Making science a process that informs all aspects of the organization's mission requires that there be appropriate scientific expertise in the organization and among its partners and greater communication between scientists and other Conservancy staff, as we have previously noted. However, it also requires that the process of science, a "science culture," permeate the organization. Science information and thinking must flow horizontally as well as vertically through the organizational structure. Many Conservancy offices, for example, use a team-based structure for both analysis and decision-making that is not evident in their formal organizational charts. By emphasizing connectivity across functions, the culture of science as one of inquiry and change might be more easily evident to people both inside and out of the Conservancy.

Effective conservation is built upon the premise that ongoing inquiry, analysis, reflection, learning, and change occur constantly and naturally in the organization. The goal should be to make everyone at the Conservancy a bit more scientific in their thinking. Many features of scientific thinking that should be fostered at the Conservancy are not unique to science: the objective analysis of factual information as a basis for developing new ideas and taking action; close attention to quantifiable measures of success; and external, independent peer review are obvious examples. One important feature of a scientific culture, however, is not widespread. Science proceeds by healthy skepticism, by proposing models or ideas of how the world seems to work and then carefully assessing those models or ideas to determine their soundness. These perspectives are part of the "way of knowing" that characterizes science. Science, of course, is also characterized by a "way of doing." Both should suffuse all aspects of the organization, whether its scope is local or international, its focus on community action, development, site stewardship, or government relations, or its concern with terrestrial, freshwater, or marine environments.

Science Leadership within the Conservancy

Meeting the present and future conservation challenges makes it more imperative that the Conservancy be truly science-driven, as opposed to simply using scientific information. To extend the driving metaphor, being science-*driven* does not require that a scientist be in the driver's seat, but it does require that scientists be at the table when the route is chosen and on board throughout the trip to make sure that the driver does not get lost. To put it more directly and succinctly, the infusion of science throughout the organization requires that scientists must be fully integrated into Conservancy leadership. It also requires that those charged with leading *for* science in the organization be recognized throughout the organization, and that they, in turn, have the vision to see how and where science can contribute to the Conservancy's mission and actions and the ability to communicate effectively within and across levels.

The Conservancy is fortunate already to have "transformational leadership" at many levels, leadership that enables the organization to question fundamental values and goals, adopt new ones, and yet maintain its identity. In order for the Conservancy to continue to make major changes in direction as envisioned in its new mission, however, this kind of leadership capacity must be distributed throughout the organization, not merely among a few individuals. It is important to foster science-based leadership, rather than just management that uses science. In a highly decentralized organization with significant localized autonomy, this will be much easier when key staff have scientific training and backgrounds; they bring the culture of science with them. The tasks involved in the management, leadership, and promotion of science at all levels of the Conservancy are formidable. Scientific knowledge and credibility are crucial, but so also are skills in management, fund raising, and the like.

Recommendations

- ***The Conservancy should become a learning organization.*** This means that it should explicitly develop organizational strategies that foster opportunities to question core values and goals based upon results, processes for evaluating expected against actual outcomes of conservation strategies, opportunities to learn from experience and literature, and processes for creating new knowledge through basic organizational work.
- ***Science as a process, as a way of knowing, must permeate all levels and activities of the Conservancy.*** "Science" cannot be sequestered in some units or programs and ignored elsewhere.
- ***Scientists and scientific thinking must be fully integrated into the leadership of the Conservancy.*** The expectation that Conservancy science staff should contribute to the development and testing of science-based conservation strategies and actions must be explicitly articulated. Those entrusted with administrative leadership should express a vision of "science-based conservation" that truly includes science.
- ***Alternative or complementary models for developing effective science leadership in the Conservancy should be reviewed.*** For example, developing career ladders for Conservancy science staff that lead to enhanced science positions rather than greater administrative responsibilities would improve both internal scientific expertise and scientific leadership. Greater use of scientists who serve on Governing Boards could also contribute to effective science leadership.

IN CONCLUSION

It is appropriate to conclude this report by returning to the seven questions originally posed by the Board of Governors. We have addressed a great many issues relating to the role and strengthening of science in the Conservancy in this report, and in the process have addressed all of the questions in one way or another. Here, however, are some reasonably succinct answers:

- Does the Conservancy demonstrate an appropriate balance between an action orientation and a scientific approach?

  Effective conservation requires action that is based on science—both scientific information and scientific thinking. Determining what sort of balance between action and science is "appropriate" is difficult. It is our view, however, that at the present time there is insufficient science within the Conservancy to meet the objectives of Conservation by Design and to realize its great potential.

- At what stages in the Conservancy's conservation process is science being used?

  To date, implementation of the conservation process contained in Conservation by Design has involved primarily the first phase, ecoregional planning. Science has been part of that process, sometimes to a considerable extent, sometimes as little more than information. We have made it clear that the long-term success of Conservation by Design requires that science be a central part of all aspects of this approach.

- Is the current conservation process (i.e., Conservation by Design) scientifically sound?

  In broad outline, yes; in practice, only sometimes. Conservation by Design can provide a strong framework for conservation that is truly science-based, but science and scientific thinking need to be more fully incorporated into the process.

- How can the Conservancy best identify and incorporate current science into its practices and into landscape and site conservation actions?

  We have discussed a number of ways in which this might be done: building needed expertise in key areas, implementing adaptive management more broadly, networking both sites and scientists, enabling science staff to do their job of bringing science into the picture, suffusing science throughout the organization, forging more and better partnerships based on the Conservancy's needs and internal expertise, and developing advanced means of information management.

- What are the key scientific problems that the Conservancy needs answers to but that are not now being addressed?

  There are a number of threats and staffing needs that have been identified by field personnel, but from a broader perspective we have emphasized the need to anticipate the future consequences of global change, economic globalization, land-use change, and the linkage to coastal marine environments. Addressing each of these issues will require collaboration among environmental scientists and environmentally oriented social scientists.

- Are adequate measures used to recruit, reward, and retain excellent science and stewardship staff?

  There is considerable room for improvement. Although Conservancy science and stewardship staff are generally enthusiastic about goals of their work and are deeply committed to the mission of the Conservancy, they are often frustrated by the lack of time available to think about science and approach problems using their scientific skills. As a result, they lose scientific currency; some, at least, come to regard themselves no longer as scientists. This is a major loss to the organization.

- How can the Conservancy best engage the scientists on its boards in the Conservancy's efforts?

  By recognizing the value of their expertise and asking them to become involved.

APPENDIX A

Background information on the Members of the External Science Review Committee

Virginia H. Dale is a senior scientist in the Environmental Sciences Division at the Oak Ridge National Laboratory and an adjunct faculty member in the Department of Ecology and Evolutionary Biology at the University of Tennessee. Her primary research interests are in ecological modeling, landscape ecology, environmental decision making, forest succession, and land-use change. She has developed tools for resources management and models of vegetation succession and land-use change for studies in the United States, South and Southeast Asia, and Latin America. She obtained her Ph.D. in mathematical ecology from the University of Washington.

Frank Davis is a professor in the Donald Bren School of Environmental Science and Management at the University of California at Santa Barbara. Since 1991 he has directed UCSB's Biogeography Lab. Between 1995 and 1998 he served as Deputy Director of the National Center for Ecological Analysis and Synthesis, a National Science Foundation Center at UCSB that sponsors synthetic, interdisciplinary ecological research. His research has focused on the ecology of California chaparral and oak woodlands, and on the use of digital satellite data and geographic information systems for mapping vegetation, modeling species distributions, Gap Analysis, and conservation planning. He has been involved in a variety of large-scale conservation and ecosystem management projects, serving as Principal Investigator of the California Gap Analysis Project, as a Science Team member on the USDA Forest Service Sierra Nevada Ecosystem Project, and as a Principal Investigator on related research projects for NASA, EPA, the USDA Forest Service, the Nature Conservancy, and the Resources Agency of California. He received his Ph.D. in Geography and Environmental Engineering from The Johns Hopkins University.

John J. Ewel is the Director of the U.S. Forest Service Institute of the Pacific Islands Forestry, headquartered in Hawaii. Prior to joining the Forest Service he was a professor at the University of Florida for 23 years, and during part of that time he served on the Board of Trustees of the Florida Chapter of The Nature Conservancy. He has conducted research in a dozen countries, primarily in Latin America and Oceania. His research deals with ecosystem processes, especially those related to restoration, invasive species, and the design of sustainable systems of land use. He received a Ph.D. from the University of North Carolina.

Malcolm L. "Mac" Hunter, Jr. is the Libra Professor of Conservation Biology in the Department of Wildlife Ecology at the University of Maine, where he has been a faculty ember since 1978. His research covers a wide range of organisms and ecosystems—birds, vascular plants, mammals, amphibians, lakes, peatlands, grasslands, and more—but his major focus is on forests. He has produced five books, the most recent of which is Maintaining Biodiversity in Forest Ecosystems (Cambridge). His interests are also geographically broad; he has worked in over 20 countries, mainly in Africa and the Himalayas. He received his Ph.D. in Zoology from Oxford University.

John C. Ogden is Director of the Florida Institute of Oceanography and Professor of Biology at the University of South Florida. He is a marine ecologist whose work has concentrated on coral reefs and associated tropical coastal ecosystems, particularly in the Caribbean and Micronesia. He has served on numerous federal and state commissions dealing with coastal ecosystem management, marine protected areas, and coral reef conservation. He was a member of the founding Advisory Council of the Florida Keys National Marine Sanctuary and he serves on the boards of the World Wildlife Fund and the Center for Marine Conservation. He is a Fellow of the American Association for the Advancement of Science. He received his Ph.D. in Biological Sciences from Stanford University.

Mary E. Power is a Professor in the Department of Integrative Biology at the University of California Berkeley, Faculty Manager of the Angelo Coast Range Reserve in Mendocino, and Director of the California Biodiversity Center (CBC). The CBC was initiated in spring 2001 to promote research and teaching synergies among field ecologists using Berkeley Field Stations, museum scientists in the Berkeley Natural History Museums ,and other colleagues with similar interests in the environmental and evolutionary drivers of ecological change. Power and her students investigate river food webs and river-watershed linkages in temperate and tropical rivers. Her research has focused on how river food webs respond to natural and altered hydrologic and productivity regimes, to invading exotic species, and to land use, including road construction, timber harvest, and floodplain alteration. Recently, the research has also focused on trophic exchange between northern California rivers and their watersheds, and the relative importance of cross-habitat fluxes of energy to terrestrial and aquatic consumers along downstream productivity gradients in drainage networks. She received her Ph.D. degree in zoology from the University of Washington.

Margaret A. Shannon is an Associate Professor at the State University of New York at Buffalo in the School of Law, Program on Environmental Law and Policy, and is affiliated with the Environment and Society Institute. Her research focuses on the emergence of a participatory approach to developing natural resource policy that engages people and organizations in substantive, creative roles rather than reactive and passive roles. To expand on her work in the United States, she is participating in a European COST Action to create and analyze participatory approaches to developing integrated, cross-sectional national forest programs within Europe and around the World. In the United States, she has followed the Interior Columbia Basin Ecosystem Management Assessment Process from its inception, as well as examining other cases of bioregional science-policy interactions. She was a member of the Committee of Scientists convened by the Department of Agriculture to develop a new conceptual framework for planning on the National Forest System lands, and was a member of the Forest Ecosystem Assessment Team° that developed the scientific report for the Northwest Forest Plan. She received her Ph.D. degree from the University of California in the School of Renewable Natural Resources.

John A. Wiens is currently a University Distinguished Professor of Biology at Colorado State University and a Sabbatical Fellow at the National Center for Ecological Analysis and Synthesis in Santa Barbara, California. His interests are in landscape ecology, community ecology, and environmental impact assessment, and he has conducted research on birds and insects in grasslands, deserts, and marine ecosystems in western United States, Alaska, South America, Norway, and Australia. He is the author or editor of five books, including the 2-volume *Ecology of Bird Communities* (Cambridge). He received a Ph.D. in Zoology from the University of Wisconsin-Madison.

APPENDIX B

Summary of Committee Fact Finding Activities

This report is based on information gathered by committee members from a large number of sources. Here we list the sites, states, and programs that were visited or from which individuals were interviewed, as well as the workshops attended; additional interviews (not listed) were conducted with individuals, both within and outside of The Nature Conservancy.

Sites and States

Arizona

California

Colorado

Connecticut

Florida

Georgia

Massachusetts

Minnesota-Dakotas

Ohio

Oregon

Pennsylvania

South Carolina

South Dakota

Tennessee

Virginia Coastal Reserve

Washington

Western New York

The Nature Conservancy

Conservation Science Division

Monitoring and Adaptive Management

Coastal Waters Program

International Program

Ecological Management and Restoration Program

Conservation Planning Program

Climate Change

Applied Research Program

Pacific Program

Smith Fellows

Workshops and Meetings

Forest Management Network Meetings (2)

Ecoregional Planning Meeting

APPENDIX C

Results of the Mail Survey Summary Findings

To obtain a broader sampling of viewpoints from Conservancy science staff beyond the individuals we could talk with directly or sites or programs we could visit, we conducted a survey of Conservancy science-related personnel in early 2001. The survey was distributed by e-mail; overall, 145 completed surveys were returned. These surveys came from individuals in 38 states and 3 foreign countries.

This appendix contains a detailed analysis of the responses to each question posed in the survey, as well as listings of additional written responses. In particular, the final listing of general comments to the committee contains some important insights and merits careful reading. In the following paragraphs we briefly summarize some of the most important points that emerged from the survey. We do not draw conclusions or make recommendations here; those are presented in the main body of our report.

Our thanks to Lee Meinicke for helping to design and distribute the survey, and to Ann Wiens for conducting the analysis and preparing the final survey report.

Summary of Major Findings

1. Demographics

The average age of those responding was almost 40 years. On average, individuals had worked for the Conservancy for 7 years, half of this in their current position. There was a considerable spread in all of these categories. Over half of the respondents hold a Master's degree, an additional 28% a Ph.D. The Nature Conservancy has a highly educated workforce.

2. Ties to the External Scientific Community

TNC scientists interact fairly often with peers in government agencies, rather less with academic scientists, and rather little with researchers in other NGOs or private industry. Interactions with scientists on Boards of Governors rarely occur. Within the Conservancy, most interactions among scientists working in different programs are related to ecoregional planning (66% report interactions to a great or moderate extent) or large-scale site planning (51%).

Most programs, states, or countries do not have a formal scientific advisory committee. Of those that do, half of the respondents considered them to be very involved in projects (and half, therefore, considered them to be only slightly involved or not involved at all).

Programs do not generally report the results of scientific activities externally, although individual scientists do attend external scientific meetings, presenting material at over half of the meetings they attend. Reporting on Conservancy science, therefore, seems to be more a matter of individual and local-program priorities than of Conservancy policy.

Conservancy scientists rely on expert opinion as their primary source of scientific information, followed by peer-reviewed journal literature. Web sites, handbooks, and on-line data bases are not used to a significant extent.

3. Experience Doing Scientific Work at TNC

Conservancy science staff appear to spend most of their time in fundraising, program management and administration, and ecoregional planning (only the last of these is primarily a scientific activity). They value their efforts in site conservation planning and ecoregional planning the most, and would prefer to increase their time allocation to research, monitoring, and ecological management and reduce the time spent in program management and administration. Most respondents feel that their scientific abilities are used only to a moderate extent, although they also feel that their efforts are considered in their performance evaluation and that their work is respected by their immediate supervisor. Half feel isolated from the broader scientific community, and note that their interactions with external scientists are limited primarily by time availability. Many individuals would like to receive additional training in GIS and remote sensing, landscape ecology, and restoration.

4. Science in TNC

Conservancy staff feel that scientific information is used to a considerable extent in ecoregional planning and site conservation planning, much less in conservation action and multi-site strategies and in measuring success of conservation efforts. The quality of this scientific information, however, was rated somewhat less than "good." Overall, 60% of the respondents feel that TNC does a good job of integrating science into its activities, although another 31% rated this performance as "barely adequate."

Very few reported having interactions with the International Science Department in the Home Office. On the other hand, nearly all respondents had some form of interaction with the Conservation Science Division, and most rated these interactions as "good."

We asked individuals to identify areas of expertise that either were planned additions to programs or that should be added at a central level. Aquatic ecology and hydrology, GIS/remote sensing, and monitoring, restoration, and stewardship were identified most frequently in the former category. At the broader level, expertise in monitoring, restoration, and stewardship was mentioned frequently, with other responses spread over a wide array of areas. Time and (to a lesser extent) funding were perceived as the biggest obstacles to obtaining the needed scientific knowledge and expertise.

5. Information Management

Respondents clearly recognized the importance of modern information management systems to the success of all elements of their conservation activities. This perception does not carry over to practice, however. Although 71% of the scientists generate original data, very few manage or store these data in a digital form, much less one that is widely available. Data exchange, both within the Conservancy and externally, tends to occur through opportunistic interactions among individuals. Respondents were evenly split between those who rated their program's information management practices as "good" and those who felt they were "barely adequate," but more than half felt that hardware and software capacity is good to excellent. This suggests that they know they have the capacity but don't really use it. Respondents felt that information management practices could be improved by more time and personnel, by standardization of data management, and by training in data management practices. There are several indications that information management capacity in the Conservancy is rapidly increasing.

6. Adaptive Management

The majority of projects undertaken by Conservancy science staff do not include adaptive management, although many of these projects could profit from it. Most applications of adaptive management rely on trial-and-error procedures or passive approaches rather than more carefully planned adaptive management. The majority of respondents said they would seek external expert opinion to interpret unexpected results.

Respondents were evenly split on the question of whether or not there were adequate mechanisms in their program or project for implementing adaptive management. Over 40% of the scientists indicated that more than half of the scientific questions that directly affect their work are not adequately answered before action is taken, generally due to insufficient time.

7. Conservation Threats

Finally, we asked respondents to identify what they considered to be the most urgent conservation threats. By far, conversion of habitat to human developments and the effects of invasive and alien species were considered to be the most important. Other threats, such as agricultural practices, fire suppression and wildfires, and hydrological alterations ranked somewhat lower. Interestingly, some of the big issues of the future, such as global climate change, ranked lower on the threat-urgency rankings.

Survey Analysis

Results are compiled from 145 surveys returned. Both the number and percentage of respondents answering each question are shown.

Section I
Personal Information

Question 1:
(145 responses (100%); 22 anonymous)

Age:

average:	39.8
range:	23 - 68

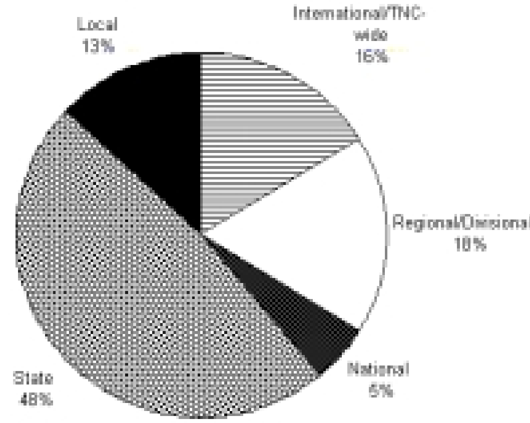
Total number of years worked for TNC:

average:	7.1
range:	<1 - 29

Number of years in current position:

Average:	3.6
range:	<1 - 17

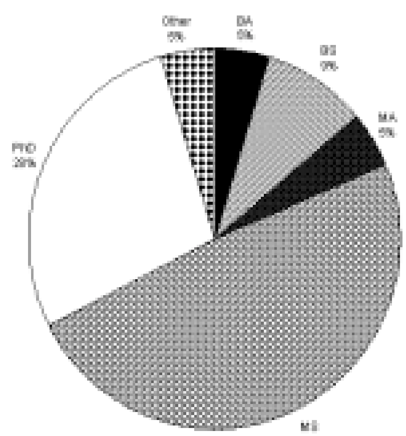
For lists of job titles, department names, and locations see Appendix D.



Question 2

Question 2:
(143 responses; 99%)

What is the scope of your overall responsibilities?



Question 3

Question 3:
(145 responses; 100%)

Highest degree held by respondents:

For list of degree subject areas, see Appendix D.

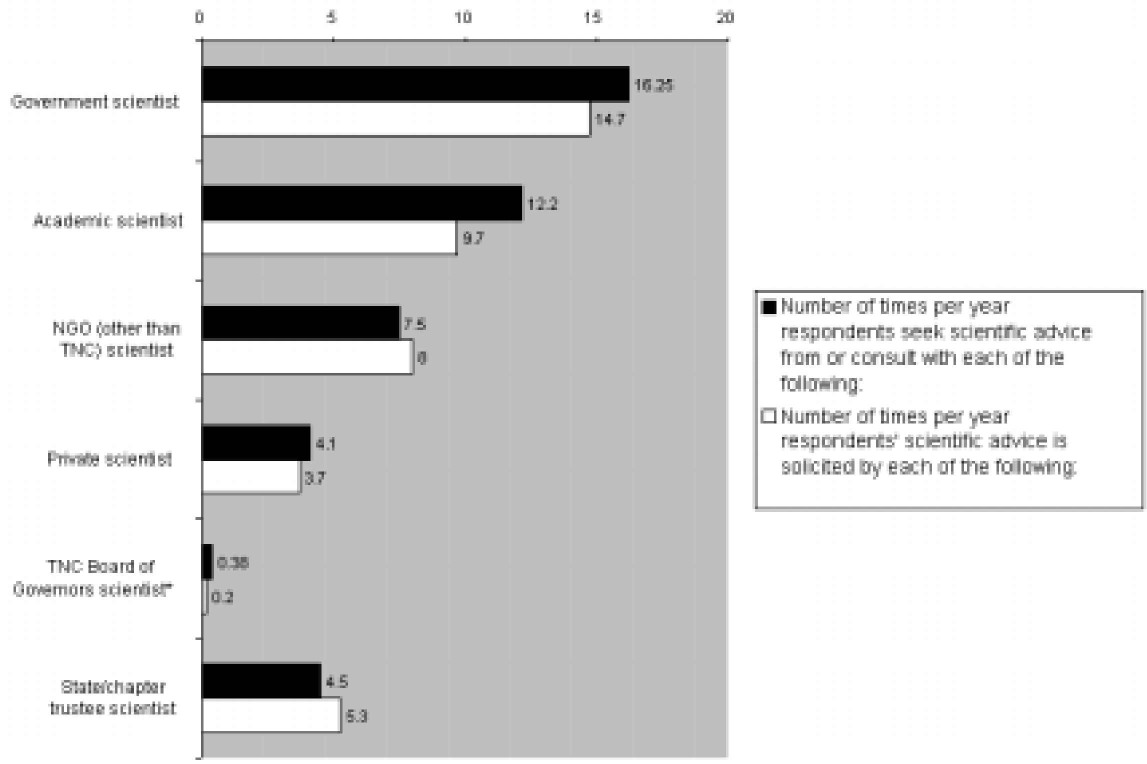
Section II

Your Ties to the Scientific Community

Question 4:
(141 responses; 97%)

Frequency of interaction with scientific peers.

Respondents were asked to quantify their interactions with their scientific peers on an annual basis. The upper bar indicates the average number of times annually respondents seek advice from or consult with various types of scientists. The lower bar indicates the average number of times annually the respondents' scientific advice is solicited by various types of scientists. *86% of respondents reported no interactions in this category.



Question 4

Question 5:
(137 responses; 94%)

Average number of the following with whom respondents currently collaborate on projects:

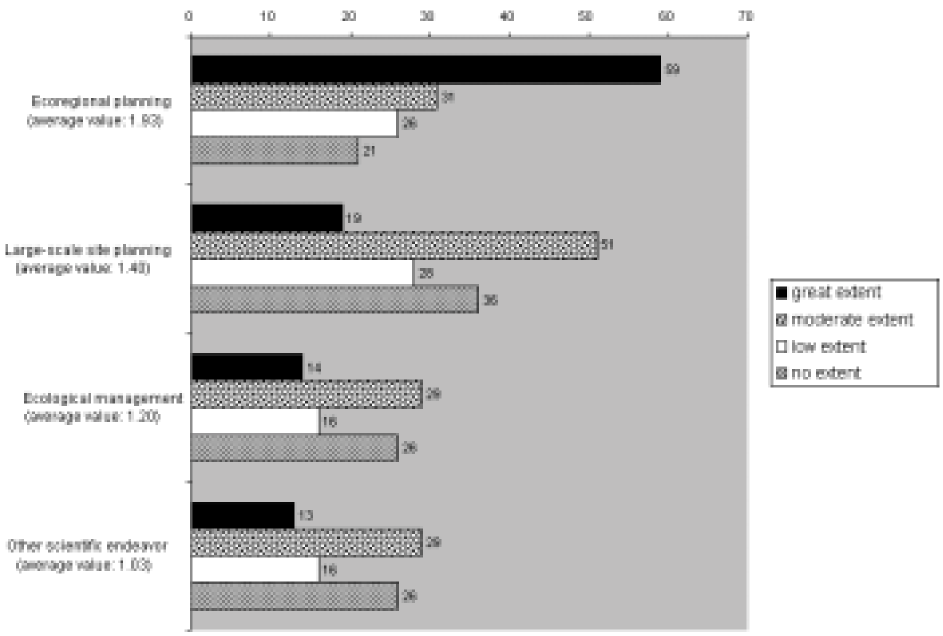
Government scientist:	5.2
Academic scientist:	4.2
NGO (non-TNC) scientist:	2.1
Private scientist:	1.2
TNC Board of Governors scientist:	0.1
State/chapter trustee scientist:	1.5

Question 6:
(137 responses; 94%)

Extent to which respondents are working collaboratively with staff in other TNC programs on projects/issues that go beyond their state/program/country borders.

Average values for each category are based on a scale of 0 to 3 (0 = no extent, 1 = low extent, 2 = moderate extent, 3 = great extent). Bars indicate number of responses for each value in each category.

For other scientific endeavors cited, see Appendix D.



Question 6

Question 7:
(133 responses; 92%)

Does your country, state, or program have a scientific advisory committee?

Yes:	31%
No:	65%
Don't know:	4%

Of those answering yes, committees meet an average of 2.7 times a year, with a range of 0 to 10 times annually. Of those who indicated their committee's level of involvement in their projects, 50% consider their committee very involved, 29% consider their committee slightly involved, and 21% consider their committee not involved.

Question 8:
(130 responses; 90%)

Does your country, state, or program regularly report on the research conducted or supported by your program?

Yes:	33%
No:	64%
Don't know:	3%

Question 9:
(140 responses; 97%)

Average number of scientific conferences and meetings attended over the last two years:

TNC:	1.88
Non-TNC:	2.65

Average number of scientific conferences and meetings at which respondents presented, served on a panel, or presented a poster over the last two years:

TNC:	1.42
Non-TNC:	1.52

Question 10:
(122 responses; 84%)

Three most recent non-TNC scientific conferences and meetings attended.

See Appendix D.

Question 11:
(136 responses; 94%)

Average frequency with which respondents teach scientific courses, give scientific seminars or presentations:

At universities and colleges: slightly less than once a year. For conservation partners: slightly more than once a year.

Question 12:
(61 responses; 42%)

Publications

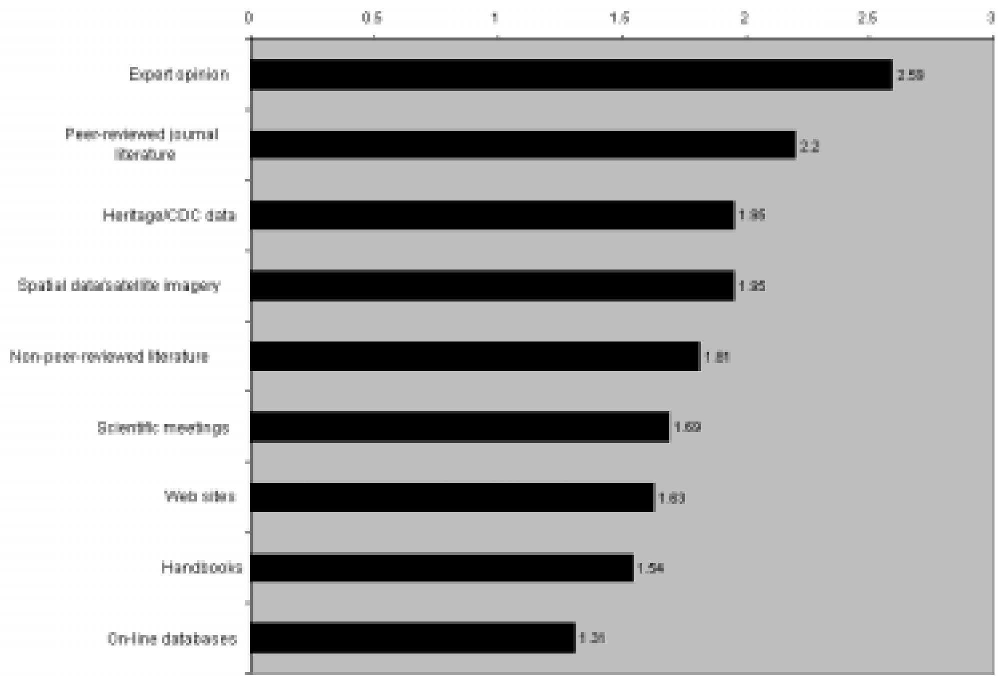
See Appendix D.

Question 13:
(141 responses; 97%)

Relative importance of scientific information sources.

Relating to the issue of where scientific information is acquired, respondents were asked to rate the relative importance of the following sources of scientific information to their work. Using a scale of 0 to 3 (3 = very significant, 2 = significant, 1 = barely significant, 0 = inconsequential), the average relative significance of each source is as listed above:

For list of additional sources mentioned, see Appendix D.



Relative Importance of Scientific Information Sources—Question 13

Section III

Your Experience Doing Scientific Work at TNC

Question 14:
(112 responses; 77%)
How time is spent and valued.

Respondents were asked to rate a series of activities according to three criteria: 1) their perception of how others, primarily supervisors and those within their program, value their overall performance of each activity; 2) the percentage of their time currently spent on each activity; and 3) the percentage of time they would ideally allocate to each activity.

Respondents approached the question a variety of ways, with many limiting their answer to only three or four activities. The following table shows the average value rank and current and ideal percentage of time spent on each activity. The final column shows the average percent increase or decrease between the current and ideal amount of time allocated to each activity. Activities are listed in order of percent change between the current and ideal.

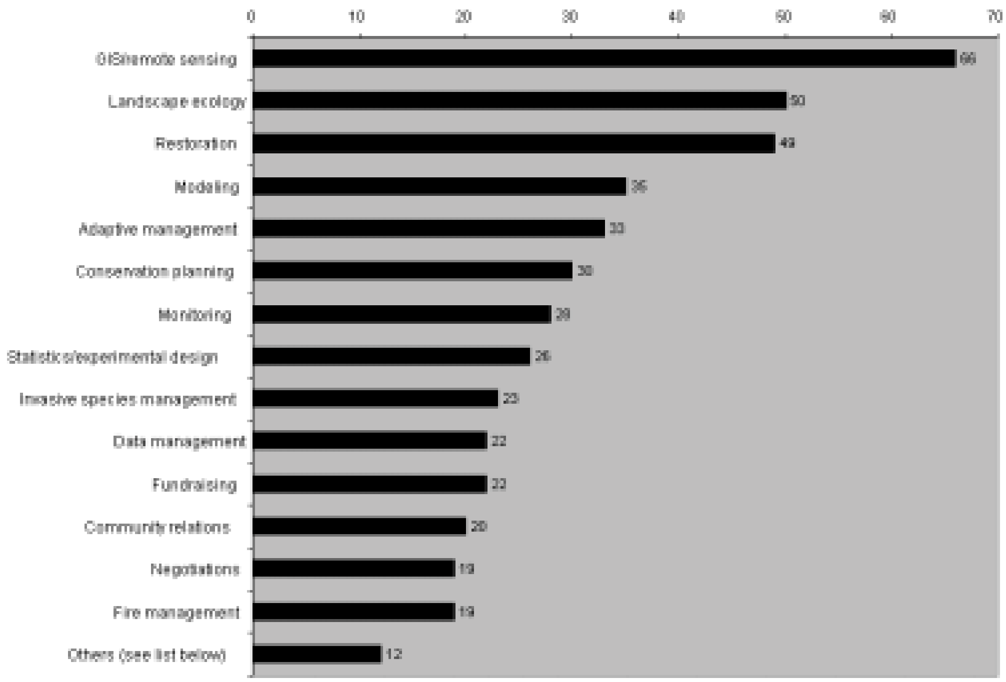
Value rank	Activity	Current %	Ideal %	Ideal increase/ (decrease)
9.	Research	7.3	14.7	+7.4
6.	Ecological Monitoring	8.9	13.1	+4.2
3.	Ecological Management	13.4	17.4	+4.0
1.	Site Conservation Planning	12.5	15.9	+3.4
5.	Partner Cultivation/Relations	10.7	13.4	+2.7
7.	Community-based Conservation	10.7	10.4	(-0.3)
2.	Ecoregional Planning	26.3	25.0	(-1.3)
10.	Custodial/Real Estate Management	6.2	3.7	(-2.5)
11.	Other (see list below)	28.4	24.8	(-3.6)
8.	Fundraising	28.4	24.4	(-4.0)
4.	Program Management/Admin.	24.6	15.7	(-8.9)

Summary of other activities mentioned:
- Professional development and training (8)
- Program management and administration (7)
- Land acquisition (5)
- Data management (5)
- Classification and inventory (5)
- Other activities (12)

Question 15:
(142 responses; 98%)

Training

Respondents were asked in what areas they would like to receive additional training to perform their jobs over the next few years. The bar graph indicates total number of responses for each area.



Question 15

Other areas mentioned are listed below:

aquatic ecology
capacity building with partner organizations; effective collaborations
communications
ecological processes of forested ecosystems
future leadership
hydrology/wetland ecology
landscape monitoring
languages (Portuguese)
project management, program management
real estate mechanics
skills in teaching/training adults
water resource management and administration and policy

Question 16:
(142 responses; 98%)

Are you doing as much science as you anticipated when you started in your current position?

Much more	1%
More	9%
As anticipated	53%
Less	28%
Much less	9%

Question 17:
(141 responses; 97%)

To what extent do you feel your scientific abilities are used appropriately?

Great extent	23%
Moderate extent	77%
Low extent	22%
No extent	0

For comments, see Appendix D.

Question 18:
(140 responses; 97%)

A. Do your non-scientist colleagues understand and respect the scientific elements of your work?

Definitely yes	22%
Probably yes	50%
Definitely no	9%
Unsure	15%
N/A	4%

B. Does your immediate supervisor understand and respect the scientific elements of your work?

Definitely yes	60%
Probably yes	24%
Definitely no	4%
Unsure	10%
N/A	2%

Note: For both part A and part B, several respondents checked "definitely yes" or "probably yes" with the comment, "respect, yes; understand, no."

Question 19:
(137 responses; 94%)

Do any of your efforts involving science influence your performance appraisal? If so, are these influences positive or negative?

N/A	4%
No influence	20%
Positive influence	74%
Negative influence	1%

Question 20:
(138 responses; 95%)

Do you feel isolated from the scientific community?

Definitely yes	13%
Probably yes	36%
Definitely no	40%
Unsure	11%

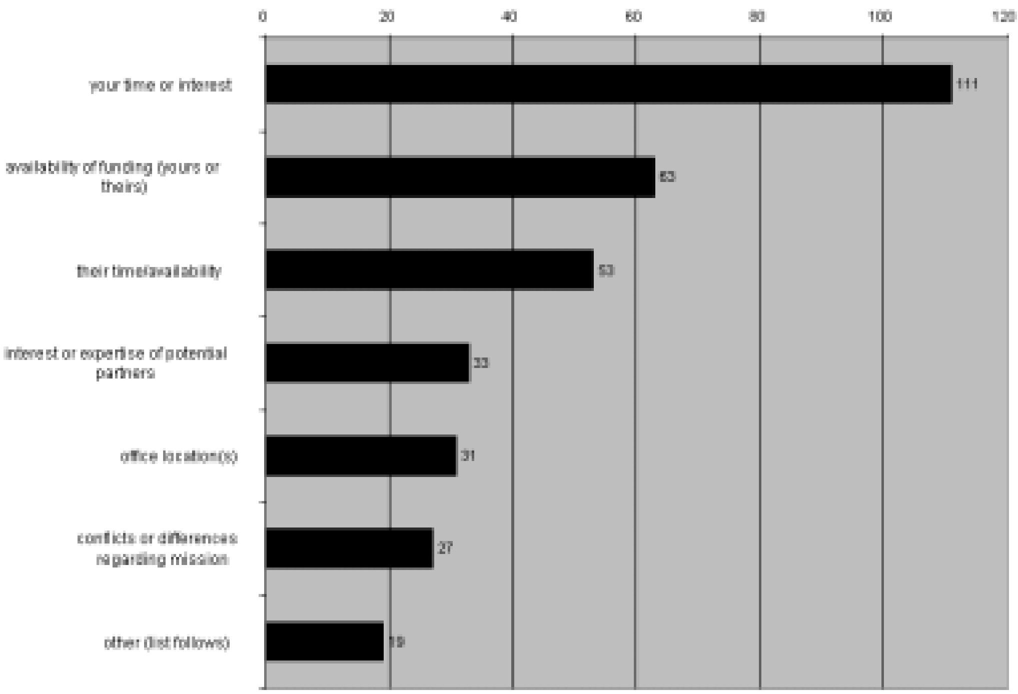
Question 21:
(139 responses; 96%)

Interactions with non-TNC scientists.

Respondents were asked to rank the top three factors limiting the extent of their interactions with non-TNC scientists. The bar chart shows the number of responses to each of six choices, followed by a list of "other" factors mentioned.

Note: many people choosing the first option, "your time or interest," specified time, not interest, as the limiting factor.

For list of other factors mentioned, see Appendix D.



Question 21

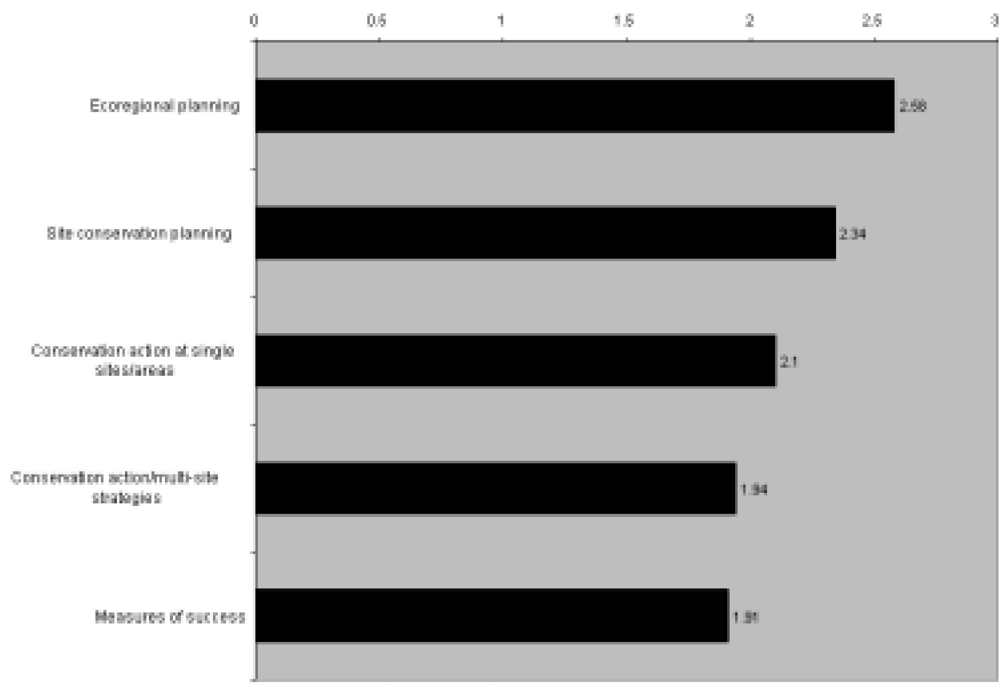
Section IV

Science in TNC

Question 22:
(131 responses; 90%)

The relative importance of scientific information.

Respondents were asked to rate the relative importance of scientific information as it is currently used in each of the following activities as compared to other factors that affect the process. The bar graph indicates the average response in each category, using a scale of 0 to 3 (0 = inconsequential, 1 = barely significant, 2 = significant, 3 = very significant).

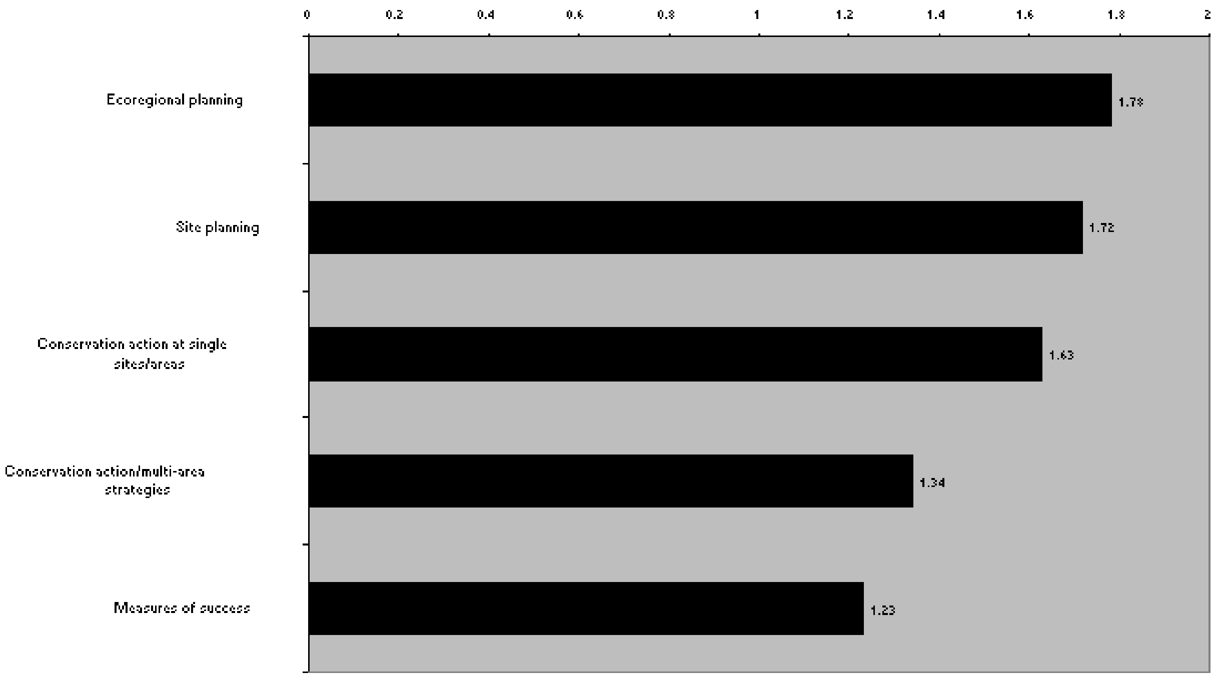


Question 22

Question 23:
(130 responses; 90%)

The quality of scientific information used in each stage of the conservation process.

Respondents were asked to rate the quality of scientific information used in each of the stages in the conservation process, using the same list of activities as in the previous question. The bar chart indicates the average response in each category, using a scale of 0 to 3 (0 = very poor, 1 = barely adequate, 2 = good, 3 = excellent).



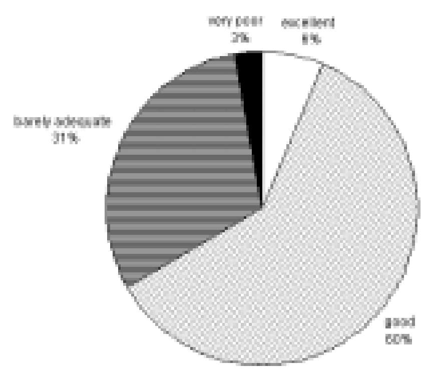
Question 23

Question 24:
(139 responses; 96%)

TNC science integration.

Respondents were asked to rate the job TNC is doing overall in integrating science into its activities.

Responses are shown in percentages.



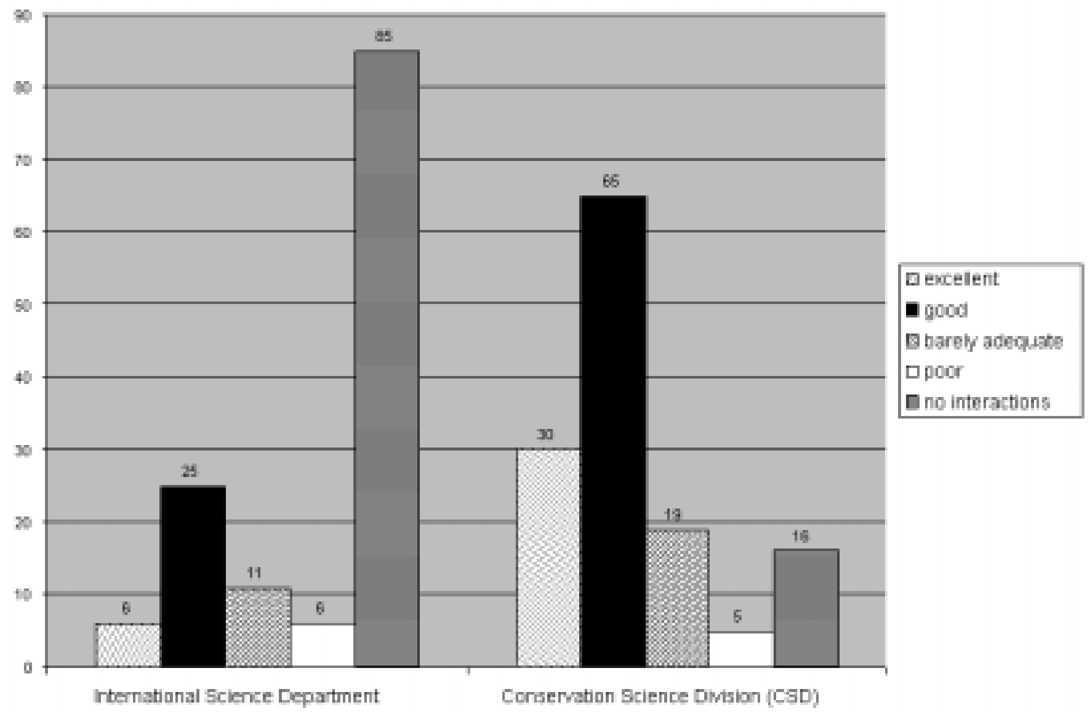
Question 24

Question 25:
(135 responses; 93%)

Respondents were asked to rate the interactions they have had with TNC central science services.

Graph indicates total number of responses in each category.

Summary of interactions with Conservation Science Division:
Twelve percent of respondents reported having no interactions with CSD. Of those who did report having some interactions, 25% considered those interactions excellent; 55% considered them good; 16% considered them barely adequate; and 4% considered them poor.



Question 25

Question 26:
(81 responses; 56%)

Respondents were asked to identify areas of scientific expertise that TNC plans to add or should add.

The following are summaries of areas identified, with number of times mentioned.

Column A: Areas of expertise that respondents' programs, at a level available to them, *plan to add* within the next year or two.
Column B: Areas of expertise respondents feel TNC *should add* at a central level.

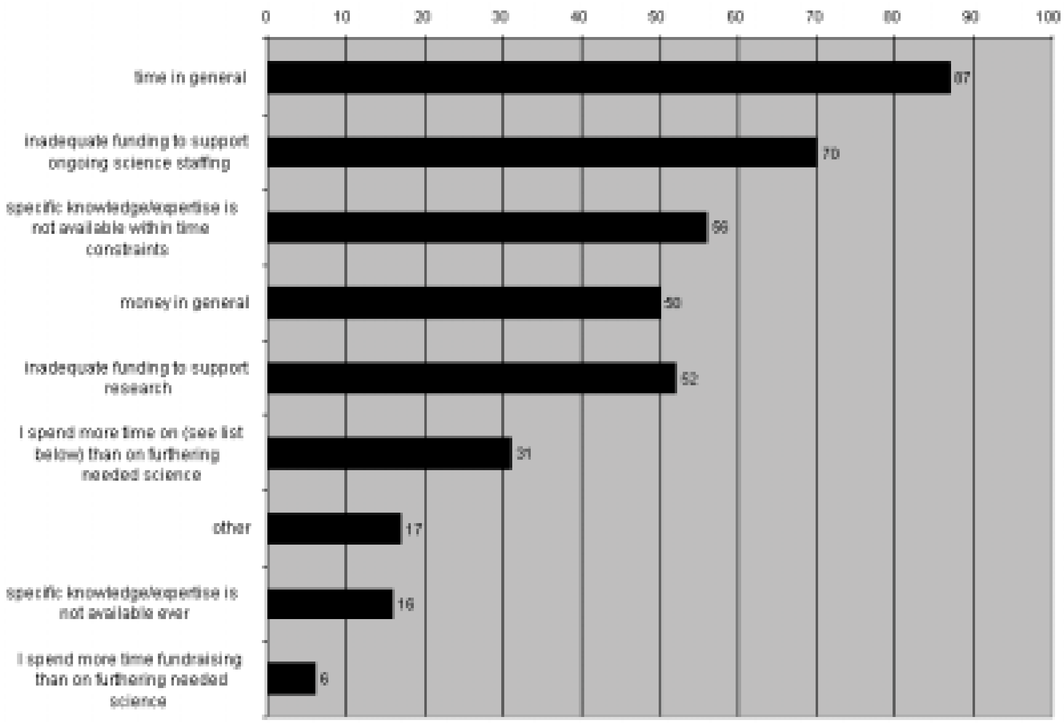
Area of expertise	**A**	**B**
Aquatic ecology	22	8
Climate, global change	0	4
Coastal marine	5	7
Ecological economics	0	2
Fire ecology/management	5	8
Forest ecology/management	5	7
GIS and remote sensing	17	8
Hydrology	10	5
Information management	1	0
Invasive species	3	8
Landscape ecology	3	0
Management/administration	2	8
Modeling/analysis	2	9
Monitoring, restoration, & stewardship	15	21
None	6	8
Planning	6	6
Policy	1	0
Population viability	0	6
Rangeland ecology, grazing	0	8
Research	0	2
Social science	2	4
Various other ecology/zoology/botany	8	22

Question 27:
(139 responses; 96%)

Biggest obstacles to getting the science knowledge and expertise that respondent's programs needed.

Respondents were asked to rate the biggest obstacles to getting the science knowledge and expertise that their program needs. Graph shows number of responses to each of nine choices.

For lists of activities respondents spend more time on than on furthering needed science and other obstacles to getting science knowledge and expertise, see Appendix D.



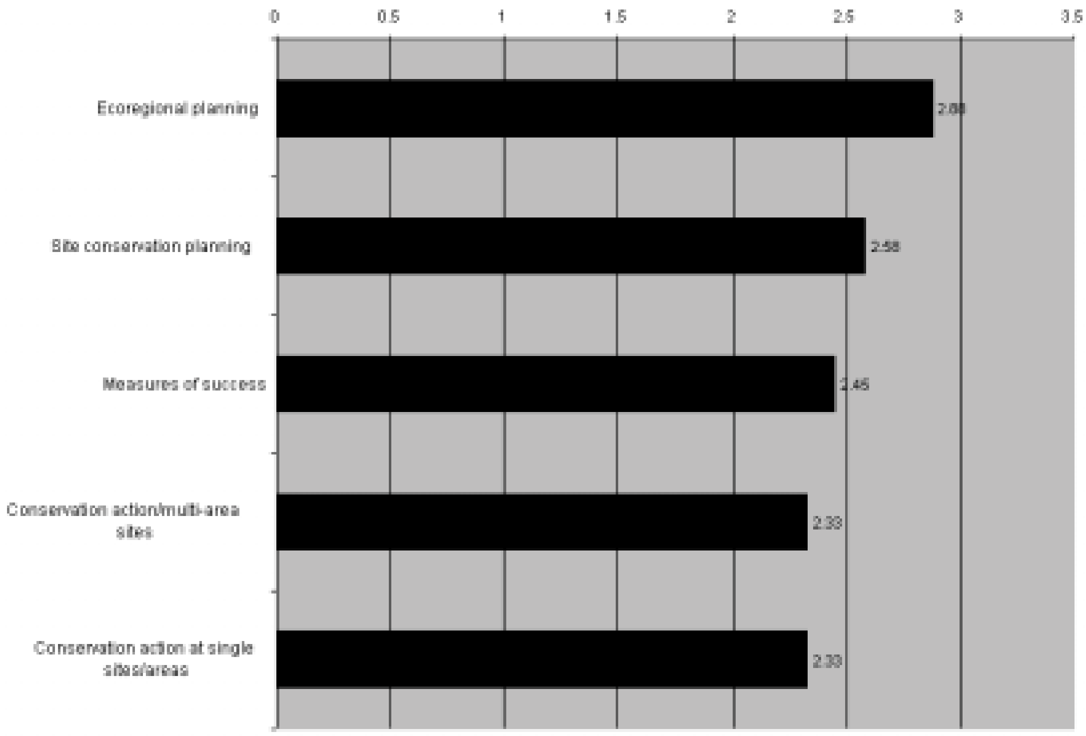
Question 27

Section V
Information Management System(s)

Question 28:
(132 responses; 91%)

Importance of modern information management systems.

Importance of modern information management systems to the success of the following activities (average values rated on a scale of 0 to 3 (0 = inconsequential, 1 = barely significant, 2 = significant, 3 = very significant):



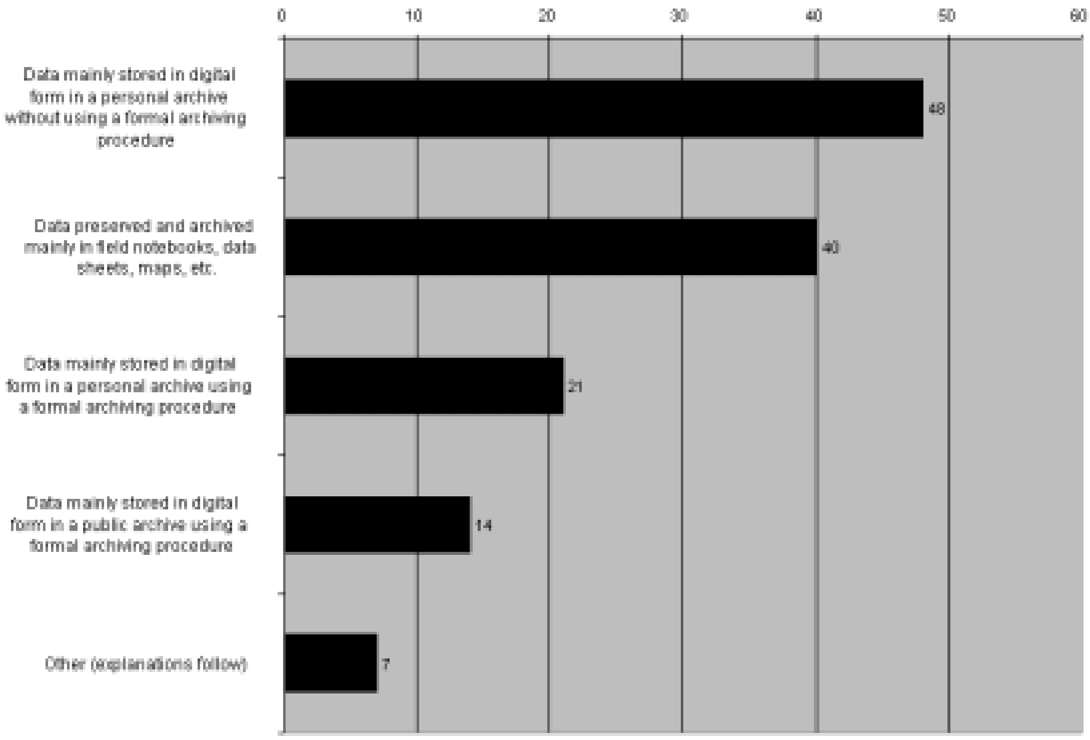
Question 28

Question 29:
(142 responses; 98%)

Do you personally generate original data in your work for TNC?

Yes:	71%
No:	29%

Those answering "yes" were asked to characterize the management of those data according to the following categories. Graph shows total number of responses to each choice; many respondents indicated more than one management system.



Question 29

Other data management systems mentioned:

Data stored in digital form in military archive

Data in digital form in public [illegible] using a less formal grading procedure. Methods/data will be more formalized when ecoregional plan appears.

Data mainly stored in digital form in an office archive using a formal archiving procedure (available only to IN-FO TNC staff).

Maintained primarily in paper and personal digital files, but provided to Heritage Program for inclusion in their digital and paper files.

Provided to field staff for their use.

Published

Published in peer-reviewed outlets

With ecoregional planning data requests and analysis generated original data (e.g., for assessing the role of restoration in ecoregional planning). However, that data was stored in Minneapolis, and not with me in Illinois other than as expressed in the ecoregional plan tables and figures. I didn't go digitize a map, assess data layers, or measure plant height. Someone else did those things.

Question 30:
(140 responses; 97%)

Which phrase best characterizes the way in which data and information from your program are exchanged among TNC personnel?

(Total does not equal 100% because some people chose more than one answer).

There is little sharing of data and information except between individuals as the need arises.	45%
There is a high level of sharing of data and information between individuals, but relatively little data sharing via accessible on-line databases.	46%
Most data and information sharing occurs by individual access to data that are available on-line.	6%
Other (explanations follow):	5%

Extensive verbal communication to build and refine databases
Data sharing currently high at internal levels. Should be high with caveats at plan publications.
There is a high level of sharing of data and information between individuals and on-line.
We don't exchange data.

Question 31:
(140 responses; 97%)

Which phrase best describes the accessibility of your program's public data and information to non-TNC users?

(Total does not equal 100% because some people chose more than one answer).

Most public data and information are distributed by TNC staff only upon request	72%
Most public data and information are distributed by a third party such as a State Heritage Program or other organization.	20%
Most public data and information are made widely available on-line by TNC.	8%
Other (explanations follow):	4%

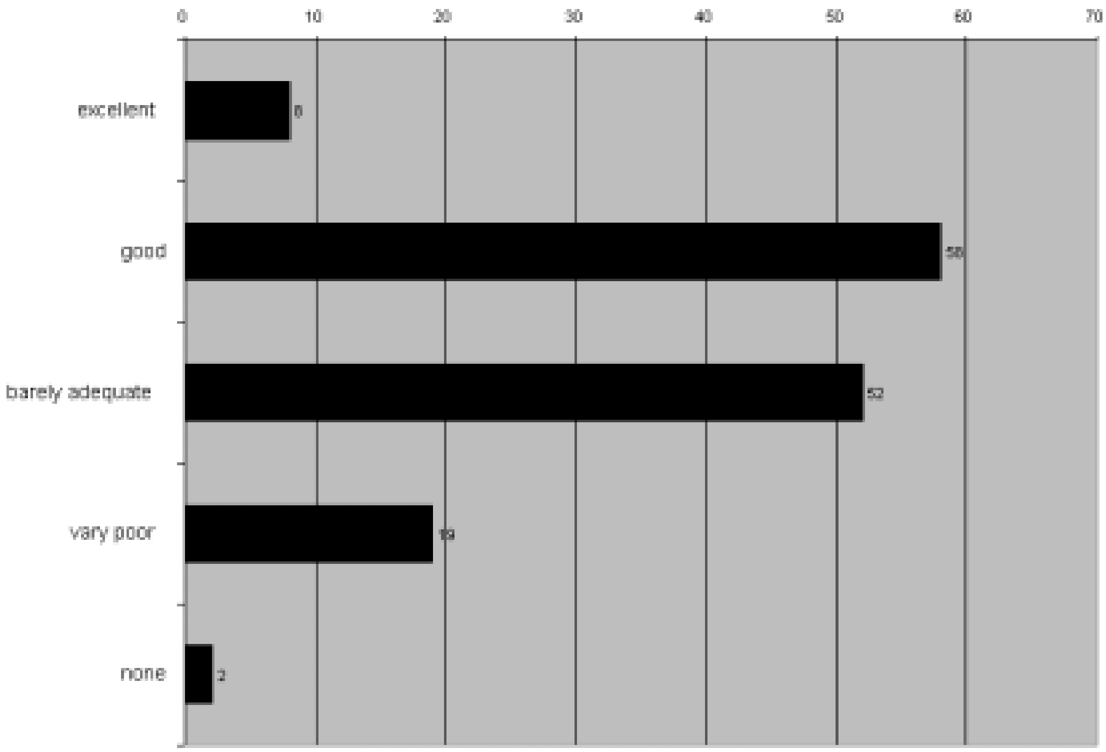
Distributed by TNC staff as needed.
We don't generate data.
Most not distributed at all.
Not sure what "public data" means, actually.

Question 32:
(140 responses; 97%)

Rating of respondent’s existing information management practices.

How would you rate your program's existing information management practices?

(Chart shows total number of responses in each category; average response is halfway between "good" and "barely adequate.")

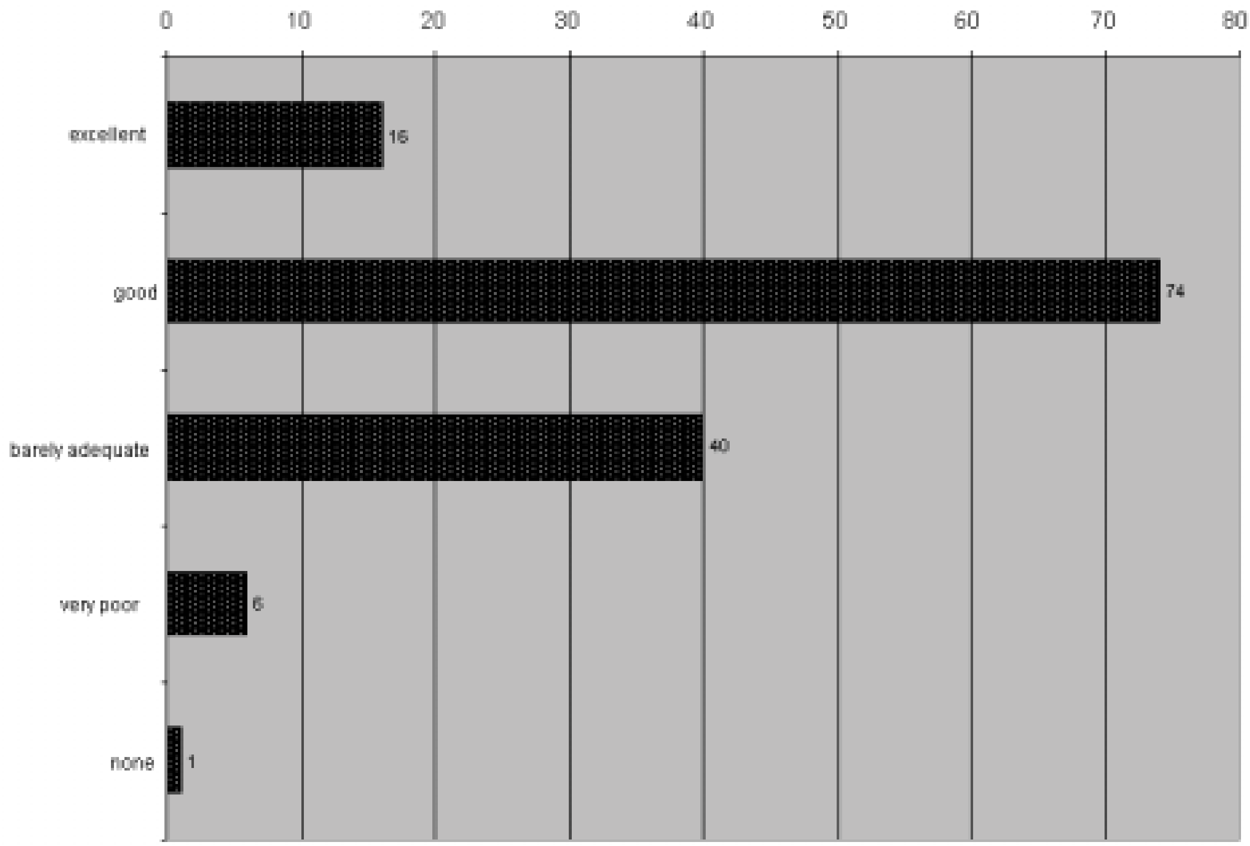


Question 32

Question 33:
(138 responses; 95%)

How would you rate your program's existing information management hardware and software?

(Graph shows total number of responses for each category; average response is "good.")

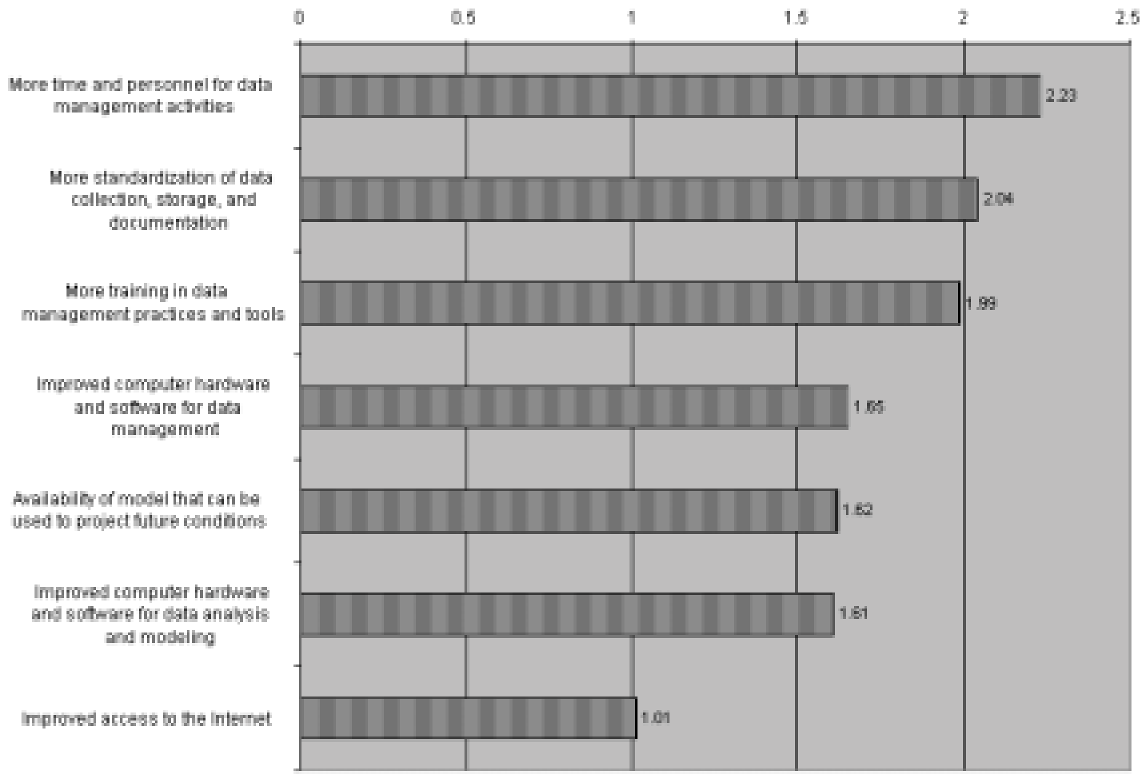


Question 33

Question 34:
(134 responses; 92%)

Respondents were asked to rate the relative importance of the following in improving data and information management practices in their program.

Graph shows average response in each category on a scale of 0 to 3 (0 = inconsequential, 1 = barely significant, 2 = significant, 3 = very significant).



Question 34

Section VI

Adaptive Management

In this section, the committee was interested in understanding to what extent the Conservancy employs adaptive management to inform its ecological management decisions. For purposes of these questions, the committee's definition of adaptive management is as follows: *a structured process for reducing uncertainty about environmental responses to management by viewing management actions as experiments*. The term "experiment" is important here, as it suggests a kind of scientific rigor based on explicit principles of experimental design.

Many respondents did not complete all or part of this section, citing that it was not applicable to them or that they did not understand the definitions, particularly of what constitutes a "project."

Question 35:
(97 responses; 67%)

Number of current projects that use adaptive management:
average: 4.3
range: 0 - 35

Instead of indicating numerically, 15% said "all" or "most"; 4% said "few" or "some."

Question 36:
(83 responses; 57%)

Number of current projects that do NOT use adaptive management:
average: 5.04
range: 0 - 36

Instead of indicating numerically, 11% said "all" or "most"; 1% said "few."

Question 37:
(65 responses; 45%)

Number of projects included in question 36 (those not using adaptive management) that would benefit from it:
average: 3.7
range: 0 - 30

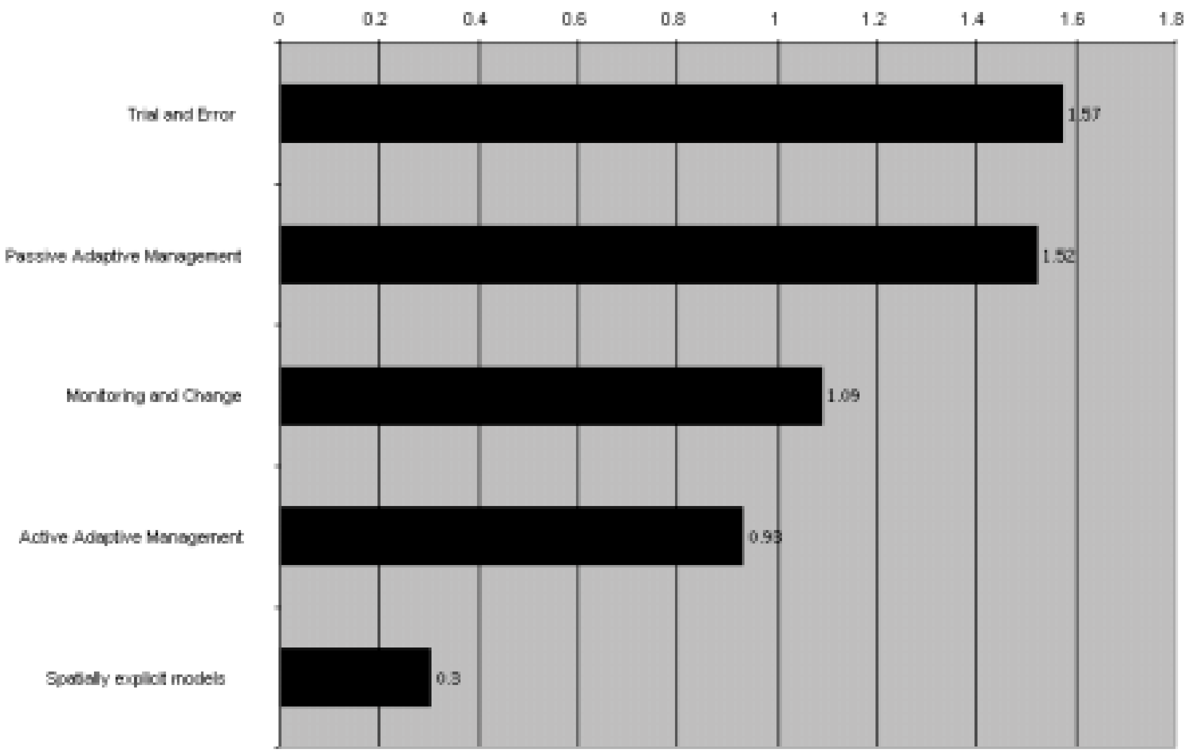
Instead of indicating numerically, 32% said "all" or "most"; 1% said "some."

Question 38:
(84 responses; 58%)

Given a list of five approaches, respondents were asked to determine how many of their projects using adaptive management rely on each approach, and to give examples.

The graph indicates the average response for each approach, rated on a scale of 0 to 3 (0 = none, 1 = a few, 2 = most, 3 = all).

Examples cited for each approach may be found in Appendix D.



Question 38

Question 39:
(98 responses; 68%)

If monitoring information reveals different outcomes than expected, which of the following would you most likely do first?

(Total is greater than 100% because several respondents chose more than one answer.)

Keep an eye on the project to see if the problem continues.	9%
Seek consultation from someone with expertise about the kind of project involved and get their view of whether changes in approach might be needed.	62%
Bring in a review team to look at the project and evaluate how best to respond with changes in project design.	22%
Work with scientists in developing a scientifically rigorous monitoring strategy to identify why outcomes are	26%

different than expected and how to incorporate that information in project redesign.

Question 40:
(90 responses; 62%)

In your program/practice, are there adequate mechanisms in place for using information on the results of an action to reassess the data or reasoning underlying that action?

No:	47%
Yes, with a mechanism available for adjusting the action on the basis of this re-examination:	49%
Yes, with no such mechanism available:	1%
Yes, with no comment on the availability of such a mechanism:	3%

Question 41:
(99 responses; 68%)

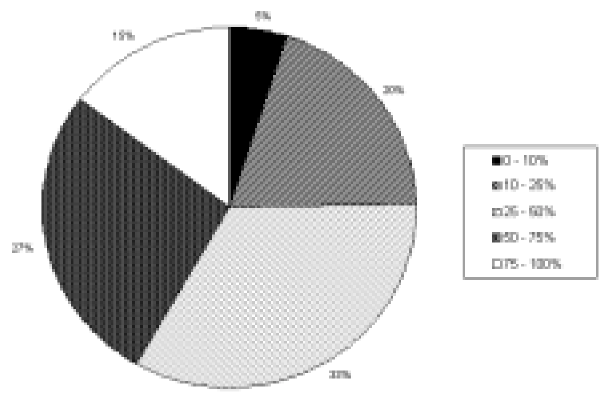
Does TNC encourage and fund an adaptive management approach?

Yes:	59%
No:	35%
Yes & no:	4%
Don't know:	2%

For comments, see Appendix D.

Question 42:
(101 responses; 70%)

Percentage of the scientific questions that directly affect respondents' work that they feel are not adequately answered before action is taken.



Question 42

Question 43:
(109 responses; 75%)

Respondents were asked what factors primarily account for the implementation of action before the questions are answered.

The general factors most frequently mentioned were:

Insufficient time	49%
Lack of information	29%
Urgency of threat/need for immediate action	26%
Lack of funding	13%
Lack of understanding of scientific processes	8%

For a comprehensive list of verbatim responses, see the Appendix D.

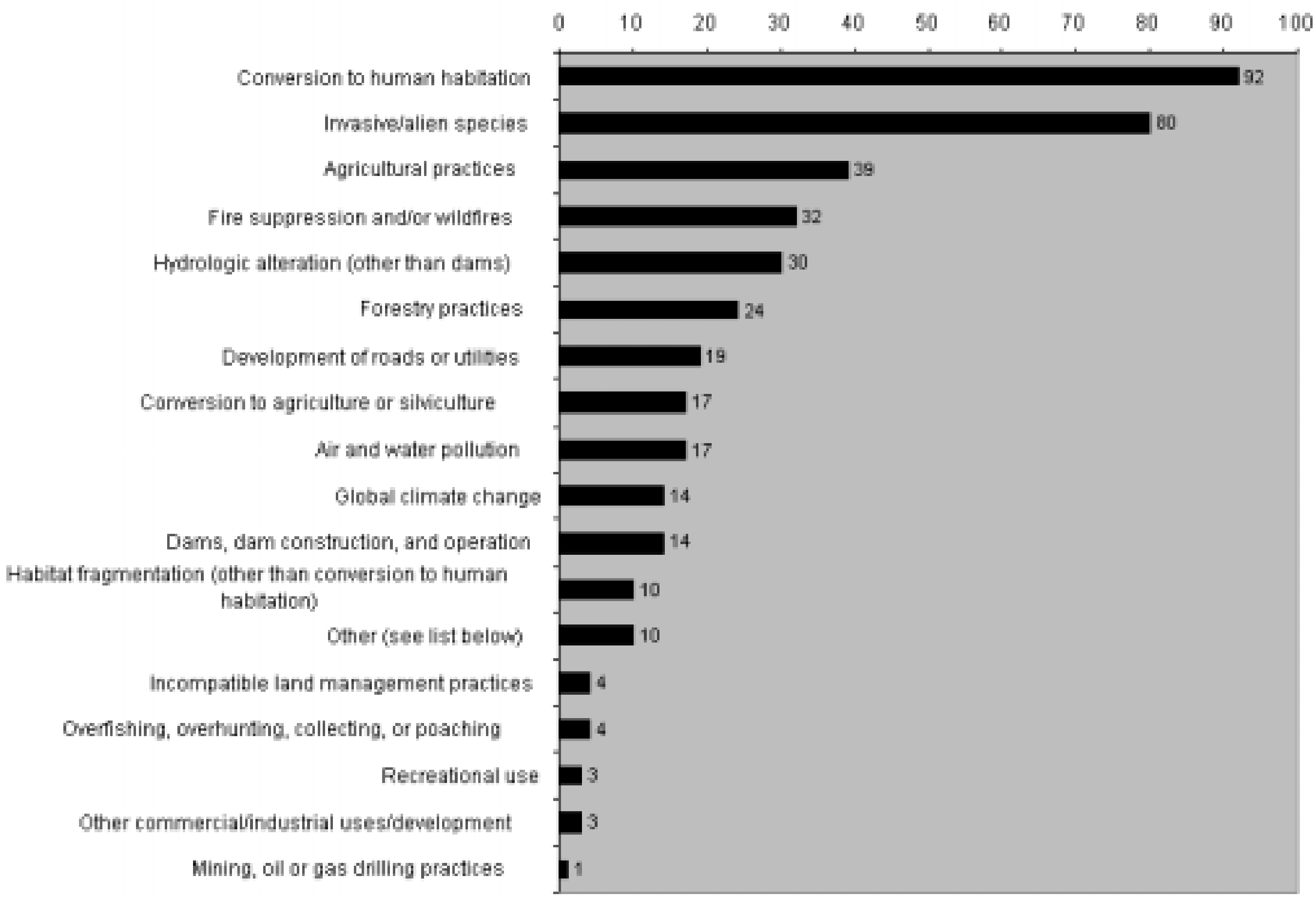
Section VII:
Conservation Threats

Question 44:
(140 responses; 97%)

Respondents were asked to rank what they considered to be the most urgent conservation threats.

They were given a list of 17 choices, plus "other." The graph shows the 17 threats in order of number of times indicated.

For a list of threats mentioned in the "other" category, see Appendix D.



Question 44

APPENDIX D

Question 1:

Personal Information

Job title:

Administrative Assistant
Aquatic Ecologist (3)
Assistant Aquatic Ecologist (3)
Assistant Director of Conservation Science
Assistant Director of Science and Stewardship (2)
Assistant Land Steward
Associate Director of Protection
Associate Scientist
Assoc. State Director for Development and Marketing
Botanist/Data Manager
Caribbean Marine Conservation Coordinator
Chief Landscape Ecologist
Climate Action Monitoring Coordinator
Community Ecologist
Community Outreach Coordinator
Conservation Biologist/Planner
Conservation Coordinator
Conservation Ecologist (3)
Conservation Planner (3)
Conservation Planner/Program Assistant
Conservation Planning Coordinator
Conservation Projects Director
Conservation Scientist
Conservation Specialist
Coordinator of Research and Monitoring
Director (2)
Director, Director of Science & Stewardship (2)
Director Conservation Planning
Director Conservation Science (4)
Director Freshwater Initiative
Director of Baja California/Gulf of California Program
Director of Conservation (2)
Director of Conservation Planning
Director of Conservation Programs (2)
Director of Conservation Science (3)
Director of Conservations Operations
Director of Government Relations
Director of Protection
Director of Science (2)
Director of Science and Stewardship (9)
Director of Science and Stewardship; Roanoke River Project Dir.
Director of Stewardship (3)
Director, Community Conservation Program
Director, Invasive Species Program
Director, Landscape Ecology
Director, Monitoring and Adaptive Management
Director, Site conservation
Director, US Conservation Science Support
Director/Ecologist, Oregon Natural Heritage Program
Ecologist (2)
Ecoregional Information Manager
Entomologist
Field Office Coordinator
Field Office Coordinator/Biologist
Field Representative
GIS Analyst (3)
GIS Manager (3)
GIS Technician
Land Steward (5)
Landscape Ecologist
Midwest Director of Science
Northeast Ecologist
Northeast Ohio Land Steward
Oregon Coast Stewardship Ecologist
Piping Plover Recovery Biologist
Program Assistant
Program Coordinator/Annalist
Program Manager (2)
Project Director (2)
Project Manager
Protected Area Specialist
Protection and Science Assistant
Regional GIS Manager
Science Information Officer
Senior Aquatic Ecologist
Senior Biohydrologist
Senior Conservation Advisor
Senior Conservation Ecologist
Senior Conservation Planner
Senior Conservation Planner/Protection Specialist
Senior Ecoregional Conservation Advisor
Senior Project Ecologist (4)
Site Conservation Planner
Southern Mexico Program Protected Areas Specialist
State Ecologist
Stewardship Biologist
Stewardship Biometrician
Stewardship Ecologist (7)
Technical Writer
Terrestrial Ecologist (2)
Volunteer
Wetlands Ecologist
Zoologist (2)

Department name:

Arkansas Field Office
Asia Pacific Region
Baraboo Hills, WI Field Office
Brazil Division-Atlantic Forest
Camp Shelby Field Office
Caribbean Div., International Conservation Program
CARO
Central and Western NY Chapter (Stewardship)
Clinch Valley Program
CO Field Office (2)
Conservation
Conservation Planning
Conservation Programs (3)
Conservation Programs/OR Field Office
Conservation Science (10)
Conservation Science - Planning /Science Support
Conservation Science Division (7)
Conservation Science, International Programs
Conservation Sciences - Field Services
Conservation-NMFO
CSD-Conservation Planning
CWNY
DE Bayshores
DE Natural Heritage Program
Development
East Texas Program
Eastern Conservation Science (3)
EMR
Field Office
Freshwater Initiative (3)
Freshwater Initiative/Conservation Science (3)
GA Field Office (3)
Government Relations
GR, Communications, Outreach
Grand Prairie Area
Great Lakes Program
Heritage (3)
HI Field Office (2)
IL Chapter
Illinois Chapter-Science Program
Indiana Office
International
International Conservation Science
KY Field Office (2)
Latin America Caribbean Mexico
Lostwood National Wildlife Refuge
Midwest Conservation Science
Midwest Resource Office
Midwest Science Center
Minnesota Field Office
Montana Field Office
Natural Heritage Program
NC Field Office
NE Colorado Program and Land Steward
NE Ohio Program
NE Field Office
Nevada Field Office
NH Stewardship
Northern Tallgrass Prairie Ecoregion
OH Chapter, Science and Stewardship
OH Field Office (2)
OK Field Office (2)
OR Field Office
Oregon Coast Preserves
Oregon Natural Heritage Program
ORFO/Stewardship
Protection (4)
Protection/Stewardship (2)
Regional Technical Unit
Sacramento River Project
Science
Science and Stewardship (4)
Science and Stewardship, MD/DC Chapter
Science and Stewardship, MO Field
Southeast Conservation Science (6)
Southern Mexico Program
Statewide Conservation
Stewardship (5)
Stewardship/Conservation Science
Stewardship/Science, Long Island Chapter
Stewardship/Southern AZ Region
Tallgrass Prairie Review
TX Field Office
US Conservation/WRO
VA Coast Reserve
VT Field Office

Western Conservation Science
Wildlands Invasive Species Program (2)
Wings of the Americas
WISP

Location:

Abingdon, VA
Ainsworth, NE (?)
Albuquerque, NM
Arlington, VA (7)
Atlanta, GA (3)
Baraboo, WI
Bethesda, MD
Boise, ID (5)
Boston, MA (3)
Boulder, CO (8)
Brunswick, ME (2)
Camp Shelby, MS (2)
Chardon, OH
Charlottesville, VA
Chicago, IL (2)
Chico, CA
Clear Lake, SD

Cold Spring Harbor, NY
Colorado Springs, CO
Concord, NH
Conshohocken, PA
Davis, CA (4)
Delaware
Dublin, OH (4)
Durham, NC (6)
East Lansing, MI (3)
Eugene, OR
Eureka, IL
Fort Collins, CO
Gainesville, FL
Helena, MT (2)
Home Office
Honolulu, HI (3)
Indianapolis, IN
Ithaca, NY
Keene Valley, NY
Kenmare, ND
Ketchum, ID
Lexington, KY
Little Rock, AR (3)
Madison, WI (4)
Milton, DE
Minneapolis, MN (4)
Montpelier, VT
Nacogdoches, TX
Nashville, TN
Nassawadox, VA
New York, NY
Niceville, FL
Otis, OR
Pawhuska, OK
Peoria, IL (2)
Phoenix, AZ
Portland, OR (8)
Providence, RI
Pulaski, NY
Red Bluff, CA
Rochester, NY
San Antonio, TX (3)
San Francisco, CA
Santa Fe, NM
Smyrna, DE
St. Louis, MO (2)
Tallahassee, FL
Tucson, AZ
Tulsa, OK
USA (2)
Curitiba, Paraná, Brazil
Mérida, Yucatán, Mexico
Quinto, Ecuador

Number of Responses by State:

AR	3
AZ	2
CA	7
CO	12
CT	1
DE	3
FL	3
GA	3
HI	4
ID	6
IL	7
IN	1
KY	2
MA	4
MD	1
ME	2
MI	5
MN	4
MO	2
MS	2
MT	2
NC	8
ND	1
NH	1
NM	2
NV	2
NY	6
OH	5
OK	3
OR	10
PA	1
RI	1
SD	1
TN	1
TX	4
VA	10
VT	1
WI	5
no state specified	3
International	3

Question 3:

Degree subject area:

Anthropology (2)
Anthropology, Hydrology & Water Resources
Applied Ecology
Aquatic Ecology (3)
Astrophysics
Biological Sciences
Biology (12)
Biology (Botany)

Biology, Marine Sciences
Biology, Water Resources
Biology/Ecology
Botany & Environmental Science Emphasis
Botany (10)
Botany (plant ecology/floristics)
Botany, Field Naturalist
Botany/Biological Aspects of Conservation
Botany/Ecology (4)
Botany/Field Natural History
Conservation Biology (3)
Conservation Biology/Insect Ecology
Drafting Design Engineering Technology
Ecological Restoration & Natural Resources Policy
Ecology (15)
Ecology (plant ecology)
Ecology and Evolutionary Biology (Botany)
Ecology, Environmental Planning
Ecology/Evolutionary Biology
Ecology/Ornithology/Entomology
English
Entomology (2)
Entomology, Behavioral Ecology
Environmental GIS and Remote Sensing
Environmental Management (2)
Environmental Policy
Environmental Science (2)
Evolutionary Biology
Evolutionary Ecology (2)
Exercise Physiology
Fisheries and Wildlife Sciences
Fisheries Sciences
Forest Ecology (3)
Forest Ecology/Forest Soils
Forest Ecology/Landscape Ecology
Forestry (2)
Geography (4)
Government/Political Science
Landscape Ecology (2)
Marine Affairs
Marine Conservation Science
Microbial Ecology
Natural Resource Management/Ecology
Natural Resource Science (Stream Ecology)
Natural Resources
Natural Resources-Land Use Planning
Natural Science/Botany
Plant Ecology (5)
Public Administration
Public Administration/Business Administration
Range Ecology
Range Science
Rangeland Ecology
Raptor Biology-Conservation Biology
Resource Ecology and Management (2)
Resource Management and Administration (2)
Science/Forestry/Ecology
Soil Science
Vertebrate Biology/Ornithology
Watershed Management
Watershed Science
Wetlands Ecology
Wildlife and Fisheries Science (2)
Wildlife Biology
Wildlife Ecology
Wildlife Management
Wildlife Resources/Conservation Biology
Wildlife Science
Zoology (5)
Zoology/Ecology
Zoology-Behavioral Ecology

Question 6:

Extent to which respondents are working collaboratively with staff in other TNC programs on projects/issues that go beyond their state/program/country borders.

Summary of other scientific endeavors cited :
Ecological management (5)
Research (5)
Species-focused conservation (5)
Classification and inventory (4)
Policy (3)
Training (1)

Question 8:

Comments:

"We don't issue reports, but instead author or co-author published papers or edit and contribute chapters to books and newsletters. We submit copies to supervisors and Selected TNC staff and other conservation workers and place notices of the availability of these items on our listserve, which reaches about 400 people nationwide and is repeated by several other listserves that reach an unknown number of people."

Question 10:

Conferences and meetings

Respondents were asked to list the host organization of the three most recent non-TNC scientific conferences and meetings they have attended, indicating the scope of those meetings. The following is a comprehensive list of responses; numbers in parentheses indication multiple mentions.

Regional scope

ABI
Agriculture Ecosystem Research Project
American Fisheries and Wildlife Society
American Fisheries Society
AR DEQ
AR GFC
Arid Lands/Shrub Steppe
Association of Southeastern Biologists (3)
Big Thicket Science Conference
CA Association of Fire Ecology (CAFÉ)
CA Department of Fish and Game
CA Exotic Pest Plant Control
CA Native Grass Society
CALEPPC (2)
CA-NV-HI Forest Fire Council
Catholic University
CO Native Plant Society
CO Riparian Association (2)
Coalition of 27 New England conservation and native plant groups
DE Biodiversity Conference
DE Invasive-Species Council
Dept. Natural Resources (3)
Ecosystems Center, Marine Bio Lab, Woods Hole, MA
Entomological Society of America (2)
Environmental Law Institute
EPA
Exxon Valdez oil spill trustees council
Fish and Wildlife Conference
FL DEP
FL Dept. Environmental Management Conference
Forest Ecosystem Information Exchange
Gopher Tortoise Council
Great Lakes Protection Fund Flows Projects Report Meeting
Gulf and Caribbean Fisheries Institute
Ice Storm Research Council
ID Weed Control Association
IL Dept. of Natural Resources
Klamath Basin
KY Academy of Science
La Encrucijada Biosphere Reserve and Institute of Natural History of Chiapas
Long Island Pine Barrens Research Forum (3)
Longleaf Alliance (2)
Manomet (2)
MI Fire Council
Mid-Atlantic EPPC
Midwest Fish and Wildlife (2)
Midwest Wildlife Conference
MO Dept. of Conservation
MS State University
National Park Service
Native Plant Society
Natural Lands Trust
Nature Conservancy Canada
NCASI (4)
New England Wildflower Society
NM Riparian Council
Northeast ARC/INFO Users (2)
Northern Taconies Res. Consortium
NW Scientific Association
NYS Natural History Conference
OH Prairie Conference
OK Academy of Science
OK Chapter Wildlife Society and Society for Range Management
OK Forestry Association
Pacific NW Coastal Ecosystems Regional Study
Paramo Project
Partners in Flight (2)
Peter Vitousek/Stanford University
PNW Coastal Ecosystem
Prairie Enthusiasts
RI Natural History Survey & University of RI
SE Water Pollution Biologists Association
Secretariat for Conservation Biology (3)
Society for Range Management
Society of Ecological Restoration
Soil and Water Conservation Society
Southeast Quail Study Group
Southeastern Water Pollution Biologist Association
Southern Weed Science Society
Southwestern Association of Naturalists (3)
State of FL Water Management Districts
The Wildlife Society (5)
TN Wildlife Resources Agency
University of Arkansas (2)
University of Idaho
University of Maine CFRU
University of Mississippi
University of Rhode Island
US Forest Service (8)
USFWS
USGS
VA Dept. of Game and Inland Fish
Vermont Monitoring Cooperative
Weed Science Society
Woods Hole Oceanographic
World Wildlife Fund

National Scope:

AIBS
American Bamboo (?) Society
American Bryol and Lichend Society (2)
American Fisheries Society
American Ornithologists Union
Chinese Conservation Biology
CO State University Ranching Symposium
Cooper Ornithological Society
Department of US Interior

Ecological Society of America (6)
Entomological Society of America
ESA (4)
Federal University of Viçosa/Winnock International
FICMNEW
Freshwater Mollusk Conservation Society
Ft. Benning Research Forum
Fundacao Mato Grosso
GAP (3)
International Association of Landscape Ecology
IUCN
Manomet-National Shorebird Plan
MO Dept. of Conservation
NAA
National Arbor Day Foundation
National Cattleman's Beef Assoc. - Cattleman's College
National Gap Analysis Program
National Park Service
National Park Service Integrated Pest Management
Natural Areas Association (14)
North American Forest Ecology Workshop
North American Prairie
Oak Ridge National Lab
SEMARNAP
Society for Conservation Biology
Society for Ecological Restoration (2)
Terrene Institute
US Fish and Wildlife Service (2)
US Forest Service (2)
USEPA
USGS BRD (GAP)
WSSA

International Scope:

American Ornithologist Union (2)
American Water Resources/Riparian
Animal Behavior
Association for Biodiversity Information
Association of Rural Sociology
Autonomous Metropolitan University, Mexico
British Ornithologists Union
Canadian Wildlife Service
CO Natural Heritage/NSF/CSU
Conservation Biology (2)
East-West Center, University of Hawaii
Ecological Society of America (5)
EIA/Environment Canada
Environmental System Research Institute
ESA (5)
ESRI (4)
GAP USGS-BRD
Great Lakes Wetlands Consortium
International Association of Great Lakes Research
International Assoc. of Landscape Ecology (2)
International Weed Science Society
IUCN World Conservation Congress
Latin American Studies Association
Lepidopterists Society
Longleaf Alliance
LTER
MO Botanical Garden
multiple public agencies and NGOs, associations
National Cave and Karst Management Symposium
National Speleological Society
Natural Areas Association (8)
North American Beathological Society (3)
North American Prairie Conference
NY Biodiversity Conference
Old Dominion University Milwaukee Public Museum
Oregon State University
Pacific Seabirds
Quillwort Conference
SCB (2)
Secretariat for Conservation Biology
Society Carib. Ornithology
Society for Cons. Biology, Colorado State University
Society for Conservation Biology (7)
Society for Conservation GIS
Society for Ecological Restoration (2)
Society for Range Management (3)
Society of Canadian Ornithologists
Society of Wetland Scientists
Society of Wetland Scientists (2)
TNC
TX Academy of Science
UN Informal Consultative Process of the Ocean & Law of the Sea
University of Minnesota
USAID/PROWID/Women in Development Research
USGS-NA Colonial Waterbird Plan
Water Environment Federation
WHSRN
Wildlife Conservation Society
World Bank
World Wildlife Fund

Question 12:

Publications

Respondents were asked to list the publication/journal of their three most recent peer-reviewed journal articles (part A) and the last three other scientific papers and publications to which they contributed (part B). The following lists are comprehensive; numbers in parentheses indicate multiple citations.

Publications/journals and dates of three most recent peer-reviewed articles :

American Fern Journal, 1996
American Journal of Botany, 2000
American Midland Naturalists, 1985
Animal Behavior, 1990
Applied Animal Behavior Science, 1999
Applied Engineering in Agriculture, 2000
Arctic and Alpine Research, 2000
Arctic, 1978
Bartonia, pending
Biogeochemistry, 1991
Biological Conservation
Biological Conservation, 1999
Bioscience, 2000
book chapter, 1999
Bulletin Wader Study Group, 2000
Canadian Field Naturalist, 2000
Canadian Journal of Forest Research, 1997
Canadian Journal of Zoology, 2000
Condor, 1994
Condor, 1998
Conservation Biology in Practice, 2000
Conservation Biology, 1995
Conservation Biology, 1997 (2)
Conservation Biology, 1998
Conservation Biology, 1999
Conservation Biology, 2000
Conservation Biology, in press 2001
Conservation Voices, 1998
Ecological Applications, 1993
Ecological Applications, 1996
Ecological Applications, 1997 (2)
Ecological Applications, 2001
Ecological Applications, in press
Ecological Monographs, 1993
Ecology, 1986
Elepaio, 2000
Entomological News, 1986
Entomological News, 2001
Environmental Management, 1999
Environmental Science and Policy, 2000
Environmental Science and Policy, 2001 (2)
Erigenia, 1997
Florida Entomologist, 1998
Fremontia, 1998
Fremontia, 1999
Freshwater Biology, 1997
Great Basin Naturalist
Great Basin Naturalist, 1988
Great Basin Naturalist, 1996
Great Lakes Entomologist, 2000
Great Lakes Wetlands, 1998
Great Plains Research, 1998
Great Plains Research, 1999
Illinois Academy of Sciences, 1999
J. Hattor's Botanical Lab, 1997
J. Torrey Bot. Soc., 1998
Journal of Coastal Research, 2001
Journal of Ecology, 1996
Journal of Environmental Quality, 1988
Journal of Field Ornithology, 2000
Journal of Herpetology, 1999
Journal of Hydrology, 2000
Journal of Lepidopterists Society, 1997
Journal of Mammology, 2000
Journal of Range Management, 1988
Journal of Range Management, 1999 (2)
Journal of Shellfish Research, 1999
Journal of Soil and Water Conservation, 2001
Journal of Tropical Lepidoptera, 1997
Journal of Vegetation Science, in review
Journal of Wildlife Management, 1998
Journal of Wildlife Management, in review
KY Academy of Science, 1991
KY Academy of Science, 2001
Lake and Reservoir Management, 2000
Landscape and Urban Planning, 1997
Landscape and Urban Planning, 1998
Landscape Ecology, 1996
Lichenographia Thomsoniana, 1998
Madrono, 1986
Madrono, 1992
Madrono, 1993
Madrono, 1994
Madrono, 2001
Madrono, in press
Marine Ecology Progress Series, in press 2001
Michigan Botanist, 1990
MO Dept. of Cons. Nat. Hist. Series No. 4, 1996
Natural Areas Journal, 1991
Natural Areas Journal, 1996
Natural Areas Journal, 1998 (2)
Natural Areas Journal, 1999
New Phytologist, 2000
Northeast Naturalist, 1997
Northeast Naturalist, 2000
Northeast Naturalist, 2001
Northeast Naturalist, pending
Northwest Science, 1993
Occasional papers, FL State Collection of Arthopods, 1999
Oceangr., 1980
Photogrammetric Eng. & Remote Sensing, 1998
Photogrammetric Eng. & Remote Sensing, 1999
Phytologia, in press
Prairie Conservation (Island Press), 1996
Prairie Naturalist, 2000
Precious Heritage book chapter, 2000
Proceedings, Midwest Forest Stewardship Conf., 1995
Proceedings, Watershed 2000 Conf., 2000
Regulated Rivers: Research & Management, 1998
Resource Management Notes, 1996
Restoration and Management Notes, 1994

Restoration and Management Notes, 1997
Restoration and Management Notes, 1999
Restoration Ecology, 1997
Restoration Ecology, 2001
Rhodora (New England note), 2000
Sida, 1999
Soil Science of America Journal, 1988
Soil Science, 1999
Stream Notes, 1999
Taxon, 1998
The AUK, 1998
The Auk, 2000
The Maryland Naturalist, 1999
Trans. NA Wildlife & Nat. Res. Conf., 1996
Trans. NA Wildlife Conference, 1995 (2)
Trans. of the ASAE, 2000
TX Journal of Science, 2000
UWGCP Ecoregional Plan, pending
VA Journal of Science, 1992
Weed Technology, 1996
Wetlands, 2000
Wetlands, 2001
Wetlands, in review
WI Academy of Arts and Letters, 1999
Wildlife Monograph, 2001
Wildlife Society Bulletin, 1999
Wilson Bulletin, 1996
Wilson Bulletin, 1999
Wilson Bulletin, in prep
Wilson Bulletin, pending

Three most recent other scientific papers and publications:

"Including Aquatic Targets in Ecoregional Portfolios," internal TNC publication, 1999
"More Than the Sum of the Parts," in Precious Heritage: Status of Biodiversity in the US, 2000
A Classification Framework for Freshwater Communities, 1997
A Guide to The Nature Conservancy's Preserves in Minnesota, 2000
Abstracts, published several conference proceedings, 1999-2000
Air-Land-Water Interactions: A Case Study in Aquatic Ecology, 1985
alien weeds
An action plan for the conservation of rare plants in the midwestern United States, Center for Plant Conservation, 1999
An Alliance Level Classification of Vegetation of the Coterminous Western United States, TNC, 1999.
An Ecological Analysis of Conservation Priorities in the Sonoran Desert Ecoregion, TNC Arizona Chapter, Sonoran Institute, Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonoro, 2000
Análisis de Impactos y sus Fuentes y Programa de Monitoreo, Reserva de la Biosfera Calakmul, México, 2000
Arickaree River Site Conservation Plan, 2000
Atlas of Idaho Wildlife: Integrating Natural Heritage Information and Gap Analysis, Idaho Dept. of Fish and Game, 1997
Atlas of KY Flora, ongoing database
Atlas of Oregon Wildlife, 1997
Bahamas Journal of Science, 1999
Bird "White Paper"
Bird Conservation, 1999
Brochure on ecoregional planning, 2000
CA Cattleman's Association, 2000
Camp McCain Biological Inventory, 2000

Camp Shelby Biological Inventory, 2000
Carbon Inventory and Monitoring Plan for the GCAP, Brazil, 1999
Caribbean Vegetation Classification, 1999
Catalytic Capacity Building in Nonprofit Organizations, 2001
Central American Vegetation Map/Report, 1998
Central Appalachian Ecoregional Plan, 2001
Central Appalachian Forest Ecoregional Plan, 1999
Central Shortgrass Prairie Ecoregional Plan, 1998
Central Tallgrass Prairie Ecoregional Plan, 2000 (2)
Chapter in Ecological Risk Management book, 2001
Characterization and classification of plant communities inhabited by the ringed boghaunter dragonfly, 1999 (unpublished TNC document distributed to Heritage and Endangered Species programs in all of NE and others).
Clark County MHSCP Adaptive Management Plan, 2000
Co-editor of book, Seashore Chronicles, 1998
Columbia Plateau Ecoregional Plan, 1997
Conservation Science Working Paper, 1999
Creating an Integrated Weed Management Plan, 2000
CSP Ecoregional Plan, 1998
Daniel Boone National Forest Inventory, 1987-94
Designing a Geography of Hope, 2000 (2)
Development of a Deforestation and Forest Degradation Trend Model in the GCAP, 1999
East Gulf Coastal Plain Ecoregional Plan, 1999
Ecological and floristic assessment of MO Prairie Foundation Lands, 1999
Ecological Classification System: National Forests in TX and LA, 1999
Ecological Models, St. John River Landscape, 2001
Ecological Stewardship (book), 2000
Ecological Systems Viability, 2001
Ecology and Conservation GP Vertebrates (book chapter)-Springer, 1997
Ecology and Conservation of ??? Migrant Land ???, Smithsonian Press, 1992
Ecoregional Planning Report on Vegetation, 1999
Ecoregions of Western Washington and Oregon. EPA Publication, 1997
Ecosystem Management: An Adaptive Community-Based Approach, 2001
Effects of the 1998 Ice Storm, 2000
Endangered and Threatened Wildlife of Michigan, 1994
Endangered Non-game Bird Species of the Northeast, 1991
ESA position paper on Freshwater Equity, 2000
Examination of a long-term monitoring technique and the effects of fire management on the herpetofauna of Chilton Creek Preserve in Shannon and Carter counties, MO, 1998
Feminist Political Ecology/Routledge Press, 1996
Field Guide for ID of Forested Wetlands for Forest Service BMPs, 1998
Final contract report to Missouri Prairie Foundation, TNC, 1999
Final Report, US Dept. of Defense Contract DAMD17-99-2-9038, TNC, 2000
fire
FL EPPC Proceedings (2), 1999
Floodplain Forest National Committee in NH, 1998
Freshwater Conservation in the Great Lakes Basin, 1998
Gap Analysis (book), 1996
GAP Analysis of LAC, 1997
Geography of Hope (2nd edition), 2000 (4)
Geography of Hope (chapter), 1997
Geography of Hope (first edition), 1998
Geography of Hope update, 1998
Geography of Hope update, 1999 (2)
Grasslands of NE America, 1997
Great Bay Management Plan, 2000
Great Swamp (NY) Conservation Strategy, 1999
Guía de Análisis de Impactos y sus fuentes en áreas naturales, 1999

Guía para la elaboración de programas de manejo para áreas naturales, 1999
Guidance documents and workshop proceedings produced by the Freshwater Initiative, 6-8 since 1998
Guidelines for Representing Ecological Communities in Ecoregional Plans, 1999 (2)
ICPS Proceedings, 2000
Improving management of non-native invasive plants in wilderness and other natural places, Wilderness science in a time of change conference, 1999
Indicators of Hydrologic Alteration (IHA), software user's manual, 2001
International Classification of Ecological Communities, 1998
Invasive Plants and Weeds of the [illegible] Garden, 1996
Invasive Plants of California's Wildlands (U. of CA Press), 2000 (2)
Journal of Animal Ecology, 1998
Kanepuu Conservation and Restoration: A plan to conserve and restore the olopua/lama dry forest community of Kanepuu Preserve, Lanai, 1999
Karnes Blue Butterfly: A Symbol of a Vanishing Landscape, 1994
Know the Pearlymussels, 1997
KY Afield Magazine (KDFWR), 2000
KY Chapter News, 2001
listserves
Lower New England/Northern Piedmont Ecoregional Plan, 2001
Lower New England/Northern Piedmont Ecoregional Plan, 2000
Lower Purgatoire Site Conservation Plan, 2001
Manual for Integrated Weed Management Plan Writing, 1999-2000
Manual on Marine Protected Areas Management, 2001
Marine Pollution Bulletin, 1999
Measuring and Monitoring Plant Populations, 1998
Middle Rockies-Blue Mountains Ecoregional Plan, 2000
Mishaklakes Report, 2000
Mitchell's Satyr, Neonympha mitchellii mitchellii recovery plan, 1994
Monitoring Plant and Animal Populations, 2001
Monitoring protocol for the Barrens Restoration Demonstration Project at Arnold Air Force Base, TN, 1998
Monitoring protocols for rare and threatened plant species at Arnold Air Force Base, TN, 1998
Monteverde (book), 2000
Mukwonago River Watershed Site Conservation Plan, 2000
National Cave and Karst Management Symposium Proceedings, 1997, 1999
National Vegetation Classification, 2000 (3)
Native Plant Revegetation Guide for Colorado, 1998
Native Warm Season Grasses for Livestock and Wildlife, 2001
Natural Resource Conservation, 1999
Northern Forested Wetlands: Ecology and Management, 1997
Numerous Heritage Program Reports, 1999-2000
Oceanography 99, 1999
Oecologia, 1999
Oregon Gap Analysis Project Final Report: A geographic approach to planning for biodiversity. Oregon Natural Heritage Program, 1999
Osage Plains/Flint Hills Ecoregional Plan, 2000
Plant Association of Oregon Dunes, 1998 (2)
Plymouth Site Conservation Plan, 1999
Prairie Conservation (book chapter)-Island Press, 1996
Precious Heritage (book chapter), 2000
Proceedings CA Riparian Conference, in progress
Proceedings of First Conference on Fire Effects on Rare and Endangered Species and Habitats, 1997
Proceedings RMRS-P-O-VOL-5
Proceedings, Southern Lake Michigan environmental issues workshop, 1997
Rare and Endangered Biota of Florida (book), 1994
Rare Plant Monitoring of Solanum nelsonii at Moomomi Preserve, Molokai, 1993-97, 2000
Rare Spp and Nat. Communities, Hanover, NH, 1999
Rare T & E Species of Oregon, various white papers, 2001

Rare, Threatened and Endangered Species of Oregon, 1993,'95,'98
Recovery Plan for campanula robinsia and justicia cooleyi (USFWS), 1994
Red data list of the birds of Ecuador, 1997
Research in the Northern Taconies, 1999
Riparion [illegible] Guidelines for St. John River Working Forests, 1999/2000
Saginaw Bay Coastal Wetland Restoration Feasibility Study, 1997
Sandy Neck Conservation Plan, 2000
Scientific Research Relating to the Effects of Pigs on Native Hawaiian Ecosystems and Feral Pig Research and Management in Hawaii: Annotated Bibliography, 2000
SER Proceedings, 1998
Setting geographic priorities for marine conservation in Latin American and the Caribbean, 1999
Several ecoregional plans
Several unpublished scientific reports to agencies and TNC, 1990-present
Site Conservation Plans (5), 1998-2000
Status of the Karner blue butterfly in Michigan, 1994
Status Survey for Derringo thamus pubolellus (??) USFWS, 1993
Status Survey for lilium iridullae (USFWA), 1994
Stewardship Across Boundaries (book chapter), 1998
Structure and Function of an Alpine Ecosystem (book chapter), 2001
Sugartown Barrens Site Conservation Plan, 2000
Sustainable use of wetlands in South America, 1997
Technical Report - HI work, 1999
The 5-S Framework for Site Conservation, 2000 (2)
The Ecology of the Fishes of Cuba, book in press
The Nature Conservancy of MS 10th Anniversary Issue, 1999
The Raven, in press
The Tallgrass Restoration Handbook (book chapter)-Island Press, 1997
TNC 5-S Framework handbook, 2000
TNC Conservation by Design, 2000
TNC Forest Bank Brochures, 1998-1999
TNC Magazine, 2000
Tualalatin (?) River Wildlife Viewing Guide, 2001
Upper Muddy River Site Conservation Plan, 2000
US65 Status and Trends of the Nation's Biological Resources, 1999
USFS Gen Tech Report, 1993
USFS Gen Tech Report, 1996
USFS Symposium Volume, 2001
Various SEUS ecoregional plans, 1999-2000
Various WI Site Conservation Plans
Vegetation Management (manual), 1999
Vegetation Monitoring in a Management Context (TNC), 1998
Video on Managing River Flows for Biodiversity, 2000
Warwick Park Site Conservation Plan, 1999
Water Policies in Ecuador, 2000
Water Reuse Policy in VA Coastal Zone, 1998
Weed Alerts
Weed Control Handbook, in progress
West Gulf Coastal Plain Ecoregional Plan, 2000
Western Allegheny Plateau Ecoregion Plan, 2000
Wildflower Guide for Busey Woods, 1992
Willamette River Basin Planning Atlas, 1998
WISP Success Stories
WISP Web site, 1997-current
WSSA Proceedings, 1999

Question 13:

Relative importance of scientific information sources-other sources listed:

consultant studies
consultants
existing maps and reports
experimental data
expert opinion within TNC
field data I gather
government agencies
listserves
original field data
own assessments
peers
personal communication (not with experts)
personal vegetation and flora data
standard reference books on statistics, ecology, & Hawaiian natural history
tech networking
TNC workshops and manuals

Question 14:

Comments:

> "Although this questionnaire is geared to regular TNC employees, our program is very different. TNC administers a grant from the MS Military Department. Although ecoregional planning and site conservation planning might be ideal pursuits, this office is restricted by the military from participating in any action that might interfere with training activities at this installation and we are not permitted to engage in activities that do not affect or are not specified by the military department."

Question 17:

To what extent do you feel your scientific abilities are used appropriately?

1. I rely on local scientists to collect data which we apply on the ground as stewardship and conservation. I am an applied ecologist.
2. I knew when hired I would no longer be doing much research, and would be focused on monitoring, ecological management, conservation planning. I try to work with academic scientists to get research done. That's fine. I really like what I am doing.
3. My role is to assure the use of good information, not to acquire information via research.
4. No longer consider myself a "scientist." I am a manager/leader with scientific training.
5. My job doesn't require specialized scientific knowledge in an academic sense, since our partners rely on scientific experts for specific site work. I facilitate workshops, make information (written materials or training opportunities) accessible to partners, assist in the generation of science-based site management documents, or bring in experts to address specific needs.
6. I'm a veg-head doing vegetation/community classification work. It's a good match.
7. We continue to deal with a shortage of staff for the work.
8. Ad-hoc needs prevent scientific work from being completed.
9. My scientific background is in a field which is different from the conservation planning work I now do.
10. The unrealistic and counterproductive time crunch for first iteration ecoregional plans (while simultaneously splitting off ABI!) has had an enormous impact on science in the organization (as many of us predicted). On the one hand, the

ERP process itself has stimulated tremendous innovation, but that would have been more appropriately accomplished with the original first iteration completion date of December 2003 (U.S. domestic; later for international), and our ABI colleagues still on board. The timeline shift has burned out and driven off good scientists, and damaged our credibility.

11. It's early yet, but I had hoped to do more proactive planning (some of that is happening). Developing research projects/ field studies - not going to happen, I'm told. Lots of "putting out fires," so I have had little orientation - haven't even had a chance to organize my office and unpack books!
12. I am being used as a technician.
13. Appropriate in that science skills are used to evaluate science or find resources - not actually conduct science.
14. My skills are valued, but underutilized because of other time-demanding tasks.
15. In so far as I am capable of doing data summary and analysis, my abilities are used appropriately. But other abilities (such as planning and doing monitoring/research) have not yet been used very much in my current position. We need to complete a programmatic review of our current monitoring/research program before I will have a good idea of how my abilities might be better applied.
16. My knowledge is used more than my scientific ability.
17. I have a split position. My scientific abilities are utilized in research and monitoring, but not as well as I feel they should be in site-conservation planning.
18. My program is not headed by a scientist; therefore, science is always secondary.
19. What does "scientific abilities" mean? The real answer to this question is a 5-page essay . . .
20. More ecological/conceptual than field inventory/research than I thought.
21. I've long since given up the notion that I should "do" science - I am a science broker. On my best days, I hope I am an effective consumer of good science.
22. The role of scientists in conservation-planning project development and conservation strategy is insufficiently valued in TNC and much less valued than that of fundraisers. A position such as Senior Ecologist is nonexistent in the International Program and certainly not highly valued or considered a high-category position. Therefore, there is a lack of highly qualified scientists in most country and divisional programs that can assist directors in developing strategies and planning.
23. Career development has not been as a scientist.
24. Instead of conducting research, I am interpreting to facilitate better stewardship and site design.
25. Ph.D. in ecology, but working primarily as GIS tech.
26. Not my field.
27. Incorporating science into state chapter decision-making process is often difficult, since most decision makers are non-scientists, view scientists as a "support" role.
28. I'm probably a better scientist than administrator.
29. Not appropriate for my job (development and marketing).
30. There is less financial support for science from HO and regional level now than in past. I have been able to pull in funding from several states to continue to utilize my scientific skills. However, this approach does not support regional networking or encourage rigorous application of scientific standards to the extent I see favorable for TNC.
31. I work across organization as consulting scientist.
32. I spend much of my time advising land management and monitoring activities and planning.
33. Science controls the conservation agenda in Indiana-which is perhaps one of the best uses of my time.
34. Would like to see expertise distributed at landscape sites based on primary need and then shared with other programs as support.
35. I am basically a manager of scientists at this point; my team is pushed so hard to meet TNC-mandated deadlines that they don't have time for robust science when they should!

36. Exclusive focus on ecoregional planning, with rush schedules, doesn't allow any real scientific work or contribution, no emphasis on publication.
37. Too many diversions to complete projects in scientific sense (or process Heritage data), but the "diversions" are often essential for conservation.
38. As a land steward in charge of a remote office, there's way too much to do, and science gets put on the back burner. I am not convinced that TNC is "science based," as we claim; most of our work is not monitored well enough to have any scientific validity.
39. I am a water scientist hired to help with aquatic conservation, now working on weeds and grazing.
40. I feel as if it took me two years before I had built the credibility to contribute effectively, and understood the culture of the organization to apply my knowledge appropriately.
41. My opinion is rarely sought for aquatic projects within the state, even when I have much experience to contribute. I mostly serve as a monitoring technician.
42. I think it would be good for me to "do more science" (engage in my own research) after I finish coming up to speed on this project. In order to engage most effectively with scientists (which is necessary if we are to bring needed scientific scrutiny to our project), I feel that our ecologists should continue to be "practicing scientists." That is, they should continue to collect and analyze data and be given time and encouraged to write papers.
43. To a considerable extent, all scientists working in TNC as scientists have to entrepreneurs, not just providing advice and assistance in their specific fields of training, but contributing to all discussions that relate to the use of the scientific method or the use of scientific knowledge and expertise in general, and constantly keeping on the lookout for opportunities to do so.
44. Wow! See what we've done with coarse filter analysis and automated comprehensive ecosystem portfolio design! GIS Con Sci Capacity at 13 western chapters! Thirty-four completed ecoregional portfolios, 680 landscape scale action sites! The Western Conservation Science Center GIS Lab, our scientific abilities are fully engaged.
45. Ecoregional planning products can be better utilized by state chapters (many of them).
46. I guide the freshwater component of ecoregional planning and am well received by conservation planners, but I feel that TNC top management outside our division does not use or respect my opinions.
47. I don't think there is much centralized thought given to training and developing scientists within TNC-we usually look to hire on expertise rather than develop it.
48. Not much time for pure science, but science-based information is constantly utilized.

Question 19:

Comments:

"Influences are negative, because time taken to remain current takes away from TNC initiatives and makes you look unproductive."

Question 21:

Primary factors limiting the extent of interactions with non-TNC scientists-other factors mentioned:
Administrative responsibility and time
Availability of relevant skills
Diminished support of science in justifying TNC projects; projects no longer under regional science (ecology) review, and more leeway for programmatic justification undermines validity and need for science.
I work primarily on joint projects with other staff. It is usually their responsibility to make the contact.
Job responsibilities
Lack of contacts
Lack of resources to go to meetings
Lack of support for contact with scientists
Limited scope of work

My current job responsibilities don't require a high interaction with non-TNC scientists.
My job duties don't require much interaction.
Necessity of our office to fulfill administrative role
Others in my office typically meet with scientists more than I do-
Producing the ecoregional plans is the only job given the timing, and urgency has forced me to minimize/eliminate existing collaborative efforts and not forge new ones.
Their lack of respect for TNC and Heritage scientists
Time limitations
TNC's interests
Travel funding specifically
We frequently need information that is either not interesting to the academic community (to collect, anyway) or needs to be collected over a longer time period than a student has available.

Comments:

"'Time' and 'interest' should NOT be linked here. Much interest, little time. Most of my time is with administration and partner relations-and most of our partners are non-scientists: landowners, managers, etc."

Question 23:

Comments:

"Define "scientific information." What information we have is fine - we just don't have much info/data on species, systems, processes, etc."

"Re questions 23 and 24: There's a huge gap between good and barely adequate - I'd put my "goods" on the low side of good."

Question 26:

Respondents were asked to identify areas of scientific expertise A) that their program, at a level that will be available to them, plans to add within the next year or two, and B) that they think TNC should add at a central level. The following lists are comprehensive, numbers in parentheses indicate multiple mentions.

Areas of scientific expertise that programs plan to add:

aquatic biologist (2)
aquatic community ecology
aquatic ecologist/hydrologist
aquatic ecology (8)
aquatic invasives specialist
aquatic/fish biologist
aquatics
biodiversity information management specialist
biohydrology (6)
carbon monitoring
coastal-marine
conservation planner (3)
contract management and administration
dedicated, full-time Program Manager
Director of Forest Programs
Director of Stewardship Science
ecological monitoring
ecologist
ecology management, monitoring, and restoration
ecoregional and site conservation planning
ecoregional planning support
estuarine ecology
experts on invasive species other than plants

field technician to collect/maintain data
fire ecology
fire management (3)
fire manager for Oregon
forest ecologist (2)
forest science
forestry
freshwater biologist
freshwater conservation
freshwater ecologist (2)
freshwater zoologist
GIS (7)
GIS analyst
GIS expert
GIS manager/practitioner
GIS technician/ecologist
GIS/remote sensing study of the Great Plains bioregion
GIS/remote sensor
GIS/spatial analyst
hydrolic modeling
hydrology (2)
invasive species
Karst ecologist (2)
landscape ecologist (3)
landscape scale site planning
mapping
marine ecologist (3)
modeling
monitoring
monitoring ecologist
monitoring/biostatistics
more stewards out in the field
ornithologist
prairie ecologist
predictive community modeling
regional ecologist
remote sensing
remote sensing (aerial videography)
restoration ecologist (3)
riparian systems
science policy-government relations
site conservation planning (2)
site planning support
social science
socioeconomic scientist
state zoologist
stewardship (2)
terrestrial
terrestrial restoration specialist
watershed ecology
We had planned an additional GIS analyst/tech, but leadership team rejected proposal.
We're in limbo in regional science centers. It's rush through ecological plans, and we'll tell you next year if you still have a job. After 10 years with TNC, it feels like working in the 'for.
Boston office is fully staffed at this point. No immediate plans (as far as I know) to add to CTFO staff.
Don't know-feel that all community-based projects need more and better access to scientific expertise.
none
none - my program (ecoregional planning support) will likely not exist in 2 years, although I think it should exist.

none at state level due to funding; divisional and country I don't know.
none in state; perhaps a regional aquatics person.
None that I know of. Well, perhaps a freshwater conservation person in the NE.
none - more likely that will be losing one position.
none - expertise is likely to be eliminated, not added.
none - hiring a government relations person, planned giving/major donor person. We can only add about one person per year.
none - we are being reorganized with no current clear picture beyond ecoregional planning ending 2002.
I'm actually pretty happy with our program structure/staff at the current time. As to adding expertise, it's much more cost effective for me to contract for services than to hire narrow, specialized skill sets.

Areas of scientific expertise respondents think TNC should add:

academic collaboration-outreach
adaptive management (2)
adaptive management (the disciplined process,
not monitoring and tinkering)
adaptive management expertise that reaches out to other
areas of our practice (beyond natural sciences)
administrative help
ag scientist
animal and plant community ecology (aquatic, terrestrial,
marine)
applied forestry and forest management in the West
aquatic biologists
aquatic ecology (2)
area-dependent ecological processes
assistant conservation planner
botanical
climate change
climate change/biodiversity landscape changes
community ecologist (3)
conservation biology (2)
conservation plan implementation assessment
data management (2)
director of stewardship
ecological modeling (2)
ecological modeling, multivariate analysis
(especially for monitoring)
ecological monitoring (2)
ecological restoration (2)
ecologist to assist with viability assessment
economic valuation of natural resources and
ecological services
economist - ecologist
ecoregional planning data management/archiving/roll-up
ecosystem ecologists
exotic species biology and control
experimental design-biostatistics
experts on invasive species, particularly taxa
other than plants
field office liaison-support for site planning/conservation
field research scientists for each ecoregion in the
areas of herpetology, ornithology, entomology,
freshwater ecology, to provide assistance on field inventory methods, species distributions, and to assist with field inventory (not database managers!).
fire ecologists

fire management (4)
forest dynamics
forest ecologist
forest ecology (2)
forest ecology and management
forestry
freshwater conservation (to assist regional program staff with target viability assessments, management practices (conservation, restoration, etc.)). This expertise doesn't necessarily have to be centrally based, but since
not all regions in the International Program can afford their own freshwater staff, this might be a way to build capacity and exchange learning.
GIS (5)
global change
grassland/range ecology (3)
grazing expert (3)
Highly qualified senior scientists at all levels, including a centralized marine program at the Latin America and Caribbean Region, or at the corporate level (currently nonexistent).
hydrology (5)
information management
invasive species research and control
invasives (more FTEs)
invertebrate zoologist (2)
island biogeographers (for viability rankings)
liaison or better connection to ABI and Heritage CDCs
marine conservation planning
marine ecology (2)
marine science (3)
modelers
monitoring (3)
more terrestrial, freshwater, marine ecologists.
Wide-ranging mammal expert - modeler. Habitat modeling for species at multiple scales. Image-processing capacity for high-resolution satellite imagery. International: Partner with ABI - CDCs on new structures for inventory.
natural community/Heritage
nonchemical weed control
none (2)
none, reduce existing
nonvascular
NY State Fire Manager
population and species viability
population ecologists
prescribed burning (2)
program evaluation
rangeland ecology
rangelands scientist
regional biostatistician
regional botanist/ecologist
remote sensing (2)
remote sensing/change detection
research
restoration ecologist or specialist (14)
saline aquatics
science fundraising
social science
social science; human dimension of conservation
sociologist
soil science
species population ecology
statistical assistance

stream ecologists
taxonomists
terrestrial invertebrate biologists
theoretical-emerging issues
tropical biologist/ecologist
weed management (3)
wetlands ecologist (2)
wildlife biologists/ecologists (2)
wildlife management-especially rare species of mammals
zoology
Areas are good, just need more and more communication tools.
CA could use a coordinator of research and monitoring, like Dan Salzer of Oregon.
Central is not the area where expansion is needed. Chapter and divisional are.
Don't know enough about central level to respond accurately.
Given that I almost never see or hear from many of our central office staff, this is mostly irrelevant to me.
I don't think we need more central level, since the country is so diverse. Need more support from TNC to cultivate outside experts, more support from within TNC to get scientists to participate. E.g., for the 2001 group for ecoregional planning - I can't get any other TNC scientists to participate on the group!
I don't think we need more central services - we need assistance with developing local capacity.
I think most science staff and most staff should be decentralized and not be added at a central level. Put people on the ground. That said, central-level expertise needed related to GIS data management.
Keep folks like Mark Anderson, Bob Zarember-need assistance on site conservation planning too.
Need capacity at state/division level in US; need serious capacity-building for science internationally, for all scientific fields. This should happen at both central and country levels.
Need more of everything to provide more field support, especially landscape ecology and modeling.
Should focus on adding at state level, not central.
stronger scientific support for landscape sites-interdisciplinary and multi-state levels very important!
support for ERP process; many positions

stronger scientific support for landscape sites-interdisciplinary and multi-state levels very important!

support for ERP process; many positions to improve process; social science knowledge; how to evaluate CBC strategies

There needs to be a grassroots review of science needs in field offices, and funding sources need to be explored for those needs-driven largely from the field and regional consensus.

Question 27:

Other obstacles to getting science knowledge and expertise:

Experts busy working on other projects, not enough experts.
Finding the right person/document takes longer than necessary, because of poor internal organization (TNC-wide) for sharing experiences and contacts about specific themes.
Greater emphasis on buying land, raising money within chapter.
Interests
Lack of coordination, preparation, vision, and assistance from regional/division, etc.
Lack of strategy to acquire the needed NEW information.
Lack of support for reading literature/attending meetings
Lack of understanding by program managers for what it takes (time, money, vision, focus) to integrate science into solutions to program problems.
Lack of understanding of supervisors higher than the division of the importance of science in doing good conservation.
Leadership not devoted to/interested in science (but situation is improving).
More support for analyses to inform state work.
Need science support staff-MS and Ph.D. scientists, not just stewards.
Need ways to make or present our data gaps in a manner that is appealing to appropriate researchers.
No commitment from organization for ecoregional planning.
Not enough science capacity within program staff; thus science staff gets pulled into other matters rather than assessing threats and measuring success.
Our science staff is not growing at the rate we are starting new projects.
Personal priorities
Priorities for ecoregional planning above everything else.
Science is not understood or supported by senior managers and state directors - entire focus is on land deals.
Self-imposed isolation

Comments:

"To answer the scientific questions we need to, there is a need to simultaneously partner with research organizations that have the expertise to tackle tough issues (e.g., viability, connectivity, social and economic evaluations, monitoring of indicator species, etc.) as well as increase the in-house capacity to develop, foster, and direct these partnerships with trained, technical capacity (e.g., aquatic ecologists, hydrologists, landscape ecologists, etc.). To carry this out, there is a need for more money to fund the research and more money to fund the internal positions (capacity), which is the only way to actually "get" more time that we need."

Question 28:

Comments:

"Should all be very significant - but it's not available or not familiar to staff doing these activities."

Question 32:

Comments:

"We are fortunate to have one GIS person in [our] office. It could be better, but it could be a lot worse, as I suspect that many programs do not have a person who is even qualified to define 'information management.'"

Question 33:

Comments:

"We have a GIS person who runs the BCD and makes GIS maps, several people with cursory training in the use of our sophisticated GPS unit with submeter accuracy, and everybody has a computer."

Question 38:

Examples:

Given a list of five approaches, respondents were asked to determine how many of their projects using adaptive management rely on each approach, and to give examples. The examples cited for each approach follow:

a. Trial and Error: initial actions are based on past experience and general information, and subsequent choices are based on those actions that "worked."

1. Effect of herbicide application on two exotic plant species in grassland.
2. Our China/Yunnan strategy was developed from lessons learned from Indonesia and Micronesia.
3. Developed classification of aquatic communities in Great Lakes, found it to be very data intensive, scaled back effort subsequently.
4. I am answering these questions considering only our direct TNC actions, not our partners' actions, which are site based.
5. Management of a few for prairie fringed orchid.
6. Prescribed burning to control reed canary grass on a wetland restoration site is performed with greater frequency if it "looks" like the grass is "losing."
7. Ecoregional plans.
8. Evaluation of the U.S. Alkali Lakes Plover Project.
9. Grazing management is trial and error, with no specific goals other than status quo.
10. Removing cattail at a Fen (every few years) that threatens globally rare dragonfly breeding habitat.
11. Serpentine barrens restoration using prescribed burning.
12. The choice of herbicide for controlling leafy spurge.
13. Fire management at Kennebunk Plains, Killich Pond. Salt-marsh restoration at Sprague Marsh.
14. Woody vegetation removal with varying herbicides or fire regimes.
15. Non-native species control.
16. Response of woody species to prescribed burn.
17. If this is AM (very passive), then I'd say all our monitoring is tracking AM efforts-season of fire influences on vegetation structure and rare species' reproduction.
18. Understanding the effect of [illegible] riparian habitats in [illegible] and riparian systems.
19. Techniques for prairie restoration.
20. We have a long history of trial-and-error riparian restoration experiments.
21. Restoring past degradation of savanna communities due to fire suppression involves a non-experimental evaluation of management options over large tracts to determine which are cost-effective approaches netting the desired initial ecological response.
22. Riparian restoration work

b. Passive Adaptive Management: existing data are thoroughly reviewed and used to inform decisions.

1 [illegible] and critical new data are gathered via rapid appraisals. This has been the standard approach for launching new projects.

6. Black Hills Community Inventory.
7. Evaluation of the U.S. Alkali Lakes Plover Project.
8. Long Pond Barrens - Used historical fire record to inform fire frequency applied.
9. Weed-control efforts are based on literature and Web sites.
10. a) Field data using National Heritage methods informs protection staff.
    b) Invasive plants' presence/absence informs restoration planning.
11. All of our projects involve baseline monitoring, implementation of management experiments, documenting response. Replication or multiple experiments are simply not feasible on any of our projects due to financial constraints and lack of support from senior managers (including state directors).

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12. Weed control with herbicides.
13. One site uses this approach to evaluate prairie reconstruction methods and the use of bio-control for purple loosestrife.
14. Community frequency data is collected on management units; trends/changes in frequency are noted and adjustments made accordingly, depending on whether management objectives are being met.
15. Parque Nacional del Este, Dominican Republic. Data collected over the last year is used.
16. Control of an exotic species with a well-researched treatment approach.
17. Exotic plant control.
18. We have long-term range data from grazed preserves which inform stocking decisions.
19. Long-term monitoring (usually species specific) used to assess general management of critically imperiled species. Essentially trend analysis.
20. Evaluating causes for declines in aquatic fauna in certain reaches of river.
21. There are some research projects designed to inform our work, but have not had the time to reach that status of evaluation yet, as this is a new concept I have been trying to initiate at new sites; e.g., butterfly distribution in response to burning. If negatively affected, then burn units might be changed.
22. Graduate research on restoration techniques.
23. Rare plant monitoring data and fire.
24. Significant steps are now being taken to collect the needed data. Data are of the system's response, but the experimental design is lacking, at least in our restoration program. We should be able to improve this situation.
25. Distribution of a rare butterfly noted in areas managed to enhance its habitat. Photos (time series) track response of invasive shrubs to fire management.
26. Prescribed fire.
27. Systematic survey of invasive species a few years ago. No time to completely revise and update, so we use the original data to guide our activities.

c. Active Adaptive Management: different approaches are tested in similar circumstances and results evaluated and used to guide future decisions.

1. Very difficult to identify "similar circumstances."
2. Current method of executing ecoregional plan creation, strategy, and implementation (in process).
3. Evaluation of the U.S. Alkali Lakes Plover Project; experimenting with various predator exclosures to determine which one best at boosting fledging rate for lowest cost.
4. Simulated 8 potential management treatments in two randomized block design experiments and demonstrated which ones met our goals for plant community restoration in the State Line Serpentine Barrens.
5. Testing 3 different methods of phragmites control for 2 years before implementing wide-scale application at the preserve.
6. Weed control with multiple methods.

7. We are starting this for the use of biocontrol in controlling leafy spurge.
8. St. John Forest management.
9. Blackland restoration test plots.
10. Research conducted over the last 10 years at our Cascade Head Preserve to compare different management strategies designed to maintain a coastal grassland ecosystem and rare butterfly population.
11. Response of given species to prescribed fire season or exotic response to different control techniques.
12. Eglin restoration research, sandhill understory sowing research.
13. Fire management program.
14. Bullfrogs are being controlled in two stretches of a creek and native frogs are being introduced to one of them.
15. Side-by-side analysis of agricultural production models used to assess impact to target systems and to inform local agricultural community about ecologically compatible options.
16. But this appears to be starting.
17. I know of one research grant from RJKOSE I got which is looking at several ways to monitor plant communities, and then will choose a best method. We also have a project to use genetic algorithms to find optimal solutions to dam operations-which is a different kind of active adaptive management per se, in that multiple options are evaluated and an optimal solution chosen. I know of other proposals to RJKOSE that I submitted that also proposed to do this active adaptive-management-type approach, but were not funded (i.e., evaluating herpetofaunal responses to multiple ways of managing wetlands to try to find an optimal solution to maximize biodiversity), and now I am faced with the problem of not being able to find other grant opportunities to carry these ideas out (i.e., sour grapes).
18. Nursery propagation of native plant seeds.
19. SITES model us. Other methods for portfolio assembly.
20. Many projects are set up as field-research experiments with spatially replicated treatment units and control units. Typically randomized block designs.
21. Compared effectiveness of cutting roots, applying herbicide, and spot-burning in killing baby's breath.
22. Wet prairie restoration.
23. Photo-monitoring of edges of invasive-species patches.

d. Monitoring and Change: a scientifically designed monitoring strategy is used to develop effectiveness information and make incremental changes in actions.

1. Effect of fire management on species abundance in grassland; effect of planned herbicide application on phragmites stem density and cover of native [illegible] herbaceous species beneath phrag.; endangered plant species recovery.
2. Komada National Park has an excellent monitoring program.
3. We are finalizing our 5-year strategy for the Mexico Program, which will include benchmarks and indicators for program objectives for adaptive management.
4. Will allow for such in ecoregional plan.
5. Monitor numbers of Glad Spurge plants at Mt. Holly preserve and implement deshading and deer-browse protection treatment (uncontrolled, unreplicated) and observed very positive effect on plant size and flowering.
6. Survival and reproductive success of an aquatic/wetland federally listed endangered species is being monitored to gauge the impact of possible water-quality effects from a massive land-leveling construction project upstream.
7. Effect of canopy removal on herbacious plant growth/abundance.
8. As a result of site conservation planning, I hope that more effort will be put into this in the near future, but to date, not much is.
9. Kennebunk Plains (blazing star inventory, grassland bird census, restoration plots from pipeline work).
10. Study where the effects of fire on forest communities are being evaluated. Another to study effects of restoration on

activities on grassland/wetland community.

11. Plant community composition changes over time in response to management - 20 sites.

12. Monitoring is set up to inform our management at all of the preserves I manage.

13. Use this approach for evaluating livestock grazing on native plant communities on all properties where grazing occurs.

14. I can't differentiate between these. If this is AM (very passive), then I'd say all our monitoring is tracking AM efforts- season of fire influences on vegetation structure and rare species' reproduction.

15. Fire management program.

16. This is being established at one site, but lack of funding is stalling the implementation.

17. Assess non-manipulated components of ecological restorations to assess ecosystem recovery - for example, at Kankakee Sands (Prairie) Restoration, invertebrate and vertebrate response to new habitats used to assess key aspects of ecological recovery. In aquatic systems, long-term monitoring programs designed to establish baseline conditions and tools for long-term trend analysis are used as our ultimate measure of success.

18. Assess the value of muskrat eradication strategies by sampling mussel shells left by muskrats.

19. But this will, no doubt, change soon.

20. In all the programs that I have been involved with since starting with TNC, this is what I have considered to be the role of the Director of Conservation Science; i.e., to make sure that we are evaluating our progress/effectiveness. This is why I dislike the terminology "Measures of Success," because it infers that the opposite is failure. I prefer "measures of progress," because we are entrusted with evaluating our progress towards achieving our mission, which is not a success-or-failure-type thing (at least for the near future).

21. Photo monitoring of erosion control sites

22. Installed a series of wells to monitor groundwater levels and their response to removing invasive shrubs and (eventually) restoring hydrology (filling ditch and removing drain tiles) from wetland.

23. Upland prairie restoration.

24. Mackinaw River Project in IL is a great example, ditto Green River in KY, but it will be years before the data are good enough to support incremental decision making about strategies. The reality of monitoring is that it takes time to get statistically sound data, particularly in highly naturally variable systems such as freshwater systems.

25. Comparison of two different management regimens for reforestation (controlled field study we hope to conduct this season-if funding comes through).

26. Currently testing effectiveness of invasive species removal techniques in selected plots, lower CT River area.

e. Spatially explicit models of changes in ecological conditions under different management scenarios.

1. GIS critical.

2. However, they all use spatially explicit models of hydrologic conditions.

3. St. John Forest management.

4. Landscape elements and avian diversity at the VCR.

5. Fire effects model.

6. Modeling alternative vegetation types for a restoration project to determine stream flow. Using MODFLOW model of preserve.

7. Roanoke River.

8. Many traditional preserves are managed to fall within a dynamic range of habitat structures. Remote sensing used to assess structural status and to inform management needs (e.g., shrub carr fens is monitored. Based on the site, a burn regimen may be intended to maintain carr at 20-35% of fen extent-prescribed fire program uses spatial extent to inform management cycles.)

9. These are very crude models - and probably not what the committee is thinking - but maps with conditions of plant communities recorded by transect, and then these are evaluated over time. The information is recorded in conjunction

with known locales on a management map with corresponding management units. It is not a fancy GIS-produced modeling exercise that can predict change.

10. We are initiating collaborative research projects to examine landscape effects on ecosystem response, although many of the initial "treatments" varied.
11. Fender's blue butterfly meta-population recovery (in progress, with Cheryl Schultz).
12. Currently looking at impact of deer browse at site through monitoring (and deer removal, enclosure of plots).

Question 39:

Comments:

"Depends on the nature of the project which course of action I would take first."

Question 41:

Does TNC encourage and fund an adaptive management approach?

1. Encourage, yes. At least cons-sci division talks the talk. But TNC has not committed resources needed to incorporate/ design appropriate monitoring programs. Also, we're not good at stating explicit hypotheses.
2. Yes so far, but as need for rigorous monitoring increases in future we will have to seek outside funding for necessary monitoring and research.
3. Not actively. Or if it does, it certainly is not getting to the project level in the international program.
4. I believe TNC encourages intuitive adaptive management, but does not invest deep in scientifically rigorous adaptive management.
5. Contracts for research with academia.
6. Generally no - TNC doesn't like to fail or admit failing, although this is beginning to change for the better.
7. In a sense yes; in my opinion the freedom (funding and organizational support) to "experiment" in the Conservancy has enabled us to achieve results in very different conditions, making the best use of available opportunities. However, as an organization we have probably reached a maturity level (and size) that requires more organization and better coordination to advance at a faster pace. While measures of success can help us move in that direction, so far I have not witnessed a change in funding/organizational support for more "scientifically rigorous" adaptive management, as you define it.
8. Encourage yes; can be difficult to find funding.
9. Barely have the resources to do the job in the first place; folks are strapped for time and cash, as a rule.
10. Encourage yes, fund no.
11. Adaptive management is a way of thinking independent of encouragement and funding.
12. Our state has never had the funding or science-staff time available to conduct rigorous adaptive management on any of our preserves.
13. Evaluation is always pushed to the back burner in favor of new projects or new tasks that require attention (time).
14. To a limited extent.
15. We should be doing this more than we do.
16. Beginning to be based on SCP, which is new in application for most sites.
17. Encourage yes, fund no.
18. Always encouraged - Funding available only on case-by-case basis - but exception, not the rule.
19. Seat-of-pants stewardship currently, but adequate at many (not most) sites.
20. TNC definitely does not do enough to encourage and fund adaptive management. Although we teach a workshop on it,

and I have participated in developing adaptive management and monitoring programs for other agencies, I have only rarely been satisfied with the results. I think there are two main problems: 1) Not enough people/time/energy (money) spent on developing a good model for our own sites, in part due to worries about money, but also in part due to a lack of realization of how much time and energy a good adaptive management program takes to develop. 2) Emphasis tends to be placed on "putting out fires" (figuratively speaking) and personnel management issues, rather than on effort required to maintain programs that don't yield immediate (or exciting) results. The latter is another way of saying that "bucks and acres" takes precedence over pretty much everything else. There are very few technicians in TNC who consistently have time to either develop an ecological model or maintain an AM program. My impression is that most states have nothing close to the funding needed for anything but seasonal personnel to collect data, let alone for the process of deciding where AM is needed and implementing and maintaining it.

21. It's highly variable within the organization, and even within this state.
22. Encourage yes, fund no. Our chapter's work reflects MY decisions and evaluations, with input from other chapter staff, but NO input from TNC staff outside this chapter.
23. I think that TNC encourages, in the broad sense, adaptive management; however, it has been difficult to get those on the ground to identify the objectives of different efforts clearly and quantitatively so that adaptive management can be used. Once we get through this step, then somehow we manage to get funding for the monitoring that is needed, but I do think that this is a shortfall of TNC - it's hard to get government money for monitoring and it takes a different approach than usual (e.g., for land acquisition) to get donors interested in funding. I think [my state's] staff are becoming more aware of this and I hope this will be less of an obstacle in the future.
24. To the best of my knowledge - not generally my department.
25. Not sure funding is adequate.
26. Encourage yes, but no future funding commitment to second interactions.
27. Encourage yes, fund no.
28. My boss would be enraged by this answer. The chapter says it is doing this, talks the good talk. But the fact is, I don't have adequate time by a long shot to apply the scientific rigor needed to do this - we'd need 2 to 3 more staff chapter-wide, and there's no way it will happen. When staff is added, the mission has already expanded way beyond the capacity provided by a single added staff.
29. Sometimes, when time and money allow.
30. To varying degrees through Rodney Johnson/KOSE grant, David Smith Fellowships, etc.
31. There is wonderful support and commitment for adaptive management from managers in the Oregon program.
32. Generally few resources available (staff and funds) to adequately carry out this work, except for the most critical questions.
33. SCP
34. Especially given your broad definition. Formal AM efforts have mainly been funded by partners in Florida.
35. In our chapter, conservation science is under-funded and understaffed.
36. We encourage but rarely fund the monitoring and assessment necessary for an adaptive management approach. Decision makers with the power of the purse often have unrealistic expectations about how much can be done for tiny sums of money on the ground, and are impatient with monitoring programs.
37. Certainly TNC has supported the AM work on [certain projects], but in general, adaptive management is poorly under-stood, under-funded, and rarely practiced. Again, I emphasize that I am talking about AM as a disciplined process involving explicitly stated models, hypotheses, and responses and monitoring processes that track both dependent and independent variables.
38. Resources required for this approach are lacking. Staff currently is required to identify, design, execute, monitor, evaluate possible approaches in addition to concurrent job duties. This is not feasible at our site levels.
39. We do very little monitoring.
40. Only to the extent that we are able to fund monitoring.

41. TNC often funds compilation of some baseline scientific data, but does not allow time to follow up on data gaps, solicit outside expertise, or revise/improve strategies based on specific goals.
42. The new emphasis on Measures of Success will encourage and give staff the authority to push for more quantitative monitoring. The shift is too new to see results yet.
43. I'm curious about what role you guys think monitoring and program management plays in field offices - monitoring for the sake of monitoring, or monitoring as a tool to refine conservation action?
44. More capacity for monitoring would help our program.
45. Not really explicit in [my state].
46. Sometimes.
47. Apparently so, and probably will more in the future.
48. We have embraced this concept fully at our newest and most challenging preserve . This is our "big talk" that we will do it, and have the commitment of staff to try it out - but recognize it is a new and big challenge that we have not tackled before, and so are uncertain of what success actually will look like. Columbus had confidence as he sailed of to the New World . . . so do we, on good days.
49. TNC definitely seems to encourage adaptive management and to some extent funds efforts in this direction, but there is not enough capacity to gather ecological data (much of which has already been gathered by agencies and universities) into a usable form to measure success and thus evaluate strategies.
50. There is barely enough stewardship capacity for necessary basics and not enough to fully implement adaptive management as you define it.
51. We are in the process of building this capacity. In part, I was hired to do this. I will work with a dedicated riparian/restoration ecologist to bring this about.
52. In general, state programs under-fund and under-appreciate the value of ecological monitoring and research.
53. In [my state] we certainly do, although I'd call it a mix of haphazard and planned.
54. True in [my] program, although more funding is needed to raise the effectiveness of our adaptive management approach to minimal acceptable level. Not so true in some other state programs.
55. There is plenty of support (mostly technical training) for such an approach at the HO-CSD level. Very little support at the state field-office level. Science staff must seek funding independently and make time for adaptive management in a schedule that is already full.
56. SCP is a key component of that approach.
57. Encourage yes, fund no.
58. We believe in it, so we do it as best we can with available resources.
59. In principle, but we have not put this into play in a rigorous manner.
60. But more encouragement than funding.
61. Hopefully soon, though; it's on the agenda at least.
62. Our funding comes through the Army National Guard fund and is just administered by TNC.
63. Yes it encourages; however, I worry that we will be pressured to make decisions not based on data because of urgency.
64. Don't know. My 2002 RJ KOSE proposal was for adaptive management - we'll see if it gets funded!
65. I participated in AM at a TNC preserve protecting tropical dryland forest remnants. We used state-of-the-art field-survey techniques to build baseline data for vegetation restoration. Latest restoration and monitoring methodologies employed including the creation of a CD-ROM with GIS resources (base layers, detailed veg. survey, GPSed monitoring plots, Heritage records for RTEs, and georeferenced aerial photos).
66. Increasingly - I see just heading in this direction.
67. My opinion is that we're reluctant to invest in 1) establishing baseline monitoring and 2) developing models to understand ecology of our systems.

68. We are beginning to talk about it as an organization and fully understanding the Conservation Process model will help some understand it better. But TNC is very action oriented, and the vast majority of the leadership at a national, international, state, and country program level is not comprised of scientists. Delaying decisions for better scientific information seems frivolous to some, even when those decisions are not urgent or time-dependent; others simply do not prioritize adding scientists to their staff highly enough. This is particularly a problem in the international program.
69. To some degree.

Comments:

"Twenty-five to 50 percent of the ecoregional plans that are more or less complete at this time require significant work to bring them up to current standards. Other plans would have benefited greatly from a modest investment in additional information prior to plan creation, such as the rapid ecological assessment that was done for the Northern Great Plains Steppe. Given the unreasonably rapid timeline that ecoregional planning (ERP) has been pushed to and the lack of normalizing ERP into the work plans of state scientists, even those programs or scientists who would prefer to invest in a stronger scientific foundation of their work have not been able to."

Question 43:

Primary factors accounting for the implementation of action before the questions are answered:

1. Action is often a means of answering a question.
2. Action is required and can be monitored and adapted if needed; never enough information; reasonable belief that experience is adequate to justify action; opportunity to take action is limited so must take advantage of it; difficulty in getting scientific community to study issue in timely fashion.
3. Asked to make a management decision.
4. Critical nature of some management activities in sustaining rare-species population or presenting more serious expenses (?) if actions are delayed.
5. Data gap, time/management deficiency.
6. Data gaps; pressure to meet deadlines, which means we move ahead regardless of scientific uncertainties; burn-out of overtapped experts we consult frequently.
7. Decision makers weren't aware of the questions.
8. Funding, decision roles.
9. Good guesswork and intuition are often okay; not enough information, time, money, people, etc.
10. Have to seize opportunities for action when they are present, whether or not we have the resources to do the job.
11. I have to say that one of the big issues is that we are tackling bigger and bigger problems for which there just isn't the information available. And the information isn't available for good reason - usually because it is hard to get. For example, what are the life-history needs of our target species, the pallid sturgeon and paddlefish, and how best to manage a water-control structure to improve their access to newly constructed backwater lakes?
12. Impending threat to integrity of site that necessitates immediate action. Need to develop programmatic capacity as an initial step to further action (capacity building at a site of known ecoregional priority).
13. Imperfect knowledge of the ecological system; applying knowledge of similar but different ecological systems.
14. Implementation driven by non-science staff; lack of understanding of total ecological processes.
15. In establishing native cover on crop land, sometimes not enough information, so we make a short-term fix, or with building removal, we don't have a good picture of what the long-term plans are for all the buildings we own.
16. In Mexico, as in most Latin American countries, scientific biodiversity information is very limited (often there's not even baseline data), and investing the necessary time to gather information is often not an option. We try to use available information/expertise to answer critical questions, and/or identify those questions that deserve investment to guide our actions.

17. In the 5 projects that are truly practicing adaptive management in the Freshwater Initiative, each has the support and general understanding of their state directors and/or Director of Conservation Programs. This support has translated into the commitment of adequate funding for research and monitoring of these sites. The other 36 projects either completely lack the support of their state directors or other senior staff, or rely upon many other agencies and state/federal funding to implement adaptive management (which never happens!). In my opinion, the single greatest problem in our organization is that very few staff (and NO senior staff) have any sort of notion about the ecological conditions/health/integrity we should be managing for at our sites. Therefore, TNC does not: 1) know how much threat reduction is needed at a site; 2) invest in any threat reduction other than land protection (they "know" this works!); 3) understand the need to monitor threat abatement or biodiversity health; 4) understand that adaptive management is the most efficient route to attaining ecological integrity.
17. Inadequate funding, insufficient time.
18. Insufficient expertise and time and staffing; not enough patience/respect for science.
19. Insufficient money and time.
20. Insufficient scientific support (to date) in designing the monitoring; insufficient resources (staff and funding) to implement any adaptive management. (We now have a staff scientist, but her attention has been focused more on site and ecoregional planning than adaptive management and other stewardship needs.)
21. Insufficient time (5 verbatim mentions).
22. Insufficient time (and funding constraints and availability of staff); lack of interest and ability to undergo actions without answering the questions; lack of qualified scientists available to contract on short notice and for short-term projects.
23. Insufficient time (or this mode of behavior). Without good, well-documented models and a formal procedure for implementing AM, it's easy to feel there is never enough information.
24. Insufficient time and money; scientific uncertainty.
25. Insufficient time and personnel to ask and answer scientific questions; never enough information, of course, but we could use a whole lot more!
26. Insufficient time and resources (staff and money); need to take some action before more damage occurs to the resource being protected.
27. Insufficient time to get scientific answers.
28. Insufficient time to really test/research because of political pressures within TNC to move quickly and to take action.
29. Insufficient time, due to a CENTRAL lack of understanding of scientific uncertainty and the high workload. For ecoregional planning to be rigorous, it must not be as rushed as it is currently.
30. Insufficient time, information, ALWAYS.
31. Insufficient time, never enough information.
32. Insufficient time, programmatic concerns (deadlines, funding, leverage).
33. Insufficient time/staff to monitor or set up studies; evidence that management is working, but not sure if it is most efficient/effective method.
34. Insufficient time; however, we do things for years without spending the time to figure out if it's working (i.e., we may not have time the first year but we would for the second and subsequent years). Then the issue is inadequate capacity to get answers (i.e., it is no one's sole job or even primary task to synthesize existing information or develop methods to get new information) - this is done on a catch-as-catch-can basis.
35. Insufficient time; science may not be able to answer many of our questions without years and years of work, and researchers often do not truly understand our information needs, or if they do, they are driven by other incentives to carry out studies and produce papers that may be of limited practical use.
36. Insufficient time - this would typically not be a problem if steps were taken at that time to evaluate the action for future adaptation.
37. Insufficient time and staff.
38. Insufficient time, scope of questions too big, not enough long-term background data exists.

39. Lack of information.
40. Lack of knowledge of biology of rare species, their habitat requirements, and their response to management and other disturbances.
41. Lack of money and time.
42. Lack of stewardship capacity.
43. Lack of time.
44. Lack of time and personnel.
45. Lack of time, appropriate information.
46. Lack of time, immediacy of a deal, "higher-ups" want the deal regardless if science supports it.
47. Legal, political, and/or social pressures beyond just science.
48. Long-term (decades) research would be needed to answer the questions.
49. Lose natural community with either no management or little management, so initiate restoration to attempt to save; never enough information.
50. Managers want quick answers and have little patience or tolerance for using our existing work as an experiment; unwilling to provide the time or money for a more rigorous, adaptive-management approach.
51. Many questions cannot be answered due to extremely high unpredictability of the situation.
52. Necessity (the biota would be gone before we are done "studying" the situation enough to be certain about anything). We know enough to get started, and hopefully get enough resources together to keep tabs on how well we are doing to learn from our actions and their effects.
53. Need for immediate action.
54. Need to act.
55. Need to continue to demonstrate progress, lack of resources.
56. Need to respond to opportunity. Programmatic benefits to others.
57. Need to take action rather than waiting. Perception that all scientists do is "collect data." Not enough time/money to answer the questions.
58. Never complete picture; urgency of taking action.
59. Never enough data, we are often doing a project for the first time it has ever been tried.
60. Never enough information.
61. Never enough information and threats do not allow postponement of action.
62. Never enough information, insufficient time (3 verbatim mentions).
63. Never enough information; impatient staff; lack of funding to do project "right."
64. No people, no research money, no time, not enough "roving scientific expertise" within TNC as a whole to help people like me who are not "academics."
65. No time to wait for answers.
66. Not enough information or time.
67. Not enough information, not enough time; inadequate understanding of the value of adaptive management to conservation success.
68. Not enough time
69. Not the right information for TNC use - need biological inventories, ecological models, quantitative threat assessment and thresholds, applicable research for answering conservation questions.
70. Perceived or real need to take action.

71. Personal commitment, character, integrity, love.
72. Pressure to take some sort of management action; never enough time to find out everything; crisis nature of some of our species/natural communities; not enough money to fund needed experiments over time.
73. Previously it was: not enough time, not enough expertise, but now it instead should be limited to: not enough time, although I don't feel we have the luxury to wait for all the information to come in, even if we have all the resources available to answer the important questions.
74. Reasonableness - we feel we learn most by humbly and conservatively ACTING.
75. Scientific "knowledge" isn't available yet.
76. Scientific information directly applicable to our circumstance doesn't exist.
77. Sense of urgency; insufficient time.
78. Some of our actions are new or effects previously unquantified. Actions pursued typically involve restoration of a natural process or removal/reduction of a known threat.
79. Specific information is not available about rare species' life cycles, needs, and tolerances. General lack of time and money for basic research to answer those types of questions. Higher conservation priorities elsewhere dictate that we use adaptive management to deal with these issues, which means moving ahead without all the information you would like.
80. Sufficient information to act; urgent need to act.
81. The need to act.
82. The window of opportunity will close and natural resources to be affected by action will be lost forever. Better to take a chance than lose opportunity.
83. This is life. In an ideal situation, there would be no pressing threats, much less, time to establish our knowledge of portfolio sites and targets. In reality, we have to articulate the scientific knowledge that we have with the pressure of economics, government, politics, and society. This is the working environment. While it is crucially important to strive for the most [illegible] information about natural systems we can get, it is unrealistic to expect the world to stop 'til we have all the info we need.
84. Threats too urgent; inaction equals failure. Better to take best available information and choose best course of action. We have discussed never regretting moving forward with buying land or doing a deal. We often regret not doing the deal.
85. Time.
86. Time is running out to conserve land - if we don't act now, there will be houses on the landscapes we are attempting to protect.
87. Time, impatience with science, drive for project completion.
88. Time, lack of knowledge about where to go for answers, most often there are no answers and research would take a very long time.
89. Time, threat of loss (act or lose), inadequate Heritage input.
90. Time, time, time.
91. TNC's reactive, rather than proactive, tendencies; insufficient time to address questions.
92. Urgency of action, insufficient time to fully research.
93. Urgency of threat (3 verbatim mentions).
94. Urgency of working with endangered species - no time to "figure it out." Never going to account for all variables and be able to tease out which one most important.
95. We need to make decision before the results are available.
96. We simply can't wait for the ice caps to melt before we do something. Usually, we try to stay out in front of the curve - initiating long-term studies and getting all the answers to all the questions usually takes years. So while we may indeed end up hiring someone to look at a problem, we will often start adjusting our conservation strategies immediately.

Question 44:

Conservation Threats

Types of habitat fragmentation other than conversion to human habitation mentioned:
any/all land conversion
development and all classes of fragmentation
infrastructure for human habitation
losses to crops and tame grass
roads

Other conservation threats mentioned:

use of nonrenewable resources (i.e., cars)
overpopulation by humans
alteration of predator community - historic predators gone and replaced with large numbers of non-native or uncharacteristically abundant mesopredators
historical habitat loss/fragmentation (I'm in the corn belt)
human overpopulation and accompanying stress on resources
human population growth
human population growth and resource consumption (Western hemisphere)
lack of ecologically successful restoration strategies (restoration from agriculture, restoring wetlands, restoring fire, restoration after invasive-species-control actions).
lack of scientific/ecological understanding
population growth

Comments:

"Urban/suburban sprawl is without a doubt the most pervasive threat, in one form or another, to all biodiversity health and conservation issues in this country. Failure to recognize and address this threat on all levels, not just buying land, will result in a mission-critical policy failure."

"Question 44 was extremely difficult to answer. Different sites have very different threats."

"You should have stated from which viewpoint this question should be answered -- nationally, locally, etc. My answers are from my Georgia frame of reference, where forestry practices have great impact."

General Comments Addressed to the External Science Review Committee

These are verbatim comments loosely organized by subject. Negative references to specific sites or individuals have been omitted.

Respect and understanding of science

- The greatest contribution you could make for our organization would be to convince senior managers of the need to take our measures of success seriously (i.e., make their assessment scientifically credible and evaluate our success accordingly, rather than solely on the basis of bucks and acres). They need to understand that buying land is only part of the job of biodiversity conservation, and for many sites only a small part of the job. If our senior managers were truly committed to achieving ecological integrity, EVERYTHING about our science programs would change for the better, because they would begin striving for attainment of this integrity in the most efficient way possible - and they would need science and scientists to do this!
- I would be unlikely to recommend TNC as an employer for entomologists; we're too few and far between in spite of the fact that arthropods are 75% of the world's biodiversity. I never felt that non-TNC scientific activities - i.e., professional service - were valued by TNC.
- While I think the science program is very strong in the Oregon Program (although there is still room for improvement), stories I hear about other TNC programs are not as encouraging. I hope the committee will be able to recommend concrete changes that will allow the entire organization to live up to the rhetoric about TNC being a "science-based" organization. A lot of our success in Oregon is a result of the very hard work and dedication of Dan Salzer, our Research and Monitoring Coordinator. Perhaps more positions like his throughout the Conservancy would help (although there is only one Dan). Also, I think there is a perception that the Heritage Program is THE science arm of TNC. This short-changes those of us doing basic research and data collection on the ground. There needs to be more recognition that many departments contribute to TNC's scientific approach.
- TNC in many ways supports science; however, the organization does not place the value on this component of the program that it does on donor-driven issues of fundraising and land conservation. It poorly recognizes and rewards efforts in science, especially compared to gift size and land project. Science rarely is classified as a "critical need," yet fundraising and staff for projects are almost always critical. Measures of success should address some of this, but I think it would be extremely valuable for state programs to meet the challenges in an accountable manner.
- I see two main issues regarding science at TNC: 1) Lack of capacity organization-wide to grapple with the questions we're facing. 2) Difficulty in communicating between TNC scientists and others in TNC (development, protection) the importance of science and the implications of not using science in our work.
- Thanks for doing this-many of us science folks in TNC have been concerned about our role and the role of science. We hope that TNC continues to be a science-based organization!
- I am not intending this as a negative review. I think TNC is trying very hard to keep our science up to speed. However, the rapid decentralization process, although very good overall, has left science in the back seat because of other more pressing needs.
- My opinion is that the greatest problem with science in TNC is that many state directors, site personnel don't realize how important scientific integrity is. We are "bucks and acres"-driven and do not realize that monitoring the conservation targets themselves is key. We confuse successful conservation action with conservation success! I believe that there needs to be a restructuring of the conservation science staff such that ALL divisions (maybe even states) would be held accountable to have a science staff with diverse expertise and that the site-action personnel would be accountable to this staff.
- There is a tremendous amount of talent in the Conservation Science Division. Our ability to provide guidance and services to field staff is marginalized by our leadership outside CSD. This leadership does not rely upon the CSD staff to provide scientific input. Instead, they actually try to develop and implement science-based processes, and simplify them

to a level of absurdity. In many cases, they make the Conservancy's work a joke to the scientific community.

- For many years, the term "science" as used by TNC meant Natural Heritage data and information, and the vast majority of "science" data and information we still use in our day-to-day conservation work in this chapter is from Heritage. But this information can best be described as "natural history information"; i.e., data on occurrences and habitats. True "scientific knowledge" - that is, data and information derived from field experiments and hypothesis testing - remains vanishingly rare, particularly given the large number of elements of biodiversity we are working to conserve.

Balancing science and time-based conservation issues

- In the conservation business, challenges are so great that timing and resource allocation are generally critical to our decisions. It is difficult to find the ideal mix of action and updated information. However, as a Conservancy employee, I've seen different approaches: 1) Sometimes we are aware that additional information would be helpful, but choose to take action while we gather it. 2) Before making a decision that will affect critical conservation allies (e.g., national site portfolio), we gather information from different sources, preferably using information validated by national scientists (when necessary/appropriate, we work with the scientific community to address information gaps), to make a decision that is not only well informed from a scientific standpoint, but one that has a higher potential for success.
- It's a struggle to understand the processes in order to save and protect these ecosystems quickly, before we lose them. We are constantly trying to balance the time it takes to do basic research (I mean literature review or very basic monitoring) with getting the plan (site or ecoregion) done. It is difficult because TNC says we are science based, but internally the pressure is not to do science, but to produce results. It's very hard to do one without the other and remain a credible organization. Having said that, science staff play a tremendous role in helping conservation practitioners locate, compare, and adapt best methods and best information to answer the tough questions. Regional and National science staff provide a broader viewpoint, and can compare and contrast information and lessons learned across ecoregions from the region and from across the U.S. I believe science staff is critical to the success of purchasing and protecting viable systems that will protect the biodiversity contained therein. This applies to ecoregional planning, site conservation planning, and preserve management.
- There are a lot of TNC folks like me out there who do work on the ground that would not pass academic, scientific muster. But it is still good conservation work that seeks positive results for our conservation targets.
- I think our research and monitoring program has a strong scientific base, and promotes well-designed adaptive management approaches to conservation. However, our conservation actions often occur opportunistically (such as when a parcel becomes available for sale), rather than strategically (such as purchasing the highest-priority tract identified in a site-conservation plan). As a result, actions are often implemented on a very short timeframe, and provide no opportunity to design adaptive-management studies. The large number of sites for which we need to do site conservation planning causes some to feel we should sacrifice some scientific rigor in favor of getting more plans done quickly. Similar concerns are voiced for ecoregional planning. Although we work with outside researchers in government agencies and universities now, I believe we would benefit from even more partnerships. More active promotion of TNC's conservation-planning process on a national scale to scientists might interest them in working with us more on a local scale.

Integrating science

- I think the two most urgent priorities for the Science Division are: 1) Organize all programs to be fully integrated with conservation, development, government relations, etc. Science will be most effective when it is so well integrated that it is hard to find as a separate group of people. 2) Develop a national initiative, similar to the Freshwater Initiative, to build adaptive management capacity in TNC.
- I'm not sure I was the appropriate person to fill out this questionnaire, but I feel that we definitely need better science.
- I'm really glad you're doing this! TNC takes such pride in a "science-based" approach, but we need to be critical about how well we're meeting this vision and supporting our science activities.
- The fact that TNC chose to segregate "science" into one compartment of its recent (January 2001) reorganization of job categories speaks volumes. In a truly science-driven organization, it would be integrated into all areas. But the fact that "science" isn't even included within "conservation" is absurd and demoralizing. As Director of Science and Stewardship, my job is in "conservation" but not within "science." Ridiculous.
- One of the biggest problems I see is the lack of communication between Resource Office and state offices and the

centralization of state offices. The lack of communication might be due to the face that most, if not all field offices do not have a science staff, nor is their focus or work directly related to science. I believe science needs to be integrated into the states to provide for support to those offices and their field personnel-to keep everyone in the loop.

- I did not complete the survey as I am not a scientist, but a government relations director in my state. Based on my lobbying experience, I want to provide my encouragement to the work of the survey team by sharing my thoughts on the great importance of the integration of science in the work of TNC. Often the most powerful information that I can bring to an issue or request for funding is our science-based data. This gives a request from TNC a level of credibility and status that helps it to rise above the crowd of competition. TNC's reputation for sound scientific information teamed with our nonconfrontational manner opens doors, provides the foundation for stimulating discussion, and leads to positive opportunities.
- TNC needs to make a much greater effort of incorporating scientific data into land-acquisition efforts, particularly at the state level, and using scientific information to direct management action and land-acquisition projects.
- Need to place emphasis on building resources to support partners to undertake scientific research at our sites/regions, then enable us to use and apply that data using adaptive approach. Areas of need: Fire, weeds, ecological restoration.
- TNC's use of science at the planning level is impressive in many respects (e.g., site conservation and ecoregional planning). I realize the necessity of plans, but I am not a planner, and my concerns are with the objective measure of success at the population, community, and landscape levels. The plan itself is a great accomplishment, but more is needed for implementing and measuring the outcome of these plans. Adaptive management sounds like the approach to take, and we advocate this in workshops. But outside of a few state programs, I've seen a more realistic understanding of the time and money needed to implement AM in government agencies that we work with than I have within TNC. My greatest fear is that we may do damage to a worthwhile concept (AM) by talking the talk but not walking the walk. For example, some TNC personnel are very quick to criticize and point out the shortcomings of AM efforts in other agencies, but there are rarely realistic alternatives offered. The tone towards others can be condescending at times. I realize none of these observations or problems are unique to TNC. I've observed the same within academia and other agencies, and TNC is to be commended for focusing on applied conservation. But more resources are needed within the organization (both money and expertise) for implementing serious science at TNC preserves.
- We are building the capacity to bring good science to our project. We have great potential and the support appears to be there. Our program suffers, and will continue to suffer, because this capacity was not built earlier.
- The science component of TNC's work program has evolved over time-and while not ideal, does represent some of the best-developed capacity among organizations that have a land-conservation mission. Although apparently "secure," the science program will continue to depend upon the demonstrated worth of scientifically developed learning. Your efforts to assist in setting a map towards an improved science capacity are appreciated.

Ties to the scientific community

- It would be very helpful in maintaining ties to the scientific community if TNC's scientific staff were adjunct faculty as appropriate at local universities. This would [illegible] scientific collaborations and involvement in graduate education and advising. TNC should be able to negotiate such arrangements institution to institution.
- Very long survey! Main points from me: 1) Need to continue interactions with non-TNC scientists. 2) Technology needs to keep up with needs. 3) In my opinion, not all good science is done on or with the Internet . . . but is still shared in some fashion. 4) Adaptive management is important to the extent that it gives valuable information, but statistical rigor in design can bog down good conservation. 5) Time is a limiting factor in sharing (and getting) information.
- TNC scientists do valuable and often original work and they should be encouraged to publish results in peer-reviewed journals, even making it part of their job description and objectives. This would help to disseminate new knowledge to a wide audience as well as increase the prestige of TNC's science program. Many of us work in geographic isolation from our peers; staff exchanges or work details with other TNC offices (national and international) would help with staffing shortages and result in sharing knowledge and building networks. Provide language training to those who are interested in international work!
- I feel like our job niche is so tightly defined with deadlines always upon us that we do not have the "luxury" of doing research, contributing to papers, or even attending many conferences. I also think TNC in general is too insulated from the broader science community.

- TNC needs to reward scientists for developing themselves as scientists-reading journals, interacting with scientists, etc., publishing-since so much of science is who you know and what you know. Right now, I am pulled in so many directions by other things, I feel like I am losing touch with the science. TNC science in the Conservation Science Division is good, but we don't have the time or expertise to do some of the work on the ground. Or our systems are too different. Need our own science at state level.

Reactions to the survey

- You should consult with government affairs and learn how to present a usable on-line survey that doesn't take all morning to complete-this one went into my "get around to it" file.
- I think this is a poorly written survey. I doubt the data you generate from it will be of value. Sorry.
- I am not a big fan of this type of survey because I think TNC scientists work in so many different roles and situations that questions such as presented will be interpreted very differently by each individual. When the responses to each question are rolled up, I'm not very confident they will adequately describe the state of science across the country. I feel personal interviews would be a better way of getting at core strengths and problems.
- Sorry if my responses are not very useful for such a great initiative. The survey was well designed. Although it went into too much detail.
- It's interesting that we weren't really asked to evaluate the role of TNC's "Central Science expertise" relative to our programs. Very curious, given the hit-or-miss nature of this resource.
- I was expecting and hoping for questions about how the field feels about services provided by the science division. I was hoping to tell you how much we value programs like the Freshwater Initiative, fire program, weed program, etc. Much of this questionnaire was not easy or appropriate for administrators of conservation programs like me.
- Obviously, from my comments I feel that this questionnaire was not well worded or well focused. A much better job was needed here. There was little questioning regarding science information sharing among TNC science staff. There is a considerable exchange of personal information going on internally within TNC.
- I would like to know why national and regional scientists were not included as an option in questions 4 and 5. I would like to know how field scientists and non-scientists use the Conservation Science and regional ecology staff-and I also think this survey overlooked the GIS scientists. I do, however, appreciate the attention to advancing science in the organization.
- I found many of the questions difficult to answer using the limited choices offered. In few cases could I give an accurate answer that would fit all, or even most cases.

Communication and processes

- I am afraid that this survey may be another example of the overly complex pseudo-science that pervades TNC without us even realizing it sometimes. We must confront basic science issues, discuss and politely debate them, develop independent science funding (separate from the PR hype that sometimes overwhelms). As an organized national/regional effort, why has our Field Office never been asked for grassroots science needs? Even now. . .
- Your questions about information management focus on program-specific uses. You may miss the big picture of the need for a consistent, standardized data-management system for conservation information across TNC - this is essential for our success, but TNC leadership seems to be less than enthusiastic about it.
- As far as data management, we have plans to more formally [illegible] data and make it available on-line within the next 1 to 2 years.

Lack of staff/expertise

- In order to implement measures of success, much more monitoring will need to be done. We do not have enough staff, or trained staff, to do monitoring and analyze results. Also do not have enough taxonomic experts to identify species. 2) We need more in-house TNC experts with whom to consult, especially on Divisional and State levels. TNC national experts are excellent, but too few and too busy. 3) Need expertise: Repeat of question 26, very important: monitoring design, hydrology, exotic species control, aquatic biology/marine biology, fire management, taxonomists to ID species.

- Once ecoregional planning is done, I worry that conservation science staff will disappear. Science staff in chapters need expert advice on planning, measures of success, etc., as often our own science skills are rusty-we do lots of stewardship and administration.

Career concerns

- No questions on compensation. If science is the crux of the mission and so crucial, why is compensation so low compared to other TNC jobs or science outside TNC? State employees with less responsibilities, fewer hours per week of work get paid much more; state employees are usually lower paid than their private counterparts.
- There is no long-term career path for scientists in TNC. All focuses are fundraising and managers. Scientists should have different career development way other than fundraising and becoming a state/county program director. And have voice in the decision-making processes.

Other comments

- I find working for TNC-CSD to be an amazing experience. We have an incredible group of intelligent and motivated scientists. We have made excellent progress in developing applied methodologies for conservation science. As a group, we have shown great foresight in investing in GIS resources and comprehensive ecoregional planning. We have also supported a vast resource of actively managed and distributed biodiversity information. We continue to make excellent progress in developing the scientific capacity of the chapter programs. The most common criticism I have heard of our efforts is that we do not publish enough or share our work well with the broader scientific and conservation community. I certainly agree, and this is a critical area of our focus for the coming months. Data Management is a critical area where we plan to expand our efforts. Particularly in terms of supporting data management capacity development within our chapters. Staff retention is a major problem for the Conservancy, even more so for CSDl Experts in the field of biodiversity information management are particularly rare and valuable and our salary range offered to these roles is not competitive. Turnover rates are way too high to run an effective science department.
- I would like the Conservation Science Division to seriously address issues in conservation of highly fragmented landscapes. This would be useful to the 25% or more of the continental U.S. sites where we work.