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**REPORT
OF
THE SMITHSONIAN INSTITUTION
SCIENCE COMMISSION**

**PRESENTED
TO**

**THE BOARD OF REGENTS
OF THE SMITHSONIAN INSTITUTION**

**THE SECRETARY
OF THE SMITHSONIAN INSTITUTION**



Smithsonian Institution

TRANSMITTAL OF REPORT

BY

THE SMITHSONIAN SCIENCE COMMISSION

DECEMBER 2002

To:

THE CHIEF JUSTICE OF THE UNITED STATES, CHANCELLOR
AND MEMBERS OF THE BOARD OF REGENTS OF
THE SMITHSONIAN INSTITUTION
THE SECRETARY OF THE SMITHSONIAN INSTITUTION

THE SMITHSONIAN INSTITUTION SCIENCE COMMISSION
UNANIMOUSLY ENDORSES THIS REPORT AND URGES ITS ADOPTION.

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EXECUTIVE SUMMARY

Smithsonian science is facing the most critical time in its 156-year history. Despite continuing financial pressures, much of the Smithsonian scientific enterprise is flourishing, as documented by recent National Academy of Sciences and National Academy of Public Administration reports. But, without inspired leadership and careful strategic planning, it might slip - like a building without maintenance - into a state of mediocrity from which it will be hard to recover. This report offers a series of fiscally responsible recommendations that the Science Commission believes will lead to significant improvements in Smithsonian science.

In order for Smithsonian science to achieve the highest levels of accomplishment, the senior administration of the Smithsonian Institution (SI) must reverse the long-term trend of declining support and relative neglect of scientific Units. To reverse this trend, senior administration must convince the Office of Management and Budget (OMB) (and ultimately the Congress) of the compelling case for financial support of science at the Smithsonian. As a first step, OMB must fund yearly salary increases, so that fundraising efforts for new initiatives can build on a secure foundation. The cannibalization of staff positions to fund these mandated increases must stop.

The backbone of science at the Smithsonian is research. This applies to all science Units. The Institution's rich array of ongoing research projects requires increased attention to both production and dissemination. This report indicates ways this can be accomplished within existing fiscal constraints. It also stresses the great importance of the collections of the National Museum of Natural History (NMNH) (approximately 124 million items), and the need to maintain this vital and unique national resource.

The Commission recommends that the Under Secretary for Science, in close consultation with Unit and Center Directors, focus SI science on four general research themes: the origin and nature of the universe; the formation and evolution of the Earth and similar planets; discovering and understanding life's diversity; and the study of human diversity and culture change. The Institution-wide integration of these themes is especially important. Through such connectivity - defined here as *Science Smithsonian* - the Institution can be more than the sum of its parts and can increase its contributions to both pressing national and international needs and geometrically advance science in general.

This report, following the charge of the Smithsonian Board of Regents, focuses on issues of leadership, structure, performance evaluation, education, outreach, budget, and implementation of recommendations. The general thrust of the Commission's recommendations in these areas can be summarized as follows:

- **Leadership:** Beyond the erosion of funding support, the lack of effective, long-term leadership has been the single most important factor in the weakening of SI science (as witnessed, for example, by the high turnover of Directors and Acting Directors at the NMNH over the last 2 decades). All leadership positions above

the level of Department Chair should be filled through nationwide searches. Plans need to be implemented to more effectively integrate public programs and exhibits with ongoing research. A full-time Director should be appointed at the Smithsonian Environmental Research Center.

- **Structure:** While there is little need to change the Institution's basic science structure, a modest restructuring of the Office of the Under Secretary of Science to facilitate planning, communications, and performance assessment is recommended. SI scientists should be detailed on a temporary, rotating basis as Special Scientific Advisors to the Under Secretary, and mechanisms put in place to engage scientists in strategic planning and management of science. Retirement incentives would allow infusion of new blood and revitalize some Units.
- **Performance evaluation:** The Commission recommends that performance evaluations be made more effective by having clear, concise, and consistent standards for the review process (such standards should be developed by members of the staff, as well as administration.) Annual reviews and Professional Accomplishment and Evaluation Committee (PAEC) reviews should be more closely meshed. All science staff subject to PAEC should be reviewed at regular intervals, and results communicated and implemented in a timely manner. Exceptional performance must be rewarded. On the Unit level, the implementation of a system of external Visiting Committees for all science Units will provide evaluations and guidance.
- **Education:** As outlined in the Smithsonian's original charter, education and outreach are integral parts of the SI science program. They should include exhibits, seminars, workshops, Web sites, publications, internships, fellowships, and research training programs. Despite their importance, these activities are diffuse and lack coordination. They have sustained major budget reductions, loss of infrastructure, and program terminations. The Commission recommends the immediate development of an Institution-wide strategic management and fund-raising plan for science education. The goal is to make the SI a world-class leader in research-based science education, accelerate the renewal of exhibitions and Web-based learning, rejuvenate Scholarly Studies and Fellowships programs, establish a biannual Smithsonian Conference series, and develop a high-level pan-Institutional Education Council to encourage coordination and collaboration.
- **Outreach:** The SI must update and put into action the science and research communication plan drafted 2 years ago. The Under Secretary for Science and all the Units must work more closely with the Office of Public Affairs to promote SI research. The Regents, Secretary, Under Secretary, and Office of Government Relations should create a committee to better inform Congress and the federal establishment about the many contributions to the public good made by SI scientists.
- **Budget:** Critical budget items for Smithsonian science include correcting the base erosion produced by unfunded mandatory salary increases; maintaining the Major Scientific Instrumentation and Research Equipment Funds; and, funding Fellowships and Scholarly Studies programs. Recent cuts have produced negative effects on scientific productivity, out of proportion to the fiscal gain.

- **Implementation:** The Board of Regents should establish a 3-year benchmark period for this report. By July 2003, the Under Secretary for Science should create a plan for carrying out the Commission's recommendations, including explicit metrics for success and a timetable for completion. This plan will be implemented through the Scientific Directors Council, comprised of the heads of each major science Unit. The Under Secretary will also assemble a distinguished Visiting Committee to review the Institution's progress, on a yearly basis, in a brief report to the Smithsonian Regents (in December 2003, 2004, and 2005).

After careful examination of the issues and constraints facing the seven science Units, the Commission concludes that visionary leadership, tightening program operation, and selective cost-cutting hold the greatest promise. The Commission does not recommend specific closures or terminations in this report, but recognizes that such action may be necessary within the individual Units. In regard to the Unit and Center slated for closure prior to the Commission's creation, the Commission makes the following recommendations:

- **The Conservation and Research Center (CRC):** This important research program should be continued and fully integrated within the National Zoological Park (NZIP). Federal funding for the Front Royal facility should be placed on a 5-year period of notice. The NZIP and the supporters of the CRC should be given 2 years to find external funds for Front Royal. If such support cannot be found, the SI should work with Congress and other appropriate constituencies to turn control of Front Royal over to the General Services Administration within the following 3 years.
- **Smithsonian Center for Materials Research and Education (SCMRE):** This unique Unit should focus on its core mission of conservation research in support of Smithsonian museums and their collections. SCMRE should focus on its original mission and coordinate its activities with the conservators at all SI museums. In addition, some of its scientists should be transferred to the NMNH's Department of Anthropology, where their important work will be more appropriately supported.

The Smithsonian can once again become a national leader in science. But, this will require strong leadership, setting of Institution-wide priorities that emphasize the four-theme vision of *Science Smithsonian*, greater transparency in planning, consultation, and fiscal activities, consistent accountability of scientific Units and individuals, and reversal of years of declining support through better communication of the importance of scientific research at the SI to the Congress and OMB.

Last, but most important, it is clear that the most significant problem facing Smithsonian science is funding. The Commission strongly recommends a four-pronged approach to solving this fiscal challenge. The Smithsonian should:

- **significantly increase its efforts to find private and foundation funding for its scientific activities;**

- **work with Congress to obtain direct federal funding for scientific research at the Smithsonian;**
- **work with the National Science Foundation to avail all Smithsonian scientists of the opportunity to apply for NSF research funding; and,**
- **work with Congress to increase the Smithsonian's base funding to fully cover mandated annual salary increases.**

1. INTRODUCTION¹

a. Background

Science was the principal activity of the Smithsonian Institution (SI) for more than a century after its founding in 1846. Until 1994, all of the Secretaries of the Smithsonian were prominent scientists, including the greatest American scientist of his time, Joseph Henry, who served as Secretary from 1846 to 1878 and whose statue stands outside the Smithsonian Castle on the Mall to this day. As recently as 1963, most non-science activities at the Smithsonian were restricted to the old Arts and Industries Building and the Freer Gallery of Art. The Smithsonian was the United States' leading scientific institution for many decades. More than any other institution, the Smithsonian exemplified American science.

But, science expanded dramatically during the first half of the 20th century, and, beginning in the 1960s, the Smithsonian increasingly became home for America's public art treasures and artifacts. More than ten art and cultural museums were founded at the Institution since the 1950s, while basic scientific research has been increasingly neglected. Financial responsibility for these new enterprises eroded funding for the Smithsonian's science mission. Thus, it is hardly surprising that the Smithsonian today is largely perceived as a collection of art and cultural museums. Many people are surprised to learn that the Smithsonian has any science mission at all!

This decline of public and Congressional awareness of Smithsonian science poses a grave threat to the future of the Institution as a whole, because it undermines the reputation on which the Institution's educational and outreach programs are based. Despite decreasing visibility and financial support, the scope of Smithsonian science still extends across a vast range of subject matter, from astrophysics to tropical biology, from estuarine ecosystem science to paleobiology, from systematics and biological conservation to anthropology, planetary science and the conservation of precious and threatened museum materials and collections. Diversity has been a unique strength of Smithsonian science and should be the basis for its resurrection. But, as the recent National Academy of Sciences (NAS) and National Academy of Public Administration (NAPA) reports emphasize, neglect of Smithsonian science over many years has seriously compromised its mission.

b. Charge to the Science Commission

The Science Commission was appointed in July 2001, by the Smithsonian Board of Regents, to review the status of Smithsonian Science and to make recommendations for its future. The text of the charge is as follows:

¹ The Commission is deeply grateful for the administrative support of many people at the Smithsonian, too numerous to mention individually. However, the Commission wishes to single out for special thanks the former Under Secretary for Science, Dr. J. Dennis O'Connor, the current Under Secretary, Dr. David L. Evans, Ms. Vera Chase, Ms. Elizabeth Tait, Mr. Carey Winfrey, and most particularly, Mr. Michael A. Lang.

“For 155 years, the Smithsonian Institution has had as its mission “the increase and diffusion of knowledge.” Given the important questions facing the scientific world today, the existing level of Institutional financial and physical resources, the strengths of the Institution’s people and its collections, how should the Smithsonian set priorities for scientific research in the years ahead and, in general, carry out its historic mission most effectively?”

- *What should be the qualifications of those chosen to lead key scientific research Units of the Smithsonian?*
- *How should the performance of scientific research by individuals and research departments be evaluated?*
- *How can the relationship between research and public programming be enhanced?*
- *What should be done to enhance public recognition of Smithsonian science?*
- *How should scientific research be organized to optimize the use of the Institution’s human, physical and financial resources?*
- *What suggestions, of any type, might the Science Commission have to strengthen research at the Smithsonian?*

The Commission’s findings will be submitted to the Regents for their consideration.”

c. Challenges to Smithsonian Science

The challenges confronting SI science today in many cases date back 2 decades and more, but are not insurmountable. Among the problems addressed in this report are:

- eroding financial support for science in the broad sense, including staff and the maintenance of the Smithsonian’s facilities and irreplaceable collections;
- lack of broad Institution-wide strategic planning for Smithsonian science and lack of significant links between Division or Unit planning and central planning;
- poor communications in administrative operations between top Smithsonian officials (“the Castle”) and Units and within the Units themselves; and,
- lack of involvement of Unit Directors and senior administrators in financial decision-making.

There has not been a Smithsonian-wide focus on science for more than 20 years. Coupled with declining support, the absence of a strategic plan for science has led to unplanned cutbacks that have distorted and undermined the scientific enterprise. Thus, while the overall SI budget has increased significantly during this period, most budgetary increases have been directed towards capital construction and deferred maintenance. Despite a rising budget for the Smithsonian as a whole, the overall science budget has steadily declined (see Appendix G). These losses have affected Smithsonian science in at least three critical ways:

- decrease in the number of research scientists and staff, especially at the National Museum of Natural History (NMNH);

- reduction of program support (e.g., fellowships, grants, libraries, and publications); and,
- reduced flexibility, which has inhibited new initiatives and appointments by limiting the funds available for major scientific instrumentation, research equipment and for staff renewal that are the life blood of any vibrant scientific enterprise.

In spite of these problems, certain Units and programs maintain high quality science staff and research programs. The ingredients of these successes must be built into strategic planning for Smithsonian science as a whole. This report recommends steps that the Science Commission believes will result in a more focused, efficient, and productive scientific enterprise at the Smithsonian. The Commission resolutely believes that these steps can, and should, provide the foundation for a careful, Institution-wide strategic planning effort, which will provide the Smithsonian with a long-term framework for action. But, as also clearly emphasized by the NAS and NAPA reports, unless the overall erosion in scientific support can be stemmed in the very near future, change and modernization will be very difficult to implement and the Smithsonian will suffer irreparable and irreversible damage.

d. Developing the Science Commission Report

During the course of the Science Commission's fact-finding phase, many individuals were interviewed (either in person or via email), including: the current and past SI Under Secretary for Science and all Directors/Deputy Directors and Associate Directors of SI Science Units, former NMNH Directors and Department Chairs, and nationally and internationally recognized leaders of scientific institutions. The Commission benefited from discussions with expert consultants (see Appendix D) from the American Museum of Natural History, the Getty Museum, the Brookfield Zoo and the San Diego Zoological Society. It obtained information from the Smithsonian Office of the General Counsel and the Office of Human Resources about Institution guidelines, expectations, and legal aspects of personnel review. Interviews also were conducted with selected Smithsonian Unit public affairs specialists and those at the Smithsonian Office of Government Relations and Office of Public Affairs. The Commission also consulted with several Congressional staffers.

Input from Smithsonian scientists proved invaluable. Commission subcommittees made site visits to all science Units and conducted open meetings with staff. The Commission received individual research statements from essentially all Smithsonian scientists, as well as strategic vision statements from the science Units, and many documents and reports from bodies such as the Congress of Scholars, the NMNH Senate of Scientists and external review committees. Budgetary data were provided by the Office of the Under Secretary for Science, Research Units, Office of Management and Budget (OMB) and other offices. The NAS and the NAPA were consulted (see Appendices K and J), as were OMB, and the Office of Science Technology and Policy.

Extensive discussions were held in executive session by this Commission over a 15-month period of time (see Appendix B).

2. VISION – “SCIENCE SMITHSONIAN”

The science mission of the Smithsonian is vital to the future of the Institution. At the start of a new millennium, it is vitally important to re-dedicate the Smithsonian to the full exercise of its original charter, as an establishment for the increase and diffusion of knowledge. However, in renewing this charge, there needs to be greater clarity of purpose. The Smithsonian cannot do everything, but it can do (and does) some kinds of science extremely well, better than any other institution or organization in the world. This new commitment to the Smithsonian’s mission requires not only strengthening the science that the Smithsonian does best, but also successfully communicating the results of this science to the public.

One great asset of U.S. science is that first-rate work can be done with a different flavor and different approaches in different settings. The Smithsonian is different from universities, which is good and important. The Smithsonian can undertake research programs that universities cannot.

One great strength of Smithsonian science is its ability to take a long-term, synthetic, big-picture perspective. The importance of such a perspective cannot be over-emphasized; without it, many of the most profound scientific questions cannot be adequately answered.

Another major strength of Smithsonian science is the concentration of resources that can be brought to bear on large questions. The Smithsonian Astrophysical Observatory (SAO) is the largest and broadest astrophysical research institute in the U.S., and the Smithsonian Tropical Research Institute (STRI) is the world’s premier tropical research institute. Furthermore, there are important synergies to be gained in combining the efforts of different Smithsonian science Units. For example, the combined resources of the National Museum of Natural History (NMNH), STRI, the Smithsonian Marine Station at Fort Pierce, the Smithsonian Caribbean Coral Reef Ecosystems Program, and the Smithsonian Environmental Research Center (SERC) comprise unrivalled expertise on the ecology of coastal marine ecosystems, while biologists at STRI and NMNH constitute the greatest concentration of specialists in tropical American forests in the world.

A further key strength is the unique and irreplaceable collections housed at the NMNH and the National Zoological Park (NKP), and the unrivalled physical facilities (e.g., STRI) built up over many decades. These resources make the Smithsonian an internationally important research center in certain areas.

But, its very diversity can make Smithsonian science appear diffuse and lacking in focus. To combat this perception, a few major science themes must be articulated as core scientific missions. These themes should capitalize on existing research strengths, the collective expertise of its scientific staff, the Institution’s unique and irreplaceable collections, and the physical facilities that have developed over the course of its history.

The Commission feels that four key themes will provide a strategic platform for both the short- and long-term growth of science at the Institution, none of which require costly, large-scale administrative reorganization. Rather, they require a change in approach to encourage different Units and groups to work more effectively together.

The four broad research themes the Commission has identified are:

- **the origin and nature of the universe;**
- **the formation and evolution of the Earth and similar planets;**
- **discovering and understanding life's diversity; and,**
- **the study of human diversity and culture change.**

These four themes should form the core scientific mission of the Institution. Increased emphasis on exploring these themes, further refining their focus and developing the interconnections among them, provides a powerful basis to allow the Institution to realize its full potential and deliver improved public benefit in both science and education.

a. The Origin and Nature of the Universe

The Smithsonian is preeminently positioned to harness new technology to study the Universe. Astrophysics is still a young field, advancing by discovery as much as from experiment, building a picture of the cosmos that lets us look toward our own origins. At field stations of the SAO, every branch of astronomical observation is being pushed forward: in Hawaii at the Submillimeter Array, in Arizona at the 6.5-meter MMT optical telescope, and in orbit with the CHANDRA X-ray Observatory. This breadth of approach, wider in scope than that at any other institution in the world, creates opportunities to understand deep connections among many threads of evidence. The SAO vision is to develop a fundamental understanding that ranges from the structure and evolution of the universe to the planetary systems around stars and to share these discoveries with the widest possible audience.

b. The Formation and Evolution of the Earth and Similar Planets

Since its beginning, the Smithsonian has been a leader in understanding the physical and chemical processes that form and shape the Earth's surface. Over the past 40 years of space exploration, it has become clear that the forces that shape planetary surfaces, and often dramatically affect the development of life, can also be illuminated through a broad study of all the planets in our solar system. Examples include a greater understanding of greenhouse warming from Venus data and the recognition of extinctions related to large meteorite impacts. The Smithsonian is already a world leader in volcanology and the study of meteorites. With the growing national and international interest in the exploration of Mars, the depth of Smithsonian expertise in remote sensing and planetary surface processes have made it a leader in this exciting new research area as well.

Two research groups within the Institution (National Air and Space Museum's Center for Earth and Planetary Studies and NMNH's Department of Mineral Sciences) study the physical and chemical processes at work on the Earth and similar planets. These groups

pursue complementary research focused on four areas in which the Smithsonian has unique depth of expertise: Planetary Volcanism, Mars Evolution, Early Solar System Processes, and the Formation and Behavior of Earth's Minerals.

c. Discovering and Understanding Life's Diversity

A focus on the science of life's diversity - biodiversity science – is an urgent area for research investment because of the current rate and magnitude of biodiversity loss, and because the Smithsonian's unique collections and facilities provide competitive advantages. Research in this area should be organized around three interrelated questions:

1. What biodiversity do we have, how did it come to be, and how is it distributed in space and time?
2. How does biodiversity contribute to the functioning of ecosystems?
3. How can biodiversity be conserved, managed, and used in sustainable ways for human benefit?

These questions need to be the primary focus of research for many of the scientists at NMNH, STRI, SERC, and NZP. This work also needs to utilize modern methods to manage and disseminate biodiversity information with a degree of urgency appropriate to the speed and magnitude of current environmental change.

d. The Study of Human Diversity and Culture Change

A key continuing objective of science at the Smithsonian should be to expand our understanding of the processes that shape human biological, cultural, and linguistic diversity and change, from the earliest origins of the human species through the present day. In the face of rapid globalization and the steady loss of languages and traditional lifeways, anthropological research in all its aspects (archaeology, biological anthropology, cultural anthropology, and linguistics), has never been more critical for providing deep historic perspectives on human impacts on, and responses to, modern environmental and social change. By building upon the Smithsonian's long history of anthropological research and using its unique collections of artifacts, photographs, and archival documents, Smithsonian scientists can make significant contributions to understanding the complex inter-relationships among humans, the planet, and its biota that are central to the future of our species.

3. RESEARCH – GENERAL RECOMMENDATIONS

The Smithsonian plays a unique role in the scope of American science. Because of its vast collections beyond those of any other institution, its collections-based research is unprecedented. Its field stations support and complement that research.

As a federally supported institution, the Smithsonian has a responsibility to make its collections available to scientists across the nation, to maintain the collections in top condition for study now and into the future, to train the next generation of scientists in museum-based research, and to support field programs, exhibits, education, and public outreach. But, that same federal support also imposes restrictions. Many Smithsonian scientists currently can apply only covertly (through collaborations with university scientists) for grants from the National Science Foundation. This constraint greatly restricts the scope, sophistication, and productivity of Smithsonian research and limits scientists' ability to move into more modern, often expensive, research areas. Since the Smithsonian does not offer educational degrees, except in fortunate circumstances, it lacks the pool of students available at universities. Smithsonian scientists are limited by research funds available directly from the Institution while they are, at the same time, unable to compete for national funds. The declining Smithsonian research budget (see Appendix G) has only exacerbated the problem. It is interesting to note that, over the last decade, the science budget has become a smaller fraction of the total Smithsonian budget, as the costs of adding new Museums have mounted. The Smithsonian cannot continue to divert funds from research if it hopes to maintain its reputation and original scientific mission.

The following recommendations address the erosion of the science budget over the last decade and seek to redress the adverse impact this has had on the morale of staff and the scope and excellence of scientific research:

Recommendation 3-a

The Commission fully endorses the National Academy of Sciences' and the National Academy of Public Administration's report recommendation that SI scientists be allowed to compete directly for federal funding. The Smithsonian administration should actively pursue all means to implement this recommendation.

Recommendation 3-b

The Fellowships and Scholarly Studies programs must be reinstated as soon as possible. The cannibalization of these funds for other Smithsonian programs has greatly weakened the scientific enterprise. Pre-doctoral and post-doctoral fellowships infuse the Institution with new, energetic scientists and provide a means of training the next generation. Scholarly Studies funds (distributed competitively based on research merit) must provide seed money for the development of external proposals along with incentives and support for the best and

brightest Smithsonian scientists. Once re-established, funds within this program must not be redirected out of the science Unit.

Recommendation 3-c

Mandated salary increments have for too long been funded by scavenging positions, to the detriment of SI science excellence and staff morale. Steps must be taken immediately to obtain full funding for annual salary increments, including within-grade increases and promotions, in the Smithsonian budget.

Recommendation 3-d

Development efforts for SI science in the private sector and among foundations should be significantly increased in the face of growing federal budget constraints.

Recommendation 3-e

Greater support for Library resources, including access to the Web of Science and other Internet search engines, and support for journals and book purchases, is essential to maintain the quality of research at the Smithsonian.

Recommendation 3-f

The Institution needs to maintain its programs of Major Scientific Instrumentation and Research Equipment. It should develop a coordinated plan for the acquisition, maintenance, and use of large scientific instruments. Equipment purchased with Institutional funds should be available to all.

Recommendation 3-g

The Institution should move more aggressively to make use of digitization and Internet technology to expand the reach of Smithsonian science and to make Smithsonian collections more available to scientists and the public.

Recommendation 3-h

The publication of book-length monographs, particularly in the social sciences, is a part of the dissemination of the results of scholarly research. If the SI Press decides to limit or even eliminate its traditional program of publishing such monographs, effective alternatives must be identified and funded.

4. WHAT SHOULD BE THE QUALIFICATIONS OF THOSE CHOSEN TO LEAD KEY SCIENTIFIC RESEARCH UNITS OF THE SMITHSONIAN?

a. The Need for Scientific Leadership

The Smithsonian Science Commission concluded that neither the science Units nor the Institution as a whole can maintain their national and international reputation without effective leadership. With the departure of the Under Secretary for Science, Dr. J. Dennis O'Connor, the Commission strongly recommended that this key position always be filled by a scientist with an international reputation and urged that it be filled immediately. This recommendation was *de facto* put into place with the recent appointment of Dr. David Evans as the Under Secretary for Science. The Commission is optimistic that Dr. Evans will provide the necessary overall leadership, restore scientific leadership at the National Museum of Natural History (NMNH) and the Smithsonian Environmental Research Center (SERC), and develop plans for the transition in leadership at the Smithsonian Astrophysical Observatory (SAO), to prepare for the retirement of the current Director in the coming years, while energizing the Institution's scientists and scientific research.

While discussions of scientific leadership often focus on traditional management hierarchy, the Commission believes that a willingness of Smithsonian scientists to assume informal leadership positions in national and international scientific organizations and panels is equally important for Institutional success. Such activities include participation through specialist scientific organizations (at which many SI scientists excel) as well as in broader organizations, National Research Council panels, and other forums (SI science leadership has generally failed to nurture and promote participation in these key arenas). Some SI scientists have achieved great success individually via these forums, but this is no substitute for SI management's active promotion of such involvement. SI scientists must work to increase their broader national and international influence through these venues.

b. Current Status of Scientific Leadership

SAO and the Smithsonian Tropical Research Institute (STRI) have benefited greatly from long-term leadership stability. Both have a focused mission and both enjoy considerable autonomy. Without doubt this increases the attractiveness of leadership positions at these Units. STRI is in the midst of a planned transition to a new Director and there are comparatively few concerns about its scientific leadership. As noted, SAO faces the imminent challenge of the transition to a new Director, and likely a different management style, but the prognosis for future leadership at SAO is good. But, the situation at the other SI science Units is more problematic. With a relatively new Director who has instituted some changes in scientific management, morale problems and tensions persist at the National Zoological Park (NZIP). The current head of SERC is not a scientist and also serves as Associate Director for Research and Collections and Acting Deputy Director at NMNH. Despite his capabilities, this triple commitment short-changes both Units over the long term. SERC needs a full-time Director. Problems with the leadership and direction at SCMRE are discussed in Section 9.e. below.

The most critical problems are at the NMNH, where long-term instability in the Office of the Director has had a bad effect on every aspect of the Museum's work. The frequent turnover of Directors² appears to be at least partly attributable to the failure of previous SI leadership to delegate the degree of authority and responsibility necessary to attract the most highly qualified candidates. Until the current Interim Director was appointed, there was not one scientist at an administrative level above that of Department Chair. There was no voice for science in the inner councils of the Director's Office. The Commission understands the difficulty, but sees the need to bring vigorous scientific direction to NMNH. (This requires not only a vision for the future of science, but also the ability to develop strategies for collections management, the capacity to develop exhibit, educational and outreach strategies, and the skill to raise significant external funding.)

c. *Criteria for Scientific Leaders*

1. Personal criteria

- Only a scientist with an international reputation can provide the requisite internal and external credibility at the top leadership positions. Directors of science Units should also be respected scientists; and,
- A rational, common-sense approach to problem-solving that effectively balances the Smithsonian's responsibilities in science and public education is also obligatory.

2. Leadership criteria

- Demonstrated commitment to excellence, including the fortitude and determination to hold scientists accountable for performance given the relative freedom they enjoy, the support they receive, and the diverse resources (*e.g.*, collections) available to them;
- Ability to identify and articulate clear Institutional vision and goals; and,
- Support for, and understanding of, basic research.

3. Management criteria

- Outstanding communications skills. The ability to listen to, and work with, staff at all levels;
- Awareness of the greater Smithsonian context;
- Experience working in the Washington science policy arena; and,
- Excellent organizational skills and multi-tasking ability.

d. *Selection of Scientific Leaders*

With the exception of internal rotating appointments such as Department Chairs, selection of leaders at all other levels should involve national searches by an appropriate committee of Smithsonian scientists, Smithsonian administration managers and, where appropriate, external representatives.

² Recent NMNH Directors: James Mello (Acting, 1979-1980); Richard Fiske (1980-1985); James Tyler (Acting, 1985); Robert Hoffmann (1985-1988); James Tyler (Acting, 1988-1989); Frank Talbot (1989-1994); Donald Ortner (Acting, 1994-1995); David Pawson (Acting, 1996); Robert Fri (1996-2001); Dennis O'Connor (Acting, 2001-2002); Douglas Erwin (Interim, 2002).

1. Under Secretary for Science

The Under Secretary for Science must be an outstanding scientist of international reputation, unquestioned scholarship, and outstanding management skills.

2. Directors for Scientific Units

Unit Directors must be outstanding scientists. They must develop greater expertise in fund-raising, have an appreciation for scholarship, a curiosity about science, and an understanding of the demands of leading a scientific organization. Candidates should have demonstrated leadership in developing and communicating a vision to the staff and the management skills to ensure effective implementation of this vision. Recruitment of such individuals will require the central SI administration to delegate appropriate authority and support to make these positions attractive.

3. Directors of Research within Units

The primary roles of the Director of Units will be fund-raising and general administrative oversight. These may necessitate the delegation of primary research responsibility to a Director of Research. The Director of Research must be a noted scientist, with management expertise and the ability to articulate the scientific goals for the Unit. The Commission recognizes a variety of possible management models, including, for example, appointment of a Chief Scientist from within the ranks of an organization, which may not be a full-time administrative position. Such a position must, however, be part of the senior executive staff of the Unit.

4. Chairs of Departments

Chairs must be credible and active scientists, chosen whenever possible from within the Unit. Departments usually benefit from long-term stability of Chairs, but senior Unit management may have to provide sufficient administrative support (in the form of GS 12-14 Departmental Administrators or Management Service Officers) to allow the Chair to provide effective leadership while maintaining an active research program. Without strong support from higher-level administrators, including their commitment to excellence and ability to follow through on commitments, chairing a Department will be seen as a thankless task.

e. Findings and Recommendations

Beyond the erosion of funding support, the lack of effective leadership has been the single most important factor in the weakening of Smithsonian science over the last 2 decades. The Institution must adhere to a policy of appointing highly respected scientists at all levels of administration in science Units. In an environment where Directors may have to concentrate on fund-raising, some primary administrators may not be scientists, but they should have an appreciation of science and have as part of their team an Associate Director who is a scientist. Leaders should be able to articulate the need for scientific research at the Institution. Stability in leadership is vitally important. Leaders must be given the autonomy they need to guide the scientific enterprises they serve within a collegial, collaborative, and supportive environment. The importance of science and scientific excellence must be encouraged and recognized as important for the Smithsonian as a whole.

Recommendation 4-a

All searches for scientific leaders above the level of Department Chair should involve an appropriate group of SI scientists and management, with appropriate non-SI involvement. Searches should be nationwide.

Recommendation 4-b

SI science leaders should develop a plan to advance SI scientists in a variety of forums. Senior scientists on Unit Advisory Boards and Councils should mentor and advocate for younger SI scientists. Career development should include expectations of participation and influence within the broader scientific community.

Recommendation 4-c

The intellectual credibility, strength, coherence and vitality of the Institution's exhibits and educational programs depend upon the activities of its scholars. The integral involvement of SI scientists in Institutional outreach programs should therefore be encouraged by both the Secretary and the Under Secretary for Science.

Recommendation 4-d

As a significant component of the SI scientific enterprise, SERC must have a full-time, on-site Director with strong scientific credentials.

5. HOW SHOULD THE PERFORMANCE OF SCIENTIFIC RESEARCH BY INDIVIDUALS AND RESEARCH DEPARTMENTS BE EVALUATED?

As should now be clear, the Smithsonian Institution (SI) must hire and retain excellent people and provide incentives for their performance and their growth. Success should be judged by international standards and, as in major U.S. universities, key positions should be filled by the best scientists in the world, representing the greatest possible diversity, especially under-represented U.S. populations.

a. Performance Evaluation of Individuals

Most SI scientists believe that the Professional Accomplishment and Evaluation Committee (PAEC) process works, and the Commission believes that it is flexible enough to meet the needs of nearly all Units. Still, there is widespread concern about:

- a “disconnect” between federally-mandated annual reviews and PAEC reviews, particularly in regard to materials candidates provide to each;
- a lack of timely communication about review results;
- a lack of consistency within Units; and,
- an absence of assessment criteria.

Not only are annual reviews not precluded from consideration in PAEC reviews, legislation explicitly encourages their inclusion. In addition, metric review instruments are not mandated; each science Unit is free to develop its own means of evaluation. However, the SI administration does have guidelines (dated 1987), and it is apparent that the current administration likes metrics.

Recommendation 5-a

Annual performance reviews should include past performance goals, the reviewee’s self-assessment, the reviewer’s assessment and ‘grading’, and future goals. Goals should be mutually arrived at. Both the reviewee’s self-assessment and that of the reviewer should be independent. Summaries should be provided to the reviewee within a 1-month period. A single individual (Head of Unit or Department) should review all scientists under his/her aegis, to ensure that all assessments are equitable.

Recommendation 5-b

Performance goals and assessments should be written with the expectation that they will be included in PAEC reviews. Review procedures for all staff (e.g., collections managers, and other categories of scientists and staff) should be established and/or clarified.

Recommendation 5-c

Evaluation criteria should be established by a science committee, with guidelines from the administration. Unit and Department Heads should participate in Office of Personnel Management training.

Recommendation 5-d

Methods for PAEC review should be established by each SI Unit, with general ‘consistency with flexibility’ guidelines following the Smithsonian Directive 204, which includes recommendations that:

1. External scientists participate;
2. Review materials should include:
 - a current c.v. and bibliography;
 - recent annual performance evaluations;
 - a statement of achievements in research, teaching, outreach, exhibits, service to professional societies, etc., during the review period;
 - a statement of goals; and,
 - a list of four or more prospective external peer reviewers (the candidate should have input into the review process by identifying experts in his/her area(s) of research; the SI Unit should seek their assessments, but also those of additional peer reviewers for objectivity);
3. Clear criteria for review should be established and agreed-upon; these could include, but not be restricted to:
 - research prominence and productivity;
 - service to the Smithsonian Institution;
 - curatorial activity;
 - professional service;
 - public speaking, outreach and educational activities; and,
 - exhibit development.

Performance maintenance is insufficient for advancement. Leadership in the greater scientific community, especially for senior-level scientists, is expected. A metric system is not required; however, a clear and consistent set of criteria for evaluation must be articulated. The input of outside reviewers should be considered in context;

4. The Chair’s or Director’s review should be thoughtful, cogent, and analytical rather than subjective;
5. A report of the results of PAEC review should be promptly made to the candidate, the Unit and SI administration. It should specify recommendations for salary/grade increases or performance improvement. The administration’s response to the review should be promptly transmitted to the SI Unit, the candidate, and the candidate’s Chair; and,
6. Recommendations for increases or for improvement should be enacted promptly.

Recommendation 5-e

Both annual and PAEC reviews should reward excellent performance. Rewards in addition to salary must be established. These might

include nomination for recognition by professional societies or by the SI (prizes, medals, lectureships, etc.)

b. Performance Evaluation of Research Departments

Recommendation 5-f

Review of Science Units and their programs appears to be *ad hoc* and infrequent. Regular oversight and review of programs and Units must be established. In addition, Visiting Committees should:

- be composed of objective, distinguished scientists and established for each Unit to evaluate programs, provide guidance on venues, and ‘sunset’ programs as appropriate. Committee members should be appointed based upon the advice and recommendations of members of the Unit. Visiting Committees are not the same as external review committees, convened once to do a specific review; also, they are distinctly separate from the Director’s Advisory Boards;
- consist of members with multi-year appointments, whose terms are staggered;
- evaluate the science, and the components that contribute to it - space, facilities, funding, personnel (at a general level), new and old programs, review procedures, etc;
- meet yearly or biennially at the Unit, and do a careful review of the Unit and its programs, offering clear and constructive advice. Recommendations should be provided with measurable, quantitative goals and terms;
- report to the Director of the Unit served; the Director and the Under Secretary for Science should respond to the Committees’ reports and recommendations;
- be structured with guidelines that are sufficiently flexible to include joint committees (*e.g.*, SAO-Harvard), with appropriate lines of reporting; and,
- be linked to boards and similar bodies as appropriate.

6. HOW CAN THE RELATIONSHIP BETWEEN RESEARCH AND PUBLIC PROGRAMMING BE ENHANCED?

a. Introduction

Since its founding, the Smithsonian Institution (SI) has been guided by dual missions: research and education. Throughout its 156-year history, these missions have defined the Institution's unique nature, combining national museum, research center, and university functions. Smithsonian curators and researchers expand the frontiers of science while they educate the public about the nature and history of the universe, the Earth, its peoples, and cultures.

In the early days, the Smithsonian's educational mandate was simpler, amounting to little more than a visual catalogue of physical objects, organisms, and artifacts, as well as publications that disseminated that knowledge. Today, its educational programs explore relationships among environments, plants, animals, and cultures; forces that shape our world, our galaxy, and our universe; and mechanisms that determine the developmental life cycles of insects and microorganisms. Science can help solve problems facing humanity today and those we will face in the future. The Smithsonian is uniquely positioned to educate the public about important issues in an increasingly stressed, changing, and interconnected world.

Despite this need and these capabilities, the Institution is not fulfilling its educational mandate. While research advances, the Smithsonian Astrophysical Observatory (SAO), the Smithsonian Environmental Research Center (SERC), and the Smithsonian Tropical Research Institute (STRI) lack exhibition facilities and the National Museum of Natural History (NMNH) can exhibit only a small percentage of its research. Funds and staff earmarked specifically for education, including exhibitions, educational programs, popular publications, and media, represent only a fraction of the Institution's research budget, and both have declined drastically in the past decade. During the same period, the elimination of senior leadership and educational infrastructure, including the Office of the Assistant Secretary for Education, the Education Outreach Fund, and the interdisciplinary Office of Seminars and Symposia, along with major reductions in the Office of Museum Programs and in fellowship and research funding, has had disastrous effects.

Increasingly decentralized, the Institution's various components have largely failed to solve the perennial shortage of educational resources, limited facilities, poor coordination, and insufficient or under-trained staff. As a result, the Institution and its constituent museums and research facilities are poorly-equipped to fill the role that James Smithson envisioned. Today's education programs are a hodge-podge of miscellaneous offerings. Although some programs are of superior quality, they exist as isolated islands in a sea of unfulfilled opportunity.

In short, the Smithsonian needs to strengthen its education capabilities. This will require a strong central administrative commitment, increased levels of funding, enhanced communication and coordination, greater attention by management to

education goals and performance, greater involvement by curators and researchers, new techniques and technologies, and strengthened outreach to underrepresented U.S. populations in order to have these students brought into the pipeline of training for future scientists.

b. The educational environment

1. Credibility

The Smithsonian boasts large and well-documented collections, extensive archives and libraries, training programs, superb physical facilities (including exhibit halls), and its location in the heart of the nation’s capital. Its greatest assets, however, are its enormous, deeply-rooted public credibility and its extraordinarily gifted staff.

2. Collections-based Research

Collections-based research and field studies greatly increase our ability to understand the world in which we live. Transmission of this knowledge is best done by those who produce it. It is they who make Smithsonian exhibitions and other educational offerings so memorable.

3. Integrating Art, History, and Science

Many of the best Smithsonian programs blend art, history, and science. This capacity to go beyond traditional boundaries is crucial for the kind of humanized science required to solve today’s complex problems and should be embraced and encouraged.

4. Program Diversity

Strength flows from diversity. Many research programs overlap in important ways. For instance, NMNH (collections-based), SERC (coastal ecology), and STRI (tropical ecology) all contribute to an understanding of complex biological systems. While there can be debate about the amount of overlap needed, the Institution’s constellation of resources offers unique opportunities to educate society about natural history and global systems.

5. Program Inventory

Smithsonian science education is produced by centrally-administered and Unit-based programs. Unit programs include:

- NMNH;
- SAO;
- the Smithsonian Center for Materials Research and Education (SCMRE);
- SERC;
- the National Zoological Park (NZIP) and its Conservation and Research Center (CRC);
- the National Air and Space Museum (NASM); and,
- the National Museum of American History’s (NMAH) “Hands On Science” and Lemelson Center.

In addition, there are four major programs located in the Office of the Under Secretary for American Museums and National Programs:

- the SI Office of Education (SIOE);
- the Smithsonian Institution Traveling Exhibition Service (SITES);
- the SI Affiliations Office (SIAO); and,
- the Smithsonian Associates (TSA).

The National Science Resources Center (NSRC), the Smithsonian Internet site, the Office of Exhibits Central, and the Smithsonian Institution Office of Fellowships (SIOF) are also important central operations for science education and outreach.

As in the Institution at large, Unit education programs may be administered by the Unit, Center, Departments, programs, or research offices. One of the surprising findings of this study is that most educational offerings – some 400 in 2001 - are grass-roots rather than centrally- or Unit-administered programs.

c. Findings and Recommendations

1. Central Programs

Despite the Institution’s charter, funding for science education and outreach is small compared to funding for research and collections. This was not always the case. From the 1970s to the early 1990s, the Institution maintained a special outreach fund for Units and facilitated the training of museum professionals. These no longer exist and Unit programs are left to their own resources with drastic consequences.

Recommendation 6-a

The central administration should encourage innovative education development within and across Units and make education a responsibility of the Under Secretaries for Science and American Programs. The proposed Unit scientific advisors detailed to the Under Secretary for Science could coordinate education programs across Units and assist in presenting SI-wide seminars and exhibitions (see Rec. 8-a). SI Fellowships and Scholarly Studies programs should be funded. The central administration must raise funds for cross-Unit education programs.

2. Science Education Management

By favoring special exhibits and creating new museums, the Institution has weakened existing Units. Units tend to emphasize exhibits over education and with funding decreases new programs like Internet development and digital collection access have been curtailed. The Smithsonian magazine and SI Press are not doing enough to publicize Smithsonian research.

Recommendation 6-b

Increase funds (federal) to science Units for exhibition and educational program development and develop a strategic management and fund-raising plan for maximum education impact. Enlist Smithsonian magazine and SI Press support to help get the word out.

3. Staffing Issues

Too many Smithsonian science-education staffers have little specialized training and are poorly paid. Getting the best science-education staff is just as important as getting the best scientific staff.

4. Science and Education Coordination and Visibility

Most Unit science-education programs suffer from lack of coordination among researchers and educational personnel and enterprises, and there is a general lack of inter-Unit collaboration where such cooperation would be mutually beneficial, for instance, in providing SERC, STRI, and SAO with exhibition space on the Mall, or participating in Mall biological exhibit projects. Similar collaboration would be beneficial among SAO, Center for Earth and Planetary Sciences (CEPS), and NMNH in geological and planetary sciences. There also exists a need for more collaboration between science and art and history Units. Lack of coordination and planning among education offices at the science Units has been a major impediment to developing funding for these efforts, resulting in each museum or research Unit pursuing its own goals and projects. There needs to be a closer tie between Smithsonian science and the programs of the NSRC, for example. Interrelations among biodiversity, conservation biology, sustainable development, human dimensions, and global change, in both historical and contemporary contexts, offer possibilities for producing synergy and added value through inter-Unit collaboration. Recent surveys and inventories of pan-Institutional education programs by the SIOE, with assistance from the SI National Board, have begun to pave the way for better inter-Unit collaboration and development efforts.

Recommendation 6-c

Broaden the membership of the pan-Institutional Education Council to include scientists and central administration personnel. Charge this group with strategic planning, fund-raising and development. Charge it with establishing a biannual pan-Institution “Smithsonian Conference” to highlight emerging issues of public interest. Greater use of SITES by STRI, SAO, SERC, and SCMRE would help provide these organizations with needed exhibition venues.

5. Internet Programming

The Institution’s Web presence varies widely and the lack of a cohesive plan diminishes its educational value. Clearly, the Smithsonian could benefit from some degree of central Web planning and coordination, as well as foundation and philanthropic funding.

Recommendation 6-d

An SI-wide Web index and guide could facilitate use of the SI Internet and help plan its further development. Thematic road-maps would better assist students and teachers in identifying educational pathways. Smithsonian collections and exhibitions could become focal points of curricula and Web site development, which could transform Smithsonian science outreach in the coming years.

6. Teacher Training

Many Smithsonian science Units train teachers and deliver subject matter to target audiences. For instance, NSRC and SAO curriculum materials reach thousands of students and school districts across the country, as do the publications *Smithsonian in the Classroom* (SIOE), *AnthroNotes* (NMNH), and products of the Lemelson Center (NMAH). SCMRE publications and videos provide training materials for private collectors, conservators, and museum professionals. More could be done, however, to provide teachers with materials, internships, and in-service training.

Recommendation 6-e

Develop nationally competitive teacher training opportunities in science, following SAO and NSRC models. (Once again, a closer tie to NSRC would improve training opportunities.) Consider implementing a grass-roots national, Internet-based program in natural history field studies, in concert with the GLOBE Project or similar programs.

7. Managing the Emerging Trust Fund Environment

Because financial realities have required many education programs to become dependent on grants and philanthropy, curatorial staff is increasingly reluctant to get involved in unfunded activities. Dependence on trust funds predisposes Units against developing long-term plans and program evaluation.

8. Scientists and Exhibit Developers

The production of high-quality educational programming and exhibits requires involvement of scientists, educators, and designers in every phase of a project. Lack of communication among Education and Exhibition Departments and the scientific staff is a chronic complaint. Striking a balance between the interests of educators and scientists in exhibit production is a difficult process. While educational project development can be stressful, the dynamic tension within the core team between scientists and educators is a vital and necessary aspect of the museum educational process.

Recommendation 6-f

Scientists must be included in the development of all science-education programs and should receive appropriate credit in their professional evaluations.

9. Conclusion: National Leadership in Science Education

The Smithsonian's science mandate demands better science education, though the educational role varies from Unit to Unit.

Should the Institution concentrate on vibrant exhibition programs, or should it focus on producing national curricula and educational materials? How much emphasis should be placed on museum educational theory and technique versus improving delivery of content? Should it shift directions or maintain its current course? These questions are not easy to answer, but answering them could lead to great opportunities.

These issues have been raised repeatedly in the past and have largely been laid aside. The tighter focus advocated in this report - the origin and nature of the universe; the formation and evolution of the Earth and planets; the understanding of life's diversity; and the study of human diversity and culture change - offers realistic targets. Building coherent, state-of-the-art educational programs around these themes would be an appropriate goal for *Science Smithsonian*.

7. WHAT SHOULD BE DONE TO ENHANCE PUBLIC RECOGNITION OF SMITHSONIAN SCIENCE?

There is a need for the Smithsonian Institution (SI) to adopt an overall Science and Research Communications Plan. As the Smithsonian Science and Research Communications Draft Report indicates, “the Smithsonian is not well known as a leader in science and research. This comprehensive plan is to improve awareness and knowledge of science and research at the Smithsonian among the general public, and with specific audiences such as the Congress, State and local officials and major donors, actual and potential. Implementation of a comprehensive plan will ensure that every museum, Unit and program has a chance to tell its story.”

In July 1998, the Office of Public Affairs (OPA) hired a public affairs specialist dedicated to science and research. The Smithsonian Astrophysical Observatory (SAO), the National Museum of Natural History (NMNH), the National Zoological Park (NZIP), the Smithsonian Tropical Research Institute (STRI), and the National Air and Space Museum (NASM) have public affairs officials. The Smithsonian Environmental Research Center (SERC) and the Smithsonian Center for Materials Research and Education (SCMRE) rely on the OPA science and research specialist. Despite her capabilities, she cannot change the perception of SI research by herself. Many researchers have made media contacts or contacted Congressional Committees on their own. In order to create a more integrated system to promote science at the Smithsonian, the Commission recommends the following:

Recommendation 7-a

The Under Secretary for Science and the Director of the OPA should review the Smithsonian Science and Research Communications Plan drafted in 2000, update it, and put it into action.

Recommendation 7-b

An SI-wide council of public affairs specialists and Unit Directors should convene to establish operational protocols to maximize communications about scientific research and practice. OPA will need the full support, cooperation and participation of the Museum and Research Directors and their public information managers and staffs.

Recommendation 7-c

The Smithsonian leadership should create opportunities – through workshops and/or training - for Smithsonian scientists and researchers to interface with the OPA.

Recommendation 7-d

The OPA should be charged with achieving the following:

- work with the Under Secretary for Science to make sure that s/he can play a strong symbolic role for science at the Smithsonian;
- establish and maintain regular channels of communication with Museum and Research Unit staff to identify story ideas and keep abreast of ongoing or future projects;
- meet regularly with the Directors and public relations managers of the NZP, STRI, SERC, SCMRE, NASM, NMNH, and SAO, to review plans and identify projects of potential interest to the media. Develop separate, but coordinated, public relations plans for each Unit;
- write a statement describing the Smithsonian's re-invigoration of science, articulating the Institution's emphasis on scientific coordination, direction and clarity;
- develop ideas for news and feature stories about the science and research activities of the Smithsonian to disseminate to the media via advisories, releases, pitch letters and direct, personal contact. Seek opportunities to showcase interdisciplinary and inter-agency projects; and,
- promote coverage of Smithsonian science and research beyond the Beltway through a concerted effort aimed at media outlets around the country, as well as wire services (Associated Press, United Press International, Reuters, etc.), news services, newspaper chains (Scripps Howard, Knight Ridder, Hearst, etc.), and the Washington bureaus of metropolitan dailies. The subjects of these features will be derived from the behind-the-scenes aspects of the Institution that have broad, general interest, such as the stewardship and conservation of icons of American popular culture, the role of Smithsonian scientists in identifying and dating forensic evidence, and the quest for new discoveries about the universe.

Recommendation 7-e

Conduct behind-the-scenes media tours of the Smithsonian's conservation facilities, including the Museum Support Center, the SCMRE, the Cultural Resources Center, and the Paul E. Garber Preservation, Restoration, and Storage Facility. The May 1999 press preview of the Star-Spangled Banner Conservation laboratory is an excellent model for this type of media event.

Recommendation 7-f

Enlist the Secretary, Under Secretary for Science, museum Directors and other high-level Institution officials to conduct semiannual briefings for science reporters and staffers.

Recommendation 7-g

Continue to dedicate the entire spring issue of “Research Reports” to a single topic. “Research Reports” reaches some 80,000 people including such key audiences as Contributing Members, Members of Congress, and journalists. The annual special editions should be promoted in advance to science writers and editors, through the OPA Newsdesk Web site, targeted press release distribution, and direct contact.

Recommendation 7-h

Offer media training seminars for key scientists, researchers and administrators.

Recommendation 7-i

The Office of Government Relations should be more proactive in advancing Smithsonian Science to Congress. It should:

- host a reception at the SI or on the Hill to celebrate science;
- develop an exhibit or display on the Hill in the Cannon or Russell Rotunda. Plan a briefing along with it. Invite a Member to sponsor it;
- volunteer to have Smithsonian scientists assist key committees and Members on important national scientific issues;
- keep track of AAAS Congressional Scholars, Knauss Grant Fellows, and Congressional Grant Fellows and recruit them to spend time at the Smithsonian. Hold Smithsonian events and involve them;
- invite Congressional Members and staffers to attend decision-makers’ field courses (STRI or SERC could do this). SI would have to raise money for scholarships for some of them to attend;
- organize fieldtrips to SAO, STRI, and SERC. Plan such trips during House and Senate recess;
- help Members to follow science issues to stay in tune with their constituencies (environment, conservation, bio-terrorism, etc.);
- bring Members and staffers from the Hill to SI to talk with scientists about issues of importance to both groups. Build Members and staffers into SI programs;
- bring relevance and a “just-in-time” context to the people in Congress. Encourage them to think of the Smithsonian as a resource place - the “go-to” place for scientific inquiry and research within Smithsonian expertise;
- develop a briefing book on Smithsonian science for Members on Capitol Hill; and,
- create brochures to explain science projects to non-scientists. Provide updates on issues. Regularly circulate brochures and inserts on the Hill.

8. HOW SHOULD SCIENTIFIC RESEARCH BE ORGANIZED TO OPTIMIZE THE USE OF THE INSTITUTION’S HUMAN, PHYSICAL, AND FINANCIAL RESOURCES?

a. Analysis of the Present Structure

Earlier analyses of Smithsonian science organization are presented below with this Commission’s findings:

- Lack of a coherent strategic plan for Smithsonian science activities.
Finding 1: There is no strategic plan for Smithsonian science, and planning at the Unit level is minimal;
- Inconsistencies in performance evaluation and staffing actions among Units.
Finding 2: There are widely varying policies for evaluation of staff scientists, and for demoting/removing poor performers;
- A disconnect between scientists and Institutional planning efforts.
Finding 3: Scientists play little role in formulating Institutional policy and tend not to be well represented even at the Unit level;
- Lack of visibility of Smithsonian science to the Secretary, Congress and the public.
Finding 4: Smithsonian science is largely invisible to Congress and the public and has been inadequately communicated to the Secretary;
- Potential redundancy or inefficiencies in operation of many small Units.
Finding 5: There is little evidence that Units are carrying out unnecessary, inefficient, or redundant work; and,
- Potential failure to exploit opportunities for “multi-disciplinary” collaboration.
Finding 6: While clear opportunities for greater cooperative work exist within the SI science efforts, assessment of Smithsonian scientists must also include their external (non-SI) collaborations.

These findings reflect weakness in strategic planning, communications, and personnel policy development. These weaknesses exist from “grass-roots” levels - the various research Units – to senior management, including the Office of the Under Secretary for Science.

b. Guiding Principles for Evaluating Structure

The Commission used the following criteria to evaluate potential restructuring of Smithsonian science:

- Science must inform Smithsonian public programs. To separate them would be counter to the stated mission of the Institution;
- The authority of the Museum or Unit Directors over their Units must be maintained;
- Administrative barriers between scientists and the Under Secretary for Science should be reduced;
- Interactions among Units separated by large geographic distances cannot be forced;
- Scientists should play a major role in developing a science vision for the Institution; and,

- Better communication of the accomplishments and activities of Smithsonian science to the central administration, Congress, and the public is required.

c. *Reorganization Plan*

There appears little need for change in the structure of the major Smithsonian Science Units. Combining or reorganizing Units would not solve problems and could delay progress. There is, however, a need for greater openness and transparency in the development of research priorities and budgets, encouragement of cooperative investigations, and better communication of research results to the Secretary, Congress, and the public. To this end, the Commission recommends:

- modifying the Office of the Under Secretary for Science to use Special Scientific Advisors, Smithsonian scientists detailed on a rotating basis from Units;
- adding administrative and management-level staff positions to the Under Secretary's office;
- that scientists become more engaged with strategic planning, collections management and preservation issues;
- that the Under Secretary establish a group to take an Institution-wide view of scientific collections, collections management, and conservation of collections;
- that periodic review of programs be improved, including establishment of a Visiting Committee structure; and,
- that Directors of science Units be scientists, with specific responsibility for no more than one Unit.

Reorganization need not be sweeping. Minimal changes in structure, effective implementation of existing policies and lines of authority, and visionary leadership of key Units can suffice. A modest restructuring with an emphasis on planning, communications, and performance assessment is recommended, along with a strong planning and advisory staff within the Office of the Under Secretary for Science and more active engagement of SI scientists in strategic planning and management of science.

Recommendation 8-a

The Under Secretary for Science should set SI science strategy. Three advisory staff scientists should be appointed on a rotating basis (e.g., 2-year terms) from the major disciplines. These Special Scientific Advisors would help the Under Secretary assess scientific progress and identify scientific highlights at the Units, encourage collaboration across Units, and prepare material for the Under Secretary, Secretary, or Congress as requested. They would organize seminars and meetings, coordinate educational and outreach efforts among the Units, act as liaison to the Congress of Scholars or other advisory groups, provide guidance on sources of science content for exhibit planning, and provide advice and information to the Under Secretary. These Advisors should receive a modest stipend in addition to their SI salary (and additional research support from the Institution) for serving in these positions. These positions should be considered prestigious and only the most respected members of the SI science

community should fill them. The National Aeronautics and Space Administration's management of research programs for space science - "discipline scientists" are drawn from the communities they serve - makes a good model. This structure would greatly increase the role of Smithsonian scientists in central administrative operations while avoiding the creation of a new (and expensive) management tier.

Recommendation 8-b

The Under Secretary for Science should retain the two existing high-level staff positions, Scientific Programs and Budget. These two Executive Officer positions require additional administrative staff assistance. There may also be a need for greater coordination of public programs, education, collections, and preservation across various Units. While the Special Scientific Advisors may fill these roles, the Commission supports the addition of new Executive Officer positions if deemed necessary by the Under Secretary.

Recommendation 8-c

The Under Secretary should solicit plans and performance descriptions from science Unit heads and from these forms annual goals, defends requests to the SI administration and Congress, and benchmarks accomplishments. Science staff across the Institution should have input in this process and in strategic planning. Scientists and scientific curators of the Council of Scholars should form a subcommittee within the Council to bring important issues before the SI administration and facilitate dialogs on policy, budget, and organizational issues affecting SI science.

Recommendation 8-d

The Under Secretary should establish a broad-based group, led by a Special Scientific Advisor, to take an Institution-wide view of scientific collections, collections management, and collections conservation. Appropriate SI art and cultural museum experts should participate. Greater collaboration among Units is needed to develop effective means of dealing with Institution-wide problems of management and collections preservation.

d. Revitalization of Smithsonian Science

The health of any institution depends on an appropriate mix of well-established and entry-level scientists. To maintain such a mix, the Smithsonian administration should examine its policy on enhanced retirement incentives as a budgetary strategy, given the points raised in this section. The average age of federally supported scientists at some Units is high, largely because many senior Smithsonian scientists do not retire until they are in their 70s. The Institution has very few federal scientists under the age of 40. While senior-level scientists provide valuable and valued perspectives, entry-level

scientists can infuse an institution with fresh, creative ideas, energy, enthusiasm, and greater familiarity with new technologies.

The high number of late-career Smithsonian scientists is also costly. Late-career scientists tend to have much higher salaries than those just starting out. In some cases, two entry-level scientists could be hired for the cost of retaining a single senior-level position. Many scientists say they are postponing retirement because they believe with some justification that their position will be eliminated. Over the last 10 years, NMNH alone has lost 30 federal scientist positions (23%). The replacement of a significant number of late-career scientists by lower-level counterparts would free up substantial funds and invigorate the Institution. Table 1 illustrates the potential annual savings.

Table 1: Savings and cost of replacement of salaries of scientists eligible to retire. Numbers reflect a 12% benefit rate for retiring scientists and a 30% benefit rate for replacements.

Unit	Amount saved if all eligible retired ³ (\$)	# of Federal staff scientists	Number eligible to retire	Cost of replacement at GS 13 (\$)	Yearly Savings (\$)
NASM	0	5	0	0	0
NMNH	3,177,506	101	24	2,066,345	1,111,161
NZP	0	22	0	0	0
SAO	2,314,290	67	16	1,403,392	910,898
SCMRE	113,419	11	1	86,097	27,322
SERC	113,419	13	1	86,097	27,322
STRI	0	26	0	0	0
TOTAL	5,605,215	234	41	3,555,834	2,076,703

e. Plan to Revitalize Smithsonian Science

The Commission sees the following plan as the cornerstone of a revitalized Smithsonian science. It assumes that the Smithsonian science budget suffers no further erosion. Future appropriations requests should ask to put any savings toward scientific programs and to fund positions lost over the last decade.

Recommendation 8-e

The Institution must irrevocably commit to replacing all retiring scientists, regardless of age, with GS 13 entry-level researchers in the same science Unit within 2 years. Savings from retirements should remain within science directorates.

Recommendation 8-f

Retirement, within federal regulations, should be incentivized. It provides the most productive and risk-free means of turnover within the Institution.

³ Eligibility to retire is a function of age and years of service

Recommendation 8-g

Demotion in rank and salary should be considered for unproductive scientists of all levels within the Smithsonian. Mediocrity should not be rewarded; the consequences of poor performance should be clearly spelled out. Distribution of Scholarly Studies funds, fellowships and other internal resources should be based solely on merit. Firm personnel actions will increase morale and clarify expectations for all.

If successfully implemented, this plan will result in a revitalization of Smithsonian science by infusing it with new blood and additional funds. It will help rebuild Departments. It may also have unforeseen benefits. For instance, an infusion of new workers may increase overall grant funding and overhead income. With their different priorities, new researchers are likely to change the directions of some programs. Revitalization will allow the Smithsonian, particularly the NMNH, to continue as one of the premier scientific institutions in the nation.

**9. WHAT SUGGESTIONS, OF ANY TYPE, MIGHT THE SCIENCE COMMISSION
HAVE THAT STRENGTHEN RESEARCH AT THE SMITHSONIAN?**

a. *Smithsonian Astrophysical Observatory (SAO)*

1. Introduction

Located on the Harvard campus in Cambridge, Massachusetts, and in far-flung research stations in Arizona, Hawaii, and the South Pole, the SAO has built a remarkable record of scientific achievement over a very broad range of astrophysical topics. Current programs range from studies of atoms to studies of planets and stars, including our own Sun, to the truly grand scale of galaxies, galaxy clustering and the universe as a whole. Methods of investigation include observational techniques using radio, infrared, optical, ultraviolet, X-ray, and gamma-ray astronomy.

2. Strengths

- a. SAO's close association with the Harvard College Observatory, doing business as the Harvard-Smithsonian Center for Astrophysics (CfA), has been beneficial to the development of both entities. A joint Visiting Committee reports regularly to the Dean of the Harvard Faculty of Arts and Sciences and to the Under Secretary for Science at the Smithsonian Institution (SI);
- b. The 19-year leadership of Irwin Shapiro has helped the SAO thrive;
- c. SAO enjoys a remarkable volume of outside support and an extraordinary ratio of outside funding (\$73 million in FY 2002) to federal dollars from the SI budget (\$28 million in FY 2002);
- d. The CfA staff includes 12 members of the National Academy of Sciences and a Nobel Prize winner. A second Nobel Prize, in Physics, was awarded in 2002 to Riccardo Giacconi, in part for work carried out during his years on the SAO staff; and,
- e. Major scientific initiatives: The Submillimeter Array in Hawaii, the MMT 6.5-meter telescope in Arizona, and the CHANDRA X-ray Observatory are all coming to fruition at the same time. These provide SAO astronomers with powerful state-of-the art instruments for research.

3. Areas of Concern

- a. The Harvard-Smithsonian relationship is not without its tensions, some of which concern joint appointments;
- b. Director Shapiro is now 73, and the SAO needs to plan for a smooth transition to a new Director;
- c. While successfully obtaining external funding as a key source of SAO support, such funding cannot replace the federal core appropriation of the SAO. As at other SI science Units, a lack of funding has led to an era of austerity and obsolescence at SAO, particularly those in areas that rely on federal support;
- d. The federal staff is aging, appointments have been few, and new fields, such as the study of planets around distant stars, are ripe for exploration. The SAO needs to renew its staff and development of a stronger theoretical division; and,

- e. Today's state-of-the-art instruments will soon be obsolete. SAO must find a way to participate in the next round of telescope building.

4. Recommendations

Recommendation 9-a1

The long-range planning process now underway at the CfA needs to be carried through, with an emphasis on the resources required to maintain current areas of expertise, and the impact of initiating new programs. In addition, SAO should address and implement, where possible, the recommendations in the 2001 Visiting Committee report. The Institution's Major Scientific Instrumentation and Research Equipment pools, upon which many of SAO's previous successes have been based, should be maintained as an open, competitive resource within the SI science enterprise.

Recommendation 9-a2

Harvard University and the Smithsonian should begin to plan for Irwin Shapiro's departure.

Recommendation 9-a3

SAO should pursue opportunities to present its achievements at the National Air and Space Museum and through the Smithsonian traveling Exhibition Service (SITES).

b. Smithsonian Tropical Research Institute (STRI)

1. Introduction

Most of the Earth's biological diversity as well as most of its people are located in the tropics, and the interests of the two are in increasing conflict - with unknown implications for the future health of global ecosystems and the quality of human life. As one of the world's great research institutes, and the premier center for tropical biological research worldwide, STRI is ideally poised to contribute to our basic understanding and potential resolution of these vital questions. STRI is a strong institution that needs to grow even stronger. The basic structure is excellent, but there are also areas that should be strengthened. STRI is particularly strong in tropical forest science, and support for this program should be continued, including an interest in soil biology. Some areas of global leadership have suffered due to departing staff and by the strains on resources caused by the need for massive administrative reorganization during the year 2000 transition in the Republic of Panama. In addition, STRI needs to interact more with the National Museum of Natural History (NMNH) and the Smithsonian Environmental Research Center (SERC) science programs.

2. Strengths

STRI was reviewed in detail in October 2000 by an external committee. The Commission has not tried to replicate the excellent document resulting from that review, which found:

- a. an outstanding community of well-supported resident scientific staff who are free to pursue fundamental questions;
- b. strong review of scientific performance and standards for publication;
- c. a management style that identifies important and appropriate areas of research and strives to establish and maintain them;
- d. superb geographic location as the bridge between two continents and the barrier between two oceans;
- e. strong commitment to long-term research;
- f. vigorous support of visiting scientists and students from around the world; and,
- g. development of new and rigorous training programs through ties with major universities.

All of these strengths combine to produce a vibrant research community with a strong sense of identity and belonging. STRI has also succeeded in building and maintaining a generally excellent set of buildings and other facilities to support its various research activities.

3. Areas of Concern

a. Research Priorities and Areas of Focus

STRI is unsurpassed in broad areas of tropical forest science, especially plant and insect ecology, life histories, and behavior. These basic activities, as well as the internationally renowned Center for Tropical Forest Science and outstanding innovations such as forest canopy cranes, have resulted in a vigorous and successful research community. Other areas that need to be better addressed with due consideration for potential collaboration with NMNH and SERC are:

1. ***Marine Ecology:*** The maintenance of excellence of marine research at STRI requires the appointment of staff scientists to replace vacancies of departing or retiring staff. The closure in 1998 of the San Blas marine station, which was the base for much of STRI's important contributions to marine science, dictated the development of new facilities. Development of the Bocas del Toro Field Station has been protracted, but an April 2003 opening is anticipated. Excellent work has continued in evolutionary biology, biogeography, behavior, life histories and development of marine organisms, as well as environmental monitoring. However, marine ecology should be developed at a level comparable to forest ecology. This opportunity is of particular concern for coral reefs - the most diverse communities in the oceans and a source of fundamental concern due to anthropogenic stress worldwide. Closer integration of facilities and programs of the Smithsonian Marine Science Network will increase the efficiency and services rendered by the marine stations and research vessels (see Section 9.h.)
2. ***Paleobiology and Archeology:*** The Center for Tropical Paleoecology and Archeology (CTPA) was established about 10 years ago to increase understanding of past tropical environments, plant and animal communities, and peoples, and to provide a better framework for recent ecological and

evolutionary studies. The CTPA enjoyed outstanding success in marine paleoecology (Panama Paleontology Project), the long-term dynamics of tropical forest climates and plant communities based on pollen records, Panamanian archeology, and origins of tropical agriculture. Archeological research is still vigorous and successful. STRI needs to re-evaluate its role in paleoecological research.

3. ***Biodiversity and Conservation:*** STRI has recently begun to develop goals in biodiversity and conservation that increasingly impinge on all aspects of basic ecological research. This includes the addition of research on the effects of fragmentation and deforestation on tropical forests, as well as restoration thereof. This is an area of potentially fruitful collaboration with NMNH and SERC.

b. Research Support

The Commission cannot overemphasize that stable federal support for science is what allowed STRI to grow and prosper as the premier tropical biological research institution in the world. Long-term research needs to be protected from the fads and fancies of research funding. Nevertheless, internal funding for core scientific programs should undergo regular formal review and be awarded through internal competition. (This funding should leverage additional outside research support.) STRI scientists have successfully obtained support from the Smithsonian Scholarly Studies program, but have not been so successful in obtaining access to National Science Foundation support. However, the reduction in Scholarly Studies funding has impacted STRI research. (STRI has obtained considerable private foundation support, particularly in tropical forest science and plant ecology, to offset diminished federal funding.)

c. Communication

STRI science's profile is increasingly rising in the broader science community, as seen by 21 papers published in *SCIENCE* and *NATURE* in 2001. But, there is too little communication among STRI, NZP, NMNH and SERC scientists. STRI needs to make an even greater effort to increase its visibility to a level commensurate with its exceptional accomplishments in research. This should include a greater presence on the Mall, in the media, and in outreach programs beyond the Republic of Panama.

d. Administrative Infrastructure

Administrative staff strength has not kept pace with the phenomenal growth in scientific staff and facilities in the 1980s and 1990s. The level of support provided by the Office of Scientific Support Services needs to be re-examined as part of the current administrative reorganization plan at STRI.

4. Recommendations

The basic structure and functioning of STRI should not be changed. STRI should address research weaknesses and become more fully integrated into the Smithsonian scientific community.

Recommendation 9-b1

STRI should continue as an autonomous research Unit reporting directly to the Under Secretary for Science. Its major scientific programs should remain intact.

Recommendation 9-b2

STRI should develop a comprehensive science plan within 1 year to address the current balance of all scientific activities, including attention to the decline in strength in marine ecology, the future of paleoecology, and policy and goals for biodiversity and conservation activities.

Recommendation 9-b3

STRI should review its ability to provide state-of-the-art scientific support to resident staff, including the extension of electronic communication to all of its widespread facilities, renewal of laboratory equipment, field support at all of its facilities, and the re-organization and role of the Office of the Assistant Director for Scientific Support Services.

Recommendation 9-b4

STRI should strengthen its communications and outreach efforts, and increase its presence in the central administration and on the Mall, perhaps including rotating residence of appropriate staff scientists in Washington on a 1-year cycle and collaborating with NMNH, the National Zoological Park (NZIP) and the National Museum of American History (NMAH) on exhibits and public outreach.

c. Smithsonian Environmental Research Center (SERC)

The Environmental Research Center supports a group of cohesive and interactive research scientists sharing a common goal to be the premier institution in the nation in the area of integrative and landscape ecology of the coastal zone, focusing on terrestrial as well as marine ecosystems. Past accomplishments have laid the groundwork for potential growth at SERC in microbial ecology, invasive species biology, global change, human/biological interactions, food web structure, modeling, and remote sensing. SERC scientists and educators have been successful in obtaining external competitive grants/contracts (including substantial NSF funding), developing philanthropic support, strengthening partnerships with collaborators, and in reassessing priorities in response to decreasing federal funding,. Educational outreach activities at the site are vigorous and successful. Leadership and management issues demand the attention of a full-time Director at SERC, who should continue to report directly to the Under Secretary for Science.

SERC would also benefit from pan-institutional collaboration and inter-unit cooperation. Currently few mechanisms exist within the Smithsonian to encourage pan-

institutional, integrative, and collaborative research. Such programs would generate more multidisciplinary research and more competitive proposals to external funding sources. For example, SERC, along with NMNH and STRI, is actively promoting the formation of the Smithsonian Marine Science Network among the five permanent field research facilities. The Network will be an excellent way to build on Smithsonian synergies.

Recommendation 9-c1

SERC should have a full-time Director (see Section 4).

Recommendation 9-c2

The pay scale for SERC research scientists and technical staff is considerably lower than scientists and technicians with similar records at other Smithsonian units. Funding should be sought to bring the salaries of SERC scientists and technical staff to equity with other Smithsonian units.

Recommendation 9-c3

SERC's laboratory and office facilities are inadequate, with more than half of the offices and many of the laboratories in trailers and temporary buildings. Six of SERC's 14 laboratories lack any federal staff support. Facilities are also inadequate for students and visiting researchers. New funding should be sought to maintain and improve SERC facilities. New facilities would allow for growth of grant-funded scientific positions.

Recommendation 9-c4

The leadership of SERC and the Undersecretary for Science should promote greater collaboration between Smithsonian marine science programs.

d. National Museum of Natural History (NMNH)

1. Introduction

The Museum of Natural History is one of the world's great museums of natural and cultural history. The importance of the Museum's science and educational missions in the 21st century cannot be overstated, given the rapidity of global change and the worldwide biodiversity crisis. The NMNH is ideally positioned to assume a global leadership role in research and education about the natural world and the relationship of humans to it. However, to do so, the Museum must restructure and reinvent itself.

NMNH employs the largest number of scientists of any institution in the world devoted to natural and cultural history through collections- and field-based research. The Museum's incomparable collections, comprising over 124 million biological, geological, archaeological, and ethnological specimens, are among the world's most extensive and valuable. Nearly a century of research on these collections has contributed greatly to the global knowledge of the geological, biological, and cultural history of Earth.

Despite these strengths and its past performance, the NMNH has not maintained the national and international scientific recognition and leadership that one would expect given the Museum's substantial resources. The Museum's budget and curatorial strength have been steadily eroding for several decades. Although there are a variety of contributing causes for this state of affairs, the Science Commission finds the main ones to be a chronic lack of both funding and consistent, long-term scientific leadership to guide, foster, and demand excellence and societal relevance in science, exhibits, and outreach. These causes are linked - the Museum can maintain adequate funding only by maintaining scientific excellence. The Museum has also failed to develop a direction. These failures have led to an erosion of staff morale, a lack of coherence of programs, turf battles, strategically poor hiring decisions (including administrative positions), lowered productivity, uneven standards for evaluating performance, and a bunker mentality of entitlement in the face of shrinking budgets.

These findings go back more than a decade. After reviewing several outside reports, in January 2000, the Integrating Committee, co-chaired by Drs. May Berenbaum and Jack Gibbons, recommended improving the NMNH's scientific leadership as the highest priority. The Integrating Committee also recommended establishing an internal science advisory board to frame a science plan for the Museum. The Integrating Committee also made specific recommendations for increasing external funding, improving science administration policy and personnel procedures, and addressing long-standing infrastructure and space issues (see Appendix H). In response to the Integrating Committee's recommendation, an NMNH Science Council was created to formulate a mission statement and a vision for future basic science directions of the Museum.

The October 2000 NMNH Science Council report (see Appendix I) is the most comprehensive statement of the Museum's research interests and directions to date (see Appendix C). The Science Council identified the NMNH's research strengths in three broad areas: (1) Earth and Planetary Sciences, (2) Evolution, Diversity, and Dynamics of Life, and (3) Human Dimensions of Diversity and Change. This led to a mission statement *to increase understanding of geological, biological and cultural patterns and processes that shape our world from the beginning of the solar system into the future.*

The Science Commission concurs with many of the findings of the Integrating Committee and respects the considerable effort of the Science Council to identify the NMNH's strengths and future directions in basic research. Still, many of the problems identified by the Integrating Committee remain unresolved. Moreover, the research agenda outlined by the Science Council report was overly broad, inclusive to a fault, and did not adequately define research priorities at the whole Museum level in the face of budget constraints.

A lack of leadership and insufficient funding are only the most visible manifestations of deeper Museum dysfunction. There are problems with the Museum's conception of itself, with its organizational complexity and lack of coherence, with its relationships with external science institutions, and with its public appeal through exhibits and educational outreach. There are also significant constraints on the NMNH imposed by

the Museum's budget and physical plant. Finally, there are significant managerial challenges in revitalizing the Museum.

2. Findings and Recommendations

- **Finding 1:** There is a clear need for improved scientific leadership to address questions of identity and direction, not only within the universe of natural history museums, but also within the larger universe of science and science education in general.

Recommendation 9-d1

The NMNH must have a distinguished scientist as Director who, in consultation with the scientific staff and outside experts, will chart and champion a new, more focused mission for the Museum. The next Director must develop a clear, integrated vision that will re-energize Museum science, increase public benefits, expand partnerships and collaborations with other institutions, and drive a long-term development campaign.

- **Finding 2:** The science mission of the NMNH is too diffuse, too poorly articulated and insufficiently prioritized to guide any successful revitalization of the Museum. Revitalizing the Museum will require a clearer, more focused research mission and will demand difficult decisions about focus and priorities. But, revitalization can produce tangible results that will strengthen the case for increased federal and private funding.

Recommendation 9-d2

The NMNH must articulate a vision that better focuses and integrates its three major research themes (see Appendix I). Each Department in the Museum must participate in the development of this vision and must identify how its research, exhibits, and outreach programs can best support it. To encourage the interdisciplinary research at which the Museum should excel, the Director should reward it.

- **Finding 3:** The collections are an essential, defining feature of the Museum. They are the unique and irreplaceable samples of cultural, biological, and geological diversity upon which the Museum's research is based. However, support for the collections has been steadily declining, threatening the future of these irreplaceable resources as well as their research and educational value. It is important that many of the collections continue to grow, and that new kinds of collections be considered, even though this further exacerbates problems of storage and maintenance. Answering fundamental scientific questions requires having actual specimens in hand. Exhaustive collections also make possible new research to answer new questions. For example, 40 years ago few scientists would have predicted that Smithsonian collections would prove to be invaluable sources of DNA for a great variety of purposes.

Recommendation 9-d3

- **The Museum must maintain and increase support for its collections. There is also a need for a more efficient use of its space, including compactorization where possible. The Museum must aggressively pursue collections-related science.**
- **The Museum should reassert its position as an international leader in bioinformatics. In order to meet the rapidly growing needs for collections-based information, especially about global biodiversity, the NMNH should be a world leader in the integration of information into databases so structured that they provide the information users need. Only by doing this can the Institution function as a repository and provider of information about the fields of knowledge that it seeks to support.**
- **Finding 4:** The NMNH educates and engages the public through exhibits on the Mall, off-Mall traveling exhibits, and the Internet. At present, however, the exhibits are not adequately integrated with the Museum's scientific research. Many of the exhibits are not up-to-date, well organized, or well connected to the science done in the Museum. Major efforts to revitalize the exhibits and outreach should be accelerated.

Recommendation 9-d4

The Museum should strengthen the connection of its science to exhibits. This will build greater public interest in, and awareness of, science and help build financial support of the Museum. Scientists must be directly involved in the design and implementation of exhibits, and programs should be integrated with Museum development efforts.

- **Finding 5:** In spite of excellence in many areas of education, the declining support for grants, fellowships and Scholarly Studies has severely damaged the education and training of young scholars. Smithsonian scientists identify the loss of these funds as the most urgent problem they face. The importance of graduate and post-doctoral trainees to the vitality of Museum science cannot be overstated. A potentially large contribution by the collections to education and training is not currently realized.

Recommendation 9-d5 (also see recommendation 3-b)

The Museum should also explore options for an expanded educational role for collections by rethinking how they can be made more accessible, especially through Internet access. The goal should be to put the tools of Museum scientists into the hands of the public to answer questions about geological, biological, and cultural diversity.

- **Finding 6:** Three of the four Departments in the Museum work satisfactorily (Anthropology, Mineral Sciences, and Paleobiology). Systematic Biology, a

recent creation of the merger of Botany, Invertebrate Zoology, Vertebrate Zoology and Entomology, is not functioning smoothly. Creation of this Department has not resulted in economies of scale, the number of administrative layers has multiplied, and there is little interaction among the research subgroups. The sheer size of the Department may be problematic, but the problems run deeper and reflect different cultures among scientists. Facilities and equipment are also an additional ‘structural’ problem for the Museum (see recommendation 3-f.)

Recommendation 9-d6

The Director of NMNH is urged to address the dysfunction of the current structure of the Department of Systematic Biology. Possible actions would include further restructuring into smaller, more homogeneous and cohesive Departments, or improving and strengthening the current structure. Mechanisms should also be put in place to promote interactions among administrative departments.

- **Finding 7:** With some exceptions, the Museum lacks a culture of excellence. Failure to promote excellence has resulted in a loss of morale, a number of strategically poor hiring decisions, failure to attract or retain the best scientists, failure to seize new research opportunities, failure to rejuvenate Departments with new appointments, and increasing insularity and declining national and international prominence.

Recommendation 9-d7

The Museum must link its Professional Accomplishment and Evaluation Committee (PAEC) review process with annual reviews, and a consistent pursuit of excellence should involve rewards for outstanding service, research, and outreach activities (see Sec. 5). The Director should explore pay-for-performance options that encourage those who exhibit high achievement, as well as recognition of these achievements through nominations for internal and external awards. Future Museum hires at all levels should be made within the context of a strategic plan. All positions vacated by retirements or resignations should revert to the NMNH Director - given a static budget, the ability to reassign positions is an important source of fiscal flexibility. A number of endowed curatorships should be funded and senior hires made to establish nuclei for growth in research excellence. Mechanisms to remove poor performers and incentives to promote retirement should be put in place, and replacement efforts need to focus on reinvigorating the Museum through appointments of excellent young scientists. Joint appointments with universities should be encouraged, as they are less costly, foster greater collaboration with university science, and create a conduit for students and fellows.

- **Finding 8:** The Center for Earth and Planetary Sciences (CEPS) at NASM and the Department of Mineral Sciences at NMNH share broadly similar interests in the evolution of the Earth and solar system and already have a strong collaborative relationship. Increasing the integration between these two groups would provide focus for their activities, and provide a foundation for increased support.

Recommendation 9-d8

The Under Secretaries for Science and American Museums and National Programs should work with the Directors and scientists in CEPS and Mineral Sciences to provide productive scientific oversight of their joint activities and coordinate their hiring and evaluations. The Commission sees no need for the physical integration of the two groups into a single location. The current configuration maximizes the presentation of science to the public.

- **Finding 9:** The placement of the molecular laboratories and their scientific staff at distant locations from NMNH (*i.e.*, MSC and NZP) has led to negative consequences. There has been insufficient interaction between scientists knowledgeable about molecular methods and curators who need to apply these methods to their research. Students and postdoctoral fellows of more traditional scientists in NMNH have had difficulties in developing and applying these methods. NMNH is falling behind other natural history museums in part because too few curators use these modern tools in their research programs. The molecular labs and their core scientists need to be physically adjacent to encourage collaboration among all NMNH scientists, and to gain a mutual understanding of the diverse methods of systematic biology and to create the kind of synergistic environment needed to gain national prominence in systematic and evolutionary biology.
- **Recommendation 9-d9**
The NMNH Director should make funding for the centralization at NMNH of the Laboratory for Analytical Biology, including molecular laboratories and core facilities (SEM, DNA sequencing, and isotope analysis) a high priority. All molecular lab staff from NZP and MSC should be relocated to NMNH. The Commission endorses the Museum's plan to provide general access to modular laboratory space, facilities, baseline funds, and human resources for major projects that use molecular methods, on the basis of need, current funding and merit. Similarly, consideration should be given to providing limited funds to facilitate collaborative and pilot ventures on the part of traditional NMNH scientists who want to apply molecular tools to their research.

e. Smithsonian Center for Materials Research and Education (SCMRE)

1. Introduction

The Smithsonian has a responsibility to collect, study, and interpret the national collections and to protect and conserve them for the future. Lacking this capability in its individual museum conservation programs (which today employ over 30 conservators), the Smithsonian created the Conservation Analytical Laboratory (CAL) in 1963. In 1996, CAL's mission was broadened to include education, and its name was changed to Smithsonian Center for Materials Research and Education (SCMRE). Today, the professional staff of 24 (down from 36 a few years ago) hold degrees in archaeology, conservation and preservation science, materials science, metallurgy, botany, chemistry, biochemistry, and other fields. Such diversity enables SCMRE to assemble research teams to tackle complex multi-disciplinary problems in many areas of materials science, conservation, and preservation.

The Center for Material Research and Education's last program review in 1995 gave its research programs good marks but pointed out a number of problems: a need for more collaboration with SI museums; for more attention to care and preservation of natural history specimens and modern materials; and, for an expanded national training program. Staff dissension and management issues also needed attention, and a regular system of program review and staff evaluation was lacking. The Science Commission found that many of the problems noted in the 1995 review still exist today.

2. Findings and Recommendations

- **Finding 1:** In addition to its primary mission of supporting Smithsonian collections and providing scientific knowledge concerning these materials, SCMRE has an important role as a national and international laboratory for the study and care of museum objects. SCMRE has been very effective in serving this need, and its work is held in high esteem by the national and international conservation, materials science, and archaeological communities for innovative research, development of new conservation techniques, and research on preservation and museum-storage techniques. No other laboratory or group in the United States has such broad interdisciplinary capability in this area or has accomplished more for the care of a wide variety of museum objects and materials (outside the field of fine arts conservation). The loss of this unique Smithsonian contribution to the national conservation effort would have a very negative impact on the preservation of the nation's heritage, and on the Smithsonian itself as the leading institution holding America's national heritage.

Recommendation 9-e1

SCMRE's principal mission should be to provide museum conservators, curators, and administrators with technical information and advice that enhance conservation, preservation, and knowledge of Smithsonian collections. Collaborative research with curators on these kinds of collections-based projects should be a primary activity. SCMRE should also continue to provide national leadership in

analytical conservation and preservation studies in areas where it has unique capabilities, while still recognizing its primary role in support of Smithsonian collections.

- **Finding 2:** SCMRE recently began to explore the serious problem of conservation and preservation of natural history collections. The NMNH collection holds some 124 million specimens, many of which were collected more than 100 years ago. Only the anthropological portion of this collection is currently receiving professional conservation and preservation care. The NMNH preservation problem is a microcosm of natural history collection neglect world-wide. In addition to addressing Smithsonian problems, creation of a natural history conservation and preservation research program in SCMRE would serve as a national resource to aid other museums in providing care for their endangered collections.

Recommendation 9-e2

SCMRE should intensify its research on conservation and preservation of natural history collections and disseminate its results to the wider museum community.

- **Finding 3:** SCMRE has developed a broad series of training and outreach programs, including internships, fellowships, traveling exhibits, workshops, Web- and media-based courses, and literature providing conservation and preservation information to various sectors of the public. Some of these programs consume large amounts of researchers' time and interfere with the Unit's primary research mission.

Recommendation 9-e3

Education programs mandated by Congress should be continued as a secondary function of the SCMRE research mission. SCMRE's off-site and non-SI education commitment should be reduced to a more manageable size, allowing research staff to concentrate primarily on research and service functions. More efficient methods should be explored for delivery of educational programs through use of contractors and remote delivery systems using the Web and video programming, funded, where possible, by user fees, grants, and collaboration with outside educational groups. Exhibitions should be done collaboratively with Mall museums and with SITES.

- **Finding 4:** SCMRE has been operating largely as an independent research institute without sufficient collaboration and interaction with Smithsonian museums and their curators and collections. While SCMRE has continued to conduct analyses and projects with Smithsonian museum staff, this collaboration has been much reduced in recent years and has not been of central concern to SCMRE management.

Recommendation 9-e4

SCMRE should re-focus its activities on the original CAL mission, providing research in support of Smithsonian collections and their long-term care and providing analytical data and information needed by the Units to understand and interpret the significance of Smithsonian collections. SCMRE should work closely with the Smithsonian Conservation Council and museum curatorial and conservation programs, as well as central administration, to help identify institutional needs and match SCMRE's capabilities with Smithsonian museums and collections. Because most of SCMRE's museum clients report to American Museums and National Programs rather than to Science, there needs to be close cooperation at the Under Secretary level to maximize benefits to all Smithsonian collections.

- **Finding 5:** The Commission believes that SCMRE's archaeological programs are of high quality and serve as national resources for collaborative study of archaeological materials. SCMRE staff provides SI and non-SI researchers with access to a variety of analytical services including neutron-activation analysis of archaeological materials at the National Institute of Standards and Technology reactor, just as SCMRE's analytical facilities and staff expertise provide resources for internal and external archaeologists. But, the Commission concludes that SCMRE's archeological programs operate largely independently from SCMRE's conservation and preservation mission. They compete with, and distract from, this mission and should be managed as part of a Unit with a larger anthropological research focus.

Recommendation 9-e5

Management of archaeometry programs should be transferred to the NMNH, where archaeological research is a major activity of the Department of Anthropology.

- **Finding 6:** SCMRE staff demonstrates a high degree of professional skill and commitment to the Institution. However, SCMRE and Smithsonian staff decry the Unit's isolation from the museums and the lack of central administration interest in its programs. This sense of isolation has been compounded by morale problems, significant staff departures, factionalism, internal dissension, complaints about management, leadership and poor communication with central administration.

Recommendation 9-e6

SCMRE requires reorganization and the appointment of a new management team, improving communication with the central administration and the museums, re-building staff, re-balancing the research and education missions, replacing out-of-date instrumentation and equipment, instituting new procedures and

performance targets for staff and Unit evaluation, and developing a fund-raising and development capability.

- **Finding 7:** SCMRE is a major Smithsonian Unit with a budget of \$3.5 million, a large professional staff, and a complex mission that includes national responsibilities for conservation and preservation research. Despite this, SCMRE has been operating for many years without periodic advice or structured review.

Recommendation 9-e7

SCMRE needs regular reviews by a Visiting Committee of prominent leaders in the fields of museum conservation, preservation, and materials research, charged with reviewing scientific output, response to Smithsonian needs, and relations with the broader professional community. Committee membership should be largely external but should include representatives from Smithsonian museums.

f. National Zoological Park (NZN) and Center for Research and Conservation (CRC)

1. Introduction

The Commission strongly endorses the NZN Director's goals to focus on conservation of a limited number of animal species, and to aspire to be the foremost zoo in the world in the area of endangered species diversity, physical facilities, veterinary medicine, reproductive biology, and visitation. This focus would bring the visitor closer to the animals, create a sense of the natural habitat of each species and show science and research in action. Current examples are a "Think Tank" that features orangutans, and the popular Panda Exhibit. This focus can also serve to unite the staff in the Department of Animal Programs and the CRC around a common goal. Such a focus on habitat protection provides an immediate and clear link to other SI conservation biology efforts. In particular, the Science Commission advocates a focus on the challenges of preserving biodiversity in human-dominated ecosystems and the adaptations of animals to such habitats. Much existing Zoo research is already related to these issues, but lacks focus.

The CRC is a unique program currently composed of two departments: Conservation Biology and Reproductive Sciences, plus additional staff for facilities upkeep. It is important to note the difference between the programmatic Center and the physical Front Royal facility. The Front Royal facility of the CRC sits on 3,200 acres of land and has 20 miles of jeep trails, 30 miles of fencing and nearly 100 buildings. Before the Commission was established, closure of the Front Royal facility was proposed in the interest of saving money and the Zoo Director has advanced a strategic and integrative vision for the Zoo that focuses on conservation-oriented research. The Science Commission finds that while some of the scientific activities at the Front Royal facility are of high-caliber and important to the mission of the NZN, others are not keeping pace with realistic SI expectations. Further, the Commission finds that the facility as a whole has been under-performing. This finding substantially agrees with the findings of previous reviews. The Commission does not, however, suggest immediate closure of the facility because we find that it may have the potential for substantial contribution to SI

and national science goals. Nevertheless, such closure may ultimately be necessary, as discussed below.

2. Findings and Recommendations

- **Finding 1:** The Commission agrees with the recommendation of the Secretary and the Director of NZP that the Zoo must set priorities, focus on areas of excellence, and de-emphasize non-focal areas. Shrinking resources and deteriorating exhibits dictate that business as usual is not an option. Specifically, the Commission supports keeping the CRC-Front Royal facility under the NZP Director, who has full responsibility for CRC staff and the Front Royal facility.
- **Finding 2:** Science has not been successfully integrated into the public exhibit area at NZP. The reasons for this include lack of dedicated staff and the absence of any ongoing evaluation of these kinds of exhibits. Staff excitement about developing a stronger exhibit development program is encouraging.

Recommendation 9-f1

The Science Gallery in Amazonia does an excellent job of bringing science into its exhibit and also does an impressive job of showcasing links to other SI science Units. This should be used as a model for future integrative exhibits at NZP.

- **Finding 3:** The current organization of the scientific and professional staff at the NZP and CRC-Front Royal facility does not optimize use of the staff. One major challenge in bringing the staff of the NZP together across programs is to combine the conservation and science activities to produce greater impact on the public experience.

Recommendation 9-f2

- a. Consistent with recommendations below regarding the CRC-Front Royal facility, the scientific and professional staff, and associated support staff, should be combined into a single directorate encompassing conservation, research and training;**
- b. Support for this directorate would involve continuation of current federal support, but the Commission strongly supports the expansion of current efforts to attract external funding for research, education and training and other programs;**
- c. The Director of the NZP should form a task force to begin to plan both short-term and long-term strategies to unite the currently disparate staffs around a common vision, mission, goals and projects;**
- d. The Reproductive Biology groups (at both Front Royal and Rock Creek) should be developed as a unique national resource. Few, if any other zoos in the world, have the capability to study reproductive aspects of so many different species, yet detailed**

knowledge of such issues is critical to the success of species conservation plans. The joint reproductive biology group should be developed and showcased as a national conservation resource. Every effort should be made to generate political and financial support, both public and private; and,

- e. Several programs at Front Royal and Rock Creek are currently engaged in science/policy interactions, and have expressed a desire to develop these interests further. The NZP senior staff will have to determine the extent to which these should be expanded, consistent with Unit goals and priorities. A working group should be established to develop a more effective policy. This group should involve experts from other government agencies involved in resource economics or land use (*e.g.*, Department of Interior), as well as non-governmental organizations.
- **Finding 4:** The evaluation of scientific staff is not perceived to value applied research and service, interdisciplinary or cross-departmental work, and collaboration in general. For example, some staff noted specifically that conservation biology and associated training and research do not receive the same recognition as basic research.

Recommendation 9-f3

As part of the review of the evaluation process discussed in Section 5, review performance evaluation standards to ensure that applied research, collaborative work and training are incorporated and appropriately weighted based on the particular position descriptions.

- **Finding 5:** Both NZP and CRC-Front Royal rely heavily on Friends of the National Zoo (FONZ) to handle development, to raise money for research and conservation activities, and to oversee other activities. Our review suggests that donors are not receiving a clear message about the new integrative vision for the Zoo.

Recommendation 9-f4

A working group of development staff, scientists, and other staff under the direction of the NZP Director should craft a common vision and mission statement to articulate to donors and other external constituencies.

- **Finding 6:** The Front Royal facility requires significant resources to maintain, and at present is not utilized to its full potential.

Recommendation 9-f5

Maintain core support for NZP scientific staff (salaries and benefits, basic all-other support) presently assigned to the Front Royal facility, while eliminating federal funding for operational staff and facilities

maintenance over a 5-year period. The Commission recognizes the potential to create a National Conservation Resource Center with the active collaboration of outside organizations. Recognizing the time required for an orderly shutdown of the facility, the Under Secretary for Science and the NZP Director should be provided with a 2-year opportunity to seek such support. If sufficient external funding is not forthcoming, the facility should be returned to the General Services Administration at the end of the 5-year period. Full-time equivalent (FTE) positions and support ‘saved’ by the phased reductions in federal support at Front Royal should be applied to avoid base reductions at NZP, or to increase operations there. The NZP Director and the Under Secretary for Science should also educate legislators and the general public about how this new direction can reinvigorate the Zoo and the research programs of the CRC.

- **Finding 7:** NZP needs to more effectively communicate its message to external constituencies.

Recommendation 9-f6

NZP must evaluate its effectiveness in delivering its central message to the public. It must learn how to better influence public views. It must also learn from the leaders in its profession, both nationally and internationally.

- **Finding 8:** NZP has great potential for collaboration with both SI and non-SI Units.

Recommendation 9-f7

- a. NZP must expand its networks to address common problems. For example, it should join forces with the Department of Systematic Biology at NMNH and other natural history museums in bioinformatics, to exchange information, and perhaps to craft a national or international message on the role of zoos and museums in world conservation of endangered species. In addition, they should take the opportunity to tap into the network of conservation organizations such as The Nature Conservancy, the World Wildlife Fund, Conservation International and the Audubon Society and elements of the environmental education movement in this country and worldwide;**
- b. NZP should build conservation and sustainable capacity into their respective organizations. They can conserve energy, recycle, and generally convey best conservation practices;**
- c. Participate in *in-situ* conservation programs. In addition to working to conserve the giant panda at the National Zoo by creating or duplicating the natural environment at the Zoo or at Front Royal (*ex-situ*); play a leadership role in educating people**

who live in those natural environments with the animals, how to protect that environment, so the species does not become endangered;

- d. **Develop a public information campaign and public education program around the shift that the Zoo is making as an environmental resource and conservation center. Promote “the public good” that this shift will have on the City, the region, the nation and the world. Also, promote ways in which the Zoo will be working with other Units of the Smithsonian and with external partners. NZP leadership must train scientists and exhibitors to be official spokespersons for this new direction as well; and,**
- e. **Modern zoos, with the Wildlife Conservation Society in New York as the best model, are increasingly devoted to preserving habitat and studying animals where they exist in the wild. Certainly, the National Zoo has had some activities of this kind, but NZP deals mainly with captive-bred animals. NZP needs to examine the role of overseas research and conservation programs, increasingly a feature of the overall portfolios of modern zoos, determine what role it should play in this arena, and seek the funds to implement it. Collaboration with STRI in this regard seems obvious.**

g. Center for Earth and Planetary Studies (CEPS)

1. Introduction

CEPS, at the National Air and Space Museum, has three major responsibilities:

- a. Original scientific research into the nature of planetary surfaces, primarily within the focus areas of planetary volcanism and Mars evolution;
- b. Curation of two museum galleries, a large-format digital theatre, the NASM moon rocks, and a National Aeronautics and Space Administration (NASA) Regional Planetary Image Facility; and,
- c. Development of innovative outreach and educational programs related to planetary exploration.

CEPS staff comprises six geologists and geophysicists, a geographer, three post-doctoral fellows, a science programs manager, physical science technicians, and administrative/fund management specialists. The Center also hosts high-school and undergraduate interns on a rotating basis. Personnel evaluations for permanent staff are performed through a rigorous, scheduled PAEC process involving all the NASM curatorial departments, the Department of Mineral Sciences (DMS) staff at NMNH, and external specialists. The Chair of CEPS is a rotating 4-5 year position.

CEPS plays a significant role in the public outreach mission of the NASM, providing scientific expertise and curatorial management for the Looking at Earth and Exploring the Planets galleries. There is thus considerable advantage to the Institution in retaining the two venues for Earth and planetary sciences (NASM and NMNH).

A key aspect of CEPS scientific and public programs is its considerable support from external sources. On average, the Center raises more than one-half its total operating budget through competitive external funding (NASA grants, corporate donations) - approximately \$160,000/yr for each federal scientist. Smithsonian endowments, such as the Becker and Lindbergh funds, provide additional support for research and post-doctoral fellowships.

CEPS research activities have been re-focused over the past 5 years to emphasize depth in the core strengths of planetary volcanism and Mars research, while de-emphasizing remote sensing of terrestrial climate change and human impacts on the environment. These changes were reflected in recent staff scientist and post-doctoral hiring decisions, and in the development of new funding proposals for research and space mission participation. The benefits of this new emphasis are clear, with an increase in group funding, press coverage, a major article in *Science*, and the selection of two staff members for the NASA Mars 2003 and 2005 mission science teams.

2. Recommendation:

Recommendation 9-g

- a. Retain the physical location of CEPS within NASM;**
- b. Continue to improve CEPS-DMS communication in hiring, evaluation, and fund-raising; and,**
- c. As new planetary mission roles develop, support these initiatives through office space rental and improved financial management systems.**

h. Pan-Institutional Research Programs

1. Introduction

The Smithsonian Institution must encourage, promote, and support pan-Institutional programs to foster integration and collaboration among research scientists from different Units. Such programs would generate more multidisciplinary studies and more competitive proposals to external funding sources. These integrative programs provide the ideal framework to support new national scientific initiatives, where success hinges on a multidisciplinary approach. They also provide the support system for measuring patterns of change across latitudinal gradients. Possible new areas of focus include systematics, developmental biology, biogeography, evolution, ecology, climatology, geochemistry, anthropology, and modeling of various ecological systems.

The Smithsonian Marine Science Network (MSN) is an example of a pan-Institutional program. The MSN is an integrated consortium of the five permanent SI field research facilities, each engaged in marine sciences and capitalizing on its unique geographical position: SERC on Chesapeake Bay; NMNH through the Smithsonian Marine Station on the Indian River Lagoon in Florida and the Smithsonian Marine Laboratory at Carrie Bow Cay on the Meso-American Barrier Reef in Belize; and STRI's Marine Laboratories at Bocas del Toro and Naos on the Panamanian Isthmus. The MSN

focuses on major environmental, ecological, and evolutionary questions in the coastal zone, and provides SI research scientists and their collaborators with an organizational structure, facilities, and a mechanism to conduct research and intensive monitoring along the western Atlantic. By virtue of the facilities within the MSN, the Smithsonian is the leading biodiversity center for invertebrates in the Caribbean and western Atlantic. Despite its success and productivity, SI does not currently fund this program. Like other pan-Institutional initiatives at SI, funding is cobbled together by the entrepreneurial spirit of its research scientists. This situation is admirable, but it is not stable or sustainable.

Other pan-Institutional initiatives generated by SI research scientists include the Invasive Species Program, the Migratory Bird Program, the Molecular Analytical Laboratory, and the Conservation Council. The NMNH Arctic Studies Center (ASC) is a different type of pan-Institutional science and education program operating across Smithsonian Units, forming an important link between science and humanities branches of the Smithsonian. SERC has expressed similar interest in developing collaborative programs with ASC/NMNH in Alaska. Other NMNH science programs, like Mexico Norte, operate as Smithsonian Affiliations programs across the Smithsonian's science and humanities boundary.

2. Recommendation:

Recommendation 9-h

- a. SI must support and provide funding for its pan-Institutional programs to foster integrative research collaborations and stimulate multidisciplinary studies among its research scientists;**
- b. SI must develop organizational and administrative support to promote integrative and interdisciplinary programs;**
- c. SI must provide stable and consistent base funding to support the infrastructure for pan-Institutional programs and research scientists who utilize cross-linked field and laboratory facilities for comparative and synthetic studies;**
- d. SI must also develop funding mechanisms, such as competitive grants and peer-review panels that promote excellence in research and multidisciplinary studies, foster participation by SI scientists, and fund visitation to the array of the Institution's facilities; and,**
- e. Each member of a pan-Institutional program, such as the MSN, must develop opportunities for research scientists from other SI Units to use its facilities.**

10. PRIORITIZED SUMMARY OF RECOMMENDATIONS

Recommendations are sequentially numbered according to the section of the report in which they are presented. The Commission has divided the recommendations into two classes: those that have no major financial implications for the Smithsonian, and those that will require either new federal allocations, new trust funds, or internal reallocation of funds. Those recommendations with no substantial financial implication are divided into two groups: a smaller, highest priority group for immediate attention, and a larger, priority group. The recommendations with financial implications have been divided into three priority groups: highest priority, high priority, and priority. Within these various priority groups, recommendations are listed in the numerical order they appear within the document.

a. Recommendations WITHOUT Substantial Financial Implications - Highest Priority

Recommendation 3-a

The Commission fully endorses the NAS and NAPA report recommendation that SI scientists be allowed to compete directly for federal funding. We recommend that the Smithsonian administration actively pursue all means to implement this recommendation.

Recommendation 4-a

All searches for scientific leaders above the level of Department Chair should involve an appropriate group of SI scientists and management, with appropriate non-SI involvement. Searches should be nationwide.

Recommendation 4-c

The intellectual credibility, strength, coherence and vitality of the Institution's exhibits and educational programs depend upon the activities of its scholars. The integral involvement of SI scientists in Institutional outreach programs should therefore be encouraged by both the Secretary and the Under Secretary for Science.

Recommendation 8-c

The Under Secretary should solicit plans and performance descriptions from science Unit heads and from these forms annual goals, defends requests to the SI administration and Congress, and benchmarks accomplishments. Science staff across the Institution should have input in this process and in strategic planning. The Commission recommends that scientists and scientific curators of the Council of Scholars form a subcommittee within the Council to bring important issues before the SI administration and facilitate dialogs on policy, budget, and organizational issues affecting SI science.

Recommendation 8-d

The Under Secretary should establish a broad-based group, led by a Special Scientific Advisor, to take an Institution-wide view of scientific collections, collections management, and collections conservation. Appropriate SI art and cultural museum experts should participate. Greater collaboration among Units is needed to develop effective means of dealing with Institution-wide problems of management and collections preservation.

Recommendation 9-d1

The NMNH must have a distinguished scientist as Director who, in consultation with the scientific staff and outside experts, will chart and champion a new, more focused mission for the Museum. The next Director must develop a clear, integrated vision for the scientific research, exhibits, and outreach enterprise of the Museum that will re-energize Museum science, increase public benefits from the Museum, expand partnerships and collaborations with other institutions, and drive a successful long-term development campaign for the science and public programs.

Recommendation 9-d2

The NMNH must articulate a vision that better focuses and integrates its three major research themes (see Appendix I). Each Department in the Museum must participate in the development of this vision and must identify how its research, exhibits, and outreach programs can best support it. To encourage the interdisciplinary research at which the Museum should excel, the Director should reward it.

Recommendation 9-d6

The Director of NMNH is urged to address the dysfunction of the current structure of Department of Systematic Biology. Possible actions would include further restructuring of Systematic Biology into smaller, more homogeneous and cohesive Departments, or improving and strengthening the current structure. Mechanisms should also be put in place to promote interactions among administrative departments.

Recommendation 9-e1

SCMRE's principal mission should be to provide museum conservators, curators, and administrators with technical information and advice that enhances conservation, preservation, and knowledge of Smithsonian collections. Collaborative research with curators on these kinds of collections-based projects should be a primary activity. SCMRE should also continue to provide national leadership in analytical conservation and preservation studies in areas where it has unique capabilities, while still recognizing its primary role in support of Smithsonian collections.

Recommendation 11

The Board of Regents should establish a 3-year benchmark period for this report. By July 2003, the Under Secretary for Science should create a plan for carrying out the Commission's recommendations, including explicit metrics for success and a timetable for completion. This plan will be implemented through the Scientific Directors Council, comprised of the heads of each major science Unit. The Under Secretary will also assemble a distinguished Visiting Committee to review the Institution's progress, on a yearly basis, in a brief report to the Smithsonian Regents (in December 2003, 2004, and 2005).

b. Recommendations WITH Substantial Financial Implications - Highest Priority

Recommendation 3-b

The Fellowships and Scholarly Studies Programs must be reinstated as soon as possible. The cannibalization of these funds for other Smithsonian programs has

greatly weakened the science enterprise. Pre-doctoral and post-doctoral fellowships infuse the Institution with new, energetic scientists and provide a means of training the next generation. Scholarly Studies funds (distributed competitively based on research merit) must provide seed money for the development of external proposals and to provide incentives and support for the best and brightest Smithsonian scientists. Once re-established, funds within this program must not be redirected out of the science Unit.

Recommendation 3-c

Mandated salary increments have for too long been funded by scavenging positions, to the detriment of SI science excellence and staff morale. Steps must be taken immediately to obtain full funding for annual salary increments, including within-grade increases and promotions, in the Smithsonian budget.

Recommendation 3-d

Development efforts for SI science in the private sector and among foundations should be significantly increased in the face of growing federal budget constraints.

Recommendation 3-g

The Institution should move more aggressively to make use of digitization and Internet technology to expand the reach of Smithsonian science and to make Smithsonian collections more available to scientists and the public.

Recommendation 5-f

Review of Science Units and their programs appears to be *ad hoc* and infrequent. Regular oversight and review of programs and Units must be established. In addition, Visiting Committees should:

- be composed of objective, distinguished scientists and established for each Unit to evaluate programs, provide guidance on venues, and ‘sunset’ programs as appropriate. Committee members should be appointed based upon the advice and recommendations of members of the Unit. Visiting Committees are not the same as external review committees, convened once to do a specific review; also, they are distinctly separate from the Director’s Advisory Boards;
- consist of members with multi-year appointments, whose terms are staggered;
- evaluate the science, and the components that contribute to it - space, facilities, funding, personnel (at a general level), new and old programs, review procedures, etc;
- meet yearly or biennially at the Unit, and do a careful review of the Unit and its programs, offering clear and constructive advice. Recommendations should be provided with measurable, quantitative goals and terms;
- report to the Director of the Unit served; the Director and the Under Secretary for Science should respond to the Committees’ reports and recommendations;
- be structured with guidelines that are sufficiently flexible to include joint committees (*e.g.*, SAO-Harvard), with appropriate lines of reporting; and,
- be linked to boards and similar bodies as appropriate.

Recommendation 8-a

The Under Secretary for Science should set SI science strategy. The Commission recommends that 3 advisory staff scientists be appointed on a rotating basis (*e.g.*,

2-year terms) from the major disciplines. These Special Scientific Advisors would help the Under Secretary assess scientific progress and identify scientific highlights at the Units, encourage collaboration across Units, and prepare material for the Under Secretary, Secretary, or Congress as requested. They would organize seminars and meetings, coordinate educational and outreach efforts among the Units, act as liaison to the Congress of Scholars or other advisory groups, provide guidance on sources of science content for exhibit planning, and provide advice and information to the Under Secretary. These Advisors should receive a modest stipend in addition to their SI salary (and additional research support from the Institution) for serving in these positions. These positions should be considered prestigious and only the most respected members of the SI science community should fill them. NASA's management of research programs for space science - "Discipline Scientists" are drawn from the communities they serve - makes a good model. This structure would greatly increase the role of Smithsonian scientists in central administrative operations while avoiding the creation of a new (and expensive) management tier.

Recommendation 8-e

The Institution must irrevocably commit to replace all retiring scientists, regardless of age, with GS 13 entry-level researchers in the same science Unit within 2 years. Savings from retirements should remain within science directorates.

Recommendation 8-f

Retirement, within federal regulations, should be incentivized. It provides the most productive and risk-free means of turnover within the Institution.

Recommendation 8-g

Demotion in rank and salary should be considered for unproductive scientists of all levels within the Smithsonian. Mediocrity should not be rewarded; the consequences of poor performance should be clearly spelled out. Distribution of Scholarly Studies funds, fellowships and other internal resources should be based solely on merit. Firm personnel actions will increase morale and clarify expectations for all.

Recommendation 9-c2

The pay scale for SERC research scientists and technical staff is considerably lower than scientists and technicians with similar records at other Smithsonian units. Funding should be sought to bring the salaries of SERC scientists and technical staff to equity with other Smithsonian units.

Recommendation 9-e6

SCMRE requires reorganization and appointment of a new management team, improving communication with the central administration and the museums, re-building staff, re-balancing the research and education missions, replacing out-of-date instrumentation and equipment, instituting new procedures and performance targets for staff and Unit evaluation, and developing a fund-raising and development capability.

Recommendation 9-f5

The Commission recommends maintaining core support for NZP scientific staff (salaries and benefits, basic all-other support) presently assigned to the Front

Royal facility, while eliminating federal funding for operational staff and facilities maintenance over a 5-year period. The Commission recognizes the potential to create a National Conservation Resource Center with the active collaboration of outside organizations. Recognizing the time required as part of the budget process for an orderly shutdown of the facility, we therefore recommend that the Under Secretary for Science and the NZP Director be provided with a 2-year opportunity to seek such support. If sufficient external funding is not forthcoming, the facility should be returned to the General Services Administration at the end of the 5-year period. FTE's and support 'saved' by the phased reductions in federal support at Front Royal should be applied to avoid base reductions at NZP, or to increase operations there. The NZP Director and the Under Secretary for Science should also educate legislators and the general public about how this new direction can reinvigorate the Zoo and the research programs of the CRC.

c. Recommendations WITH Substantial Financial Implications – High Priority

Recommendation 3-e

Greater support for Library resources, including access to the Web of Science and other Internet search engines, and support for journals and book purchases, is essential to maintain the quality of research at the Smithsonian.

Recommendation 4-b

SI science leaders should develop a plan to advance SI scientists in a variety of forums. Senior scientists on Unit Advisory Boards and Councils should mentor and advocate for younger SI scientists. Career development should include expectations of participation and influence within the broader scientific community.

Recommendation 6-a

The central administration should encourage innovative education development within and across Units and make education a responsibility of the Under Secretaries for Science and American Programs. The proposed Unit scientist advisors detailed to the Under Secretary for Science could coordinate education programs across Units and assist in presenting SI-wide seminars and exhibitions. SI fellowship programs and Scholarly Studies should be funded. The central administration must raise funds for cross-Unit education programs.

Recommendation 6-b

Increase funds (federal) to science Units for exhibition and educational program development and develop a strategic management and fund-raising plan for maximum education impact. Enlist Smithsonian magazine and SI Press support to help get the word out.

Recommendation 6-c

Broaden the membership of the pan-Institutional Education Council to include scientists and central administration personnel. Charge this group with strategic planning, fund-raising and development. Charge it with establishing a biannual pan-Institution "Smithsonian Conference" to highlight emerging issues of public interest. Greater use of SITES exhibition services by STRI, SAO, SERC, and SCMRE would help provide these organizations with needed exhibition venues.

Recommendation 8-b

The Under Secretary for Science should retain the two existing high-level staff positions, Scientific Programs and Budget. These two Executive Officer positions require additional administrative staff assistance. There may also be a need for greater coordination of public programs, education, collections and preservation across various Units. While the Special Scientific Advisors may fill these roles, the Commission supports the addition of new Executive Officer positions if deemed necessary by the Under Secretary.

Recommendations 9-c1 and 4-d

SERC should have a full-time Director (see Section 4).

Recommendation 9-c3

SERC's laboratory and office facilities are inadequate, with more than half of the offices and many of the laboratories in trailers and temporary buildings. Six of SERC's 14 laboratories lack any federal staff support. Facilities are also inadequate for students and visiting researchers. New funding should be sought to maintain and improve SERC facilities. New facilities would allow for growth of grant-funded scientific positions.

Recommendation 9-d3

- The Museum must maintain and increase support for its collections. There is also a need for a more efficient use of its space, including compactorization where possible. The Museum must aggressively pursue collections-related science.
- The Museum should reassert its position as an international leader in bioinformatics. In order to meet the rapidly growing needs for collections-based information, especially about global biodiversity, the NMNH should be a world leader in the integration of information into databases so structured that they provide the information users need. Only by doing this can the Institution function as a repository and provider of information about the fields of knowledge that it seeks to support.

Recommendation 9-d5

The Museum should also explore options for an expanded educational role for the collections by rethinking how they can be made more accessible, especially through Internet access. The goal should be to put the tools of Museum scientists into the hands of the public for answering their practical questions about geological, biological, and cultural diversity.

Recommendation 9-d7

The Museum must link its PAEC review process with the annual reviews, and a consistent pursuit of excellence should involve rewards for outstanding service, research, and outreach activities (see Sec. 6). The Director should explore pay-for-performance options that encourage those who exhibit high achievement, as well as recognition of these achievements through nominations for internal and external awards. Future Museum hires at all levels should be made within the context of a strategic plan. All positions vacated by retirements or resignations should revert to the NMNH Director - given a static budget, the ability to reassign positions is an important source of fiscal flexibility. A number of endowed curatorships should be funded and senior hires made to establish nuclei for growth

in research excellence. Mechanisms to remove poor performers and incentives to promote retirement should be put in place and replacement efforts need to focus on reinvigorating the Museum through appointments of excellent young scientists. Joint appointments with universities should be encouraged, as they are less costly, foster greater collaboration with university science, and create a conduit for students and fellows.

Recommendation 9-f7

- a. NZP must expand its networks to address common problems. For example, it should join forces with the Systematic Biology department at NMNH and other natural history museums in bioinformatics, to exchange information, and perhaps to craft a national or international message on the role of zoos and museums in world conservation of endangered species. In addition, it should take the opportunity to tap into the network of conservation organizations such as the Nature Conservancy, the World Wildlife Fund, Conservation International and the Audubon Society, and elements of the environmental education movement in this country and worldwide.
- b. NZP should model conservation and sustainable capacity building in the way they run their respective organizations. It can conserve energy, recycle, and generally convey best conservation practices.
- c. NZP should participate in *in-situ* conservation programs. In addition to working to conserve the giant panda at the National Zoo by creating or duplicating the natural environment at the Zoo or at CRC (*ex-situ*), play a leadership role in educating people on who live in those natural environments with the animals on how to protect that environment so the species does not become endangered.
- d. Develop a public information campaign and public education program around the shift that the Zoo is making as an environmental resource and conservation center. Promote “the public good” that this shift will have on the City, the region, the nation and the world. Also, promote ways in which the Zoo will be working with other Units of the Smithsonian and with external partners. NZP leadership must train scientists and exhibitors to be official spokespersons for this new direction as well; and,
- e. Modern zoos, with the Wildlife Conservation Society in New York as the best model, are increasingly devoted to preserving habitat and studying animals where they exist in the wild. Certainly the National Zoo has had some activities of this kind, but mainly dealing with captive-bred animals. NZP needs to examine the role of overseas research and conservation programs, increasingly a feature of the overall portfolios of modern zoos, determine what role it should play in this arena, and seek the funds to implement it. Collaboration with STRI in this regard seems obvious.

Recommendation 9-h

- a. SI must support and provide funding for its pan-Institutional programs to foster integrative research collaborations and stimulate multidisciplinary studies among its research scientists;
- b. SI must develop organizational and administrative support to promote integrative and interdisciplinary programs;

- c. SI must provide stable and consistent base funding to support the infrastructure for pan-Institutional programs and research scientists who utilize cross-linked field and laboratory facilities for comparative and synthetic studies;
- d. SI must also develop funding mechanisms, such as competitive grants and peer-review panels that promote excellence in research and multidisciplinary studies, foster participation by SI scientists, and fund visitation to the array of the Institution's facilities; and,
- e. Each member of a pan-Institutional program, such as the MSN, must develop opportunities for research scientists from other SI Units to use its facilities.

d. Recommendations WITHOUT Substantial Financial Implications - Priority

Recommendation 5-a

Annual performance reviews should include past performance goals, the reviewee's self-assessment, the reviewer's assessment and 'grading', and future goals. Goals should be mutually arrived at. Both the reviewee's self-assessment and that of the reviewer should be independent. Summaries should be provided to the reviewee within a 1-month period. A single individual (Head of Unit, Center, or Department) should review all scientists under his/her aegis, to ensure that all assessments are equitable.

Recommendation 5-b

Performance goals and assessments should be written with the expectation that they will be included in PAEC reviews. Review procedures for all staff (*e.g.*, collections managers, and other categories of scientists and staff) should be established and/or clarified.

Recommendation 5-c

Evaluation criteria should be established by a science committee, with guidelines from the administration. Unit and Department Heads should participate in Office of Personnel Management (OPM) training.

Recommendation 5-d

Methods for PAEC review should be established by each SI Unit, with general 'consistency with flexibility' guidelines following the Smithsonian Directive 204, which includes recommendations that:

1. External scientists participate;
2. Review materials should include:
 - a current c.v. and bibliography;
 - recent annual performance evaluations;
 - a statement of achievements in research, teaching, outreach, exhibits, service to professional societies, etc., during the review period;
 - a statement of goals; and,
 - a list of four or more prospective external peer reviewers (the candidate should have input into the review process by identifying experts in his/her area(s) of research; the SI Unit should seek the assessments, but also those of additional peer reviewers for objectivity);
3. Clear criteria for review should be established and agreed-upon; these should include, but not be restricted to:

- research prominence and productivity;
- service to the Smithsonian Institution;
- curatorial activity;
- professional service;
- public speaking, outreach and educational activities; and,
- exhibit development.

Performance maintenance is insufficient for advancement. Leadership in the greater scientific community, especially for senior-level scientists, is expected. A metric system is not required; however, a clear and consistent set of criteria for evaluation must be articulated. The input of outside reviewers should be considered in context;

4. The Chair's or Director's review should be thoughtful, cogent, and analytical rather than subjective;
5. A report of the results of PAEC review should be promptly made to the candidate, the Unit and SI administration. It should specify recommendations for salary/grade increases or performance improvement. The administration's response to the review should be promptly transmitted to the SI Unit, the candidate, and the candidate's Chair; and,
6. Recommendations for increases or for improvement should be enacted promptly.

Recommendation 7-a

The Under Secretary for Science and the Director of the Office of Public Affairs (OPA) should review the Smithsonian Science and Research Communications Plan drafted in 2000, update it, and put it into action.

Recommendation 7-b

A SI-wide council of public affairs specialists and Unit Directors should convene to establish operational protocols to maximize communications about scientific research and practice. OPA will need the full support, cooperation and participation of the Museum and Research Directors and their public information managers and staffs.

Recommendation 7-c

The Smithsonian leadership should create opportunities – through workshops and/or training - for Smithsonian scientists and researchers to interface with the Office of Public Affairs.

Recommendation 7-d

The Office of Public Affairs should be charged with achieving the following:

- work with the Under Secretary for Science to make sure that s/he can play a strong symbolic role for science at the Smithsonian;
- establish and maintain regular channels of communication with Museum and Research Unit staff to identify story ideas and keep abreast of ongoing or future projects;
- meet regularly with the Directors and public relations managers of NZP, STRI, SERC, NMNH, SCMRE, NASM, and SAO, to review plans and identify projects of potential interest to the media. Develop separate, but coordinated, public relations plans for each Unit;

- write a statement describing the Smithsonian’s re-invigoration of science, articulating the Institution’s emphasis on scientific coordination, direction and clarity;
- develop ideas for news and feature stories about the science and research activities of the Smithsonian to disseminate to the media via advisories, releases, pitch letters and direct, personal contact. Seek opportunities to showcase interdisciplinary and inter-agency projects; and,
- promote coverage of Smithsonian science and research beyond the Beltway through a concerted effort aimed at media outlets around the country, as well as wire services (Associated Press, United Press International, Reuters, etc.), news services, newspaper chains (Scripps Howard, Knight Ridder, Hearst, etc.), and the Washington bureaus of metropolitan dailies. The subjects of these features will be derived from the behind-the-scenes aspects of the Institution that have broad, general interest, such as the stewardship and conservation of icons of American popular culture, the role of Smithsonian scientists in identifying and dating forensic evidence, and the quest for new discoveries about the universe.

Recommendation 7-e

Conduct behind-the-scenes media tours of the Smithsonian’s conservation facilities, including the Museum Support Center, the Smithsonian Center for Materials Research and Education, the Cultural Resources Center, and the Paul E. Garber Preservation, Restoration, and Storage Facility. The May 1999 press preview of the Star-Spangled Banner Conservation laboratory is an excellent model for this type of media event.

Recommendation 7-f

Enlist the Secretary, Under Secretary for Science, museum Directors and other high-level Institution officials to conduct semiannual briefings for science reporters and staffers.

Recommendation 7-g

Continue to dedicate the entire spring issue of “Research Reports” to a single topic. “Research Reports” reaches some 80,000 people including such key audiences as Contributing Members, Members of Congress and journalists. The annual special editions should be promoted in advance to science writers and editors, through the OPA Newsdesk Web site, targeted press release distribution, and direct contact.

Recommendation 9-a1

The long-range planning process now underway at the CfA needs to be carried through, with an emphasis on the resources required to maintain current areas of expertise, and the impact of initiating new programs. In addition, SAO should address and implement, where possible, the recommendations in the 2001 Visiting Committee report. The Institution’s Major Scientific Instrumentation and Research Equipment pools, upon which many of SAO’s previous successes have been based, should be maintained as an open, competitive resource within the SI science enterprise.

Recommendation 9-a2

Harvard University and the Smithsonian should begin to plan for Irwin Shapiro's departure.

Recommendation 9-a3

SAO should pursue opportunities to present its achievements at the National Air and Space Museum and through SITES.

Recommendation 9-b1

STRI should continue as an autonomous research Unit reporting directly to the Under Secretary for Science. Its major scientific programs should remain intact.

Recommendation 9-b2

STRI should develop a comprehensive science plan within 1 year to address the current balance of all scientific activities, including attention to the decline in strength in marine ecology, the future of paleoecology, and policy and goals for biodiversity and conservation activities.

Recommendation 9-b3

STRI should review its ability to provide state-of-the-art scientific support to resident staff, including the extension of electronic communication to all of its widespread facilities, renewal of laboratory equipment, field support at all of its facilities, and the re-organization and role of the Office of the Assistant Director for Scientific Support Services.

Recommendation 9-c4

The leadership of SERC and the Undersecretary for Science should promote greater collaboration between Smithsonian marine science programs.

Recommendation 9-d4

The Museum should strengthen the connection of its science to exhibits. This will build greater public interest in, and awareness of, science and help build financial support of the Museum. Scientists must be directly involved in the design and implementation of exhibits, and programs should be integrated with Museum development efforts.

Recommendation 9-d8

The Under Secretaries for Science and American Museums and National Programs should work with the Directors and scientists in CEPS and Mineral Sciences to provide productive scientific oversight of their joint activities and coordinate their hiring and evaluations. The Commission sees no need for the physical integration of the two groups into a single location. The current configuration maximizes the presentation of science to the public.

Recommendation 9-e2

SCMRE should intensify its research on conservation and preservation of natural history collections and disseminate its results to the wider museum community.

Recommendation 9-e3

Education programs mandated by Congress should be continued as a secondary function of the SCMRE research mission. SCMRE's off-site and non-SI education commitment should be reduced to a more manageable size, allowing research staff to concentrate primarily on research and service functions. More efficient methods should be explored for delivery of educational programs through use of contractors and remote delivery systems using the Web and video

programming, funded, where possible, by user fees, grants, and collaboration with outside educational groups. Exhibitions should be done collaboratively with Mall museums and with SITES.

Recommendation 9-e4

SCMRE should re-focus its activities on the original CAL mission, providing research in support of Smithsonian collections and their long-term care and providing analytical data and information needed by the Units to understand and interpret the significance of Smithsonian collections. SCMRE should work closely with the Smithsonian Conservation Council and museum curatorial and conservation programs, as well as central administration, to help identify institutional needs and match SCMRE's capabilities with Smithsonian museums and collections. Because most of SCMRE's museum clients report to American Museums and National Programs rather than to Science, there needs to be close cooperation at the Under Secretary level to maximize benefits to all Smithsonian collections.

Recommendation 9-f1

The Science Gallery in Amazonia does an excellent job of bringing science into its exhibit and also does an impressive job of showcasing links to other SI science Units. This should be used as a model for future integrative exhibits at NZP.

Recommendation 9-f2

- a. Consistent with recommendations below regarding the CRC-Front Royal facility, the scientific and professional staff, and associated support staff, should be combined into a single directorate encompassing conservation, research and training;
- b. Support for this directorate would involve continuation of current federal support, but the Commission strongly supports the expansion of current efforts to attract external funding for research, education and training and other programs;
- c. The Director of the NZP should form a task force to begin to plan both short-term and long-term strategies to unite the currently disparate staffs around a common vision, mission, goals and projects;
- d. The Reproductive Biology groups (at both Front Royal and Rock Creek) should be developed as a unique national resource. Few, if any other zoos in the world, have the capability to study reproductive aspects of so many different species, yet detailed knowledge of such issues is critical to the success of species conservation plans. The joint reproductive biology group should be developed and showcased as a national conservation resource. Every effort should be made to generate political and financial support, both public and private; and,
- e. Several programs at Front Royal and Rock Creek are currently engaged in science/policy interactions, and have expressed a desire to develop these interests further. The NZP senior staff will have to determine the extent to which these should be expanded, consistent with Unit goals and priorities. A working group should be established to develop a more effective policy. This group should involve experts from other government agencies involved in

resource economics or land use (e.g., Department of Interior), as well as non-governmental organizations.

Recommendation 9-f3

As part of the review of the evaluation process discussed in Section 5, review performance evaluation standards to ensure that applied research, collaborative work and training are incorporated and appropriately weighted based on the particular position descriptions.

Recommendation 9-f4

A working group of development staff, scientists, and other staff under the direction of the NZP Director should craft a common vision and mission statement to articulate to donors and other external constituencies.

Recommendation 9-f6

NZP must evaluate its effectiveness in delivering its central message to the public. It must learn how to better influence public views. It must also learn from the leaders in its profession, both nationally and internationally.

Recommendation 9-g

- a. Retain the physical location of CEPS within NASM;
- b. Continue to improve CEPS-Department of Mineral Sciences communication in hiring, evaluation, and fund-raising; and,
- c. As new planetary mission roles develop, support these initiatives through office space rental and improved financial management systems.

e. Recommendations WITH Substantial Financial Implications - Priority

Recommendation 3-f

The Institution needs to maintain its programs of Major Scientific Instrumentation and Research Equipment. It should develop a coordinated plan for the acquisition, maintenance, and use of large scientific instruments. Equipment purchased with Institutional funds should be available to all.

Recommendation 3-h

The publication of book-length monographs, particularly in the social sciences, is a part of the dissemination of the results of scholarly research. If the SI Press decides to limit or even eliminate its traditional program of publishing such monographs, effective alternatives must be identified and funded.

Recommendation 5-e

Both annual and PAEC reviews should reward excellent performance. Rewards in addition to salary must be established. These might include nomination for recognition by professional societies or by the SI (prizes, medals, lectureships, etc.)

Recommendation 6-d

An SI-wide Web index and guide could facilitate use of the SI Internet and to help plan its further development. Thematic road-maps would better assist students and teachers in identifying educational pathways. Smithsonian collections and exhibitions could become focal points of curricula and Web site development, which could transform Smithsonian science outreach in the coming years.

Recommendation 6-e

Develop nationally competitive teacher training opportunities in science, following SAO and NSRC models. (Once again, a closer tie to NSRC would improve training opportunities.) Consider implementing a grass-roots national, Internet-based program in natural history field studies, in concert with the GLOBE Project or similar programs.

Recommendation 6-f

Scientists must be included in the development of all science education programs and should receive appropriate credit in their professional evaluations.

Recommendation 7-h

Offer media training seminars for key SI scientists, researchers and administrators.

Recommendation 7-i

The Office of Government Relations should be more proactive in advancing Smithsonian Science to Congress. It should:

- host a reception at the SI or on the Hill to celebrate science;
- develop an exhibit or display on the Hill in the Cannon or Russell Rotunda. Plan a briefing along with it. Invite a Member to sponsor it;
- volunteer to have Smithsonian scientists assist key committees and Members on important national scientific issues;
- keep track of AAAS Congressional Scholars, Knauss Grant Fellows, and Congressional Grant Fellows and recruit them to spend time at the Smithsonian. Hold Smithsonian events and involve them;
- invite Congressional Members and staffers to attend decision-makers' field courses (STRI or SERC could do this). SI would have to raise money for scholarships for some of them to attend;
- organize fieldtrips to SAO, STRI, and SERC. Plan such trips during House and Senate recess;
- help Members to follow science issues to stay in tune with their constituencies (environment, conservation, bio-terrorism, etc.);
- bring Members and staffers from the Hill to SI to talk with scientists about issues of importance to both groups. Build Members and staffers into SI programs;
- bring relevance and a "just-in-time" context to the people in Congress. Encourage them to think of the Smithsonian as a resource place - the "go-to" place for scientific inquiry and research within Smithsonian expertise;
- develop a briefing book on Smithsonian science for Members on Capitol Hill; and,
- create brochures to explain science projects to non-scientists. Provide updates on issues. Regularly circulate brochures and inserts on the Hill.

Recommendation 9-b4

STRI should strengthen its communications and outreach efforts, and increase its presence in the central administration and on the Mall, perhaps including rotating residence of appropriate staff scientists in Washington on a 1-year cycle and collaborating with NMNH, NZP and NMAH on exhibits and public outreach.

Recommendation 9-d9

The NMNH Director should make funding for the centralization at NMNH of the Laboratory for Analytical Biology, including molecular laboratories and core facilities (SEM, DNA sequencing, and isotope analysis) a high priority. All molecular lab staff from NZP and MSC should be relocated to NMNH. The Commission endorses the Museum's plan to provide general access to modular laboratory space, facilities, baseline funds, and human resources for major projects that use molecular methods, on the basis of need, current funding and merit. Similarly, consideration should be given to providing limited funds to facilitate collaborative and pilot ventures on the part of traditional NMNH scientists who want to apply molecular tools to their research.

Recommendation 9-e5

Management of archaeometry programs should be transferred to the National Museum of Natural History, where archaeological research is a major activity of the Department of Anthropology.

Recommendation 9-e7

SCMRE needs regular reviews by a Visiting Committee of prominent leaders in the fields of museum conservation, preservation, and materials research, charged with reviewing scientific output, response to Smithsonian needs, and relations with the broader professional community. Committee membership should be largely external but should include representatives from Smithsonian museums.

11. MONITORING IMPLEMENTATION

The Science Commission strongly urges dynamic and prompt implementation of the recommendations contained in this report. Several previous reports regarding science at the Smithsonian, when making similar arguments for change, have been of little lasting effect due to a lack of assessment mechanisms and criteria for success. To provide a strong basis for evaluation, the Commission recommends the following structure:

Recommendation 11

The Board of Regents should establish a 3-year benchmark period for this report. By July 2003, the Under Secretary for Science should create a plan for carrying out the Commission's recommendations, including explicit metrics for success and a timetable for completion. This plan will be implemented through the Scientific Directors Council, comprised of the heads of each major science Unit. The Under Secretary will also assemble a distinguished Visiting Committee to review the Institution's progress, on a yearly basis, in a brief report to the Smithsonian Regents (in December 2003, 2004, and 2005).

At the end of the 3-year period (December 2005), the Science Commission membership and the Visiting Committee should convene in a joint meeting to prepare a summary of Smithsonian successes and failures in implementation, and submit this report to the Board of Regents.

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Appendix A - Science Commission Member Biographies

Dr. Jeremy A. Sabloff, Chairman

The Williams Director
University of Pennsylvania Museum of Archaeology and Anthropology
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National Academy of Sciences, Member;
American Philosophical Society, Member;
American Academy of Arts and Sciences, Fellow.
Society for American Archaeology, Former President;
American Association for the Advancement of Science, Fellow.

Dr. Sabloff's research centers on archaeological theory and method and the history of American archaeology as well as the nature of ancient civilizations. More specifically, he studies pre-industrial urbanism and the use of settlement pattern studies to illuminate the development of urban organization. Field research has focused on the Maya lowlands and the study of the transition from Classic to Postclassic Maya civilization. He is the author or editor of more than a dozen books.

Dr. Alice Alldredge

Professor, Ecology, Evolution & Marine Biology
Biological Sciences
University of California
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Henry Bryant Bigelow Gold Medal in Oceanography;
American Geophysical Union, Fellow;
American Association for the Advancement of Science, Fellow.

Dr. Alldredge is a biological oceanographer whose interests encompass marine plankton ecology, carbon cycling, microbial ecology, and especially the role of large visible particles, known as marine snow, in the ecology of the ocean. Marine snow rains down upon the ocean bottom and is an important source of food for the deep sea as well as being central in oceanic carbon and nutrient cycling. Research is conducted at sea, aboard research ships, small boats, and in a laboratory on the Santa Barbara campus. Her experience is particularly valuable given the extensive marine facilities.

Dr. Francisco J. Ayala

Donald Bren Professor of Biological Sciences and Professor of Philosophy
Ecology and Evolutionary Biology
University of California at Irvine
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National Medal of Science;
National Academy of Sciences, Member;
American Academy of Arts and Sciences, Fellow;
President's Committee of Advisors on Science and Technology;
California Academy of Sciences, Fellow;
American Association for the Advancement of Science, Former President and Chairman.

Dr. Ayala's research focuses on population and evolutionary genetics, including the origin of species, genetic diversity of populations, the origin of malaria, the population structure of parasitic protozoa, and the molecular clock of evolution. He writes about the interface between religion and science, and on philosophical issues concerning epistemology, ethics, and the philosophy of biology.

Dr. D. James Baker

President
Academy of Natural Sciences
1900 Ben Franklin Parkway
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baker@acnatsci.org

National Oceanic and Atmospheric Administration (NOAA), Former Administrator;
U.S. Department of Commerce, Former Under Secretary for Oceans and Atmosphere;
American Meteorological Society, Fellow;
American Association for the Advancement of Science, Fellow.

Dr. Baker was previously President of Joint Oceanographic Institutions Incorporated, Dean of the College of Ocean and Fishery Sciences at the University of Washington, and a member of the faculties of Harvard University and the University of Rhode Island. He is author of *Planet Earth: The View from Space*, and has written more than 100 articles on climate, oceanography, and space technology, natural resource management, and sustainable development.

Dr. Bruce A. Campbell

Geophysicist and Department Chair
Center for Earth and Planetary Studies
National Air and Space Museum
MRC 315, Smithsonian Institution
Washington, D.C. 20560
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Dr. Campbell uses a variety of remote sensing techniques to study the Earth and the planets, with special emphasis on radar backscatter data. His current research interests include radar remote sensing of volcanic and impact crater deposits on Venus and the Moon, Venus geologic mapping, and development of improved radar scattering

models for planetary surfaces. Dr. Campbell is also leading an effort to develop a Mars orbital radar mission under the NASA Scouts Program.

Dr. Peter R. Crane

Director
Royal Botanical Gardens, Kew, England
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Fellow of the Royal Society;
National Academy of Sciences, Foreign Associate;
Linnean Society Bicentenary Medal;
Field Museum, Former Director and Vice President for Academic Affairs.

Professor Crane's research has dealt with large-scale patterns of plant evolution and the integration of paleobotanical data with information from living plants. His research has clarified the evolution and radiation of the flowering plants in the Early Cretaceous period and has also synthesized data on spores and pollen to clarify the dynamics of global vegetation change during the Cretaceous. Through his work at Kew, he is actively involved in plant conservation.

Dr. Douglas H. Erwin

Research Paleobiologist and Curator,
Interim NMNH Director
Department of Paleobiology
National Museum of Natural History, MRC 121
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Paleontological Society, Charles Schuchert Award.

Dr. Erwin is a paleobiologist (and 2002 Interim NMNH Director) specializing in large-scale evolutionary patterns, particularly genomic, developmental and ecologic aspects of the origin and early evolution of animals during the Cambrian and the end-Permian mass extinction and post-extinction biotic recoveries, particularly during the Early Triassic. His interests include the evolutionary dynamics and systematics of Paleozoic gastropods. Dr. Erwin is an external faculty member at the Santa Fe Institute and a member of the Harvard/MIT node of the NASA Astrobiology Institute.

Dr. Ilka C. Feller

Animal Ecologist
Smithsonian Environmental Research Center
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Dr. Feller's research interests focus on coastal, estuarine and marine ecosystems with particular reference to mangrove ecology. In mangrove systems, her research emphasis is placed on nutrient cycling and adaptations for nutrient conservation. Her other research studies include animal plant interactions and especially insect plant interactions in forested and marine ecosystems and how resource availability affects them.

Dr. William W. Fitzhugh

Director, Smithsonian Arctic Studies Center
Curator, Department of Anthropology
National Museum of Natural History
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Dr. Fitzhugh's research encompasses archaeological and ethnographic studies of circumpolar Arctic peoples, necessitating fieldwork in many parts of the Arctic. He specializes in culture contact and change as precipitated by environmental factors and acculturation of Arctic peoples into modern global systems in the historic period. Dr. Fitzhugh's personal research has focused recently on circumpolar artistic traditions and symbolism in burial practices. He is also active in public outreach, curating a number of major traveling exhibits including *Ainu: Spirit of a Northern People* and *Vikings: The North Atlantic Saga* which has resulted in films, websites, and both popular and scholarly publications

Dr. Stephen P. Hubbell

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Pew Fellows Program in Conservation and the Environment, Fellow;
American Association for the Advancement of Science, Fellow;
National Council for Science and the Environment (formerly Committee for the National Institute of the Environment), Chairman.

Dr. Hubbell's research focuses on the population biology and community ecology of tropical forests. He is known especially for conceiving and helping to implement a long-term, global research program on tropical forest dynamics that comprises seventeen 120-acre permanent plots in 15 countries, which contain over 3 million individually monitored trees of 5,000 species, representing about 8% of the world's entire tree flora. Dr. Hubbell is known for developing a general mathematical theory of biodiversity and biogeography. In addition to his ongoing field studies and theoretical work, he has been active in setting national science policy for the environment. Dr. Hubbell has a part time appointment as a research scientist for STRI, and works extensively on the Barro Colorado Nature Monument in Panama.

Dr. Jeremy B.C. Jackson

William and Mary B. Ritter Memorial Professor of Oceanography and
Director, Geosciences Research Division
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Secretary's Gold Medal for Exceptional Service, Smithsonian Institution
American Academy of Arts and Sciences, Fellow;
American Association for the Advancement of Science, Fellow.

Dr. Jackson is a marine ecologist and paleontologist. His early research demonstrated the importance of competition and predation among coral reef species in the development of reef communities. His studies of speciation in the fossil record showed that morphological evolution is not gradual but occurs in bursts after long period of quiescence. He also co-founded the Panama Paleontology Project, an international team of some 30 scientists, to document the extensive marine biological consequences of the formation of the land barrier between the oceans that changed marine environments and caused mass extinction of Caribbean marine biotas. Dr. Jackson's recent research centers on the historical causes of the modern collapse of coastal marine ecosystems around the world, and on new ways to use this historical perspective for more effective ecological restoration and management. He currently holds a part-time appointment as a Senior Research Scientist at STRI where, from 1984-1998, he was a full-time staff member.

Dr. Robert P. Kirshner

Professor of Astronomy
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National Academy of Sciences, Member;
American Academy of Arts and Sciences, Fellow.

Dr. Kirshner's research is directed towards the observations of supernovae, supernova remnants, galaxy dynamics and evolution, clusters and galaxy distributions on very large scales using Kitt Peak National Observatory (KPNO), Cerro Tololo Inter-American Observatory (CTIO), Las Campanas, Whipple Observatory, HST, and the MMT.

Dr. Simon Levin

George M. Moffett Professor of Biology
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National Academy of Sciences, Member;
American Academy of Arts and Sciences, Fellow;
American Association for the Advancement of Science, Fellow;
Ecological Society of America, Former President;
Society of Mathematical Biology, Former President;
Princeton Environmental Institute, Former Director;
Beijer Institute of Ecological Economics, Former Board Chairman;
Robert MacArthur Award;
Guggenheim Fellowship;
Society for Mathematical Biology and the Japanese Society for Theoretical Biology, Okubo Award.

Dr. Levin's major interests relate to the problem of scale, and the manifestation and interpretation of pattern across different scales. Research projects involve collaborative and integrated theoretical and empirical studies of the dynamics of the grasslands, forests, and the intertidal, as well as work on marine and terrestrial animal groupings. The focus of much of this work is on relating broad scale patterns and remotely sensed images to the finer scale processes that help determine them, and understanding effects of global change on biological diversity. His other research is concerned principally with the dynamics of natural populations, the relation to community and ecosystem organization, the problem of scale, and associated evolutionary questions. Of particular interest are models of dispersal, and the interaction between genetics and ecology: the importance of genetic change in population regulation, coevolutionary problems in natural communities, and ecological approaches to evolutionary questions.

Dr. Yolanda T. Moses

President

American Association for Higher Education

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City University of New York, Former President;
American Anthropological Association, Former President;
Ford Foundation, Member Board of Trustees;
The Women's Forum, Inc., Member

The principal research interest of Dr. Moses relates to cultural change in the United States and in the Caribbean, cultural change in higher education, and cultural diversity and public policy issues. As a consultant for the Association of American Colleges and Universities (AAC&U), she produced the important monograph, *Black Women in Academe* and she was a member of the Association's national panel on liberal learning that resulted in two significant publications. Under Dr. Moses' leadership, CUNY played a leading role in launching a national higher education diversity initiative, in cooperation with the AAC&U, entitled "Racial Legacies and

Learning: An American Dialogue." The project brought together a coalition of leaders from education, business, politics, the religious community, and grassroots organizations to discuss building "One America" in support of President Clinton's Initiative on Race.

Dr. Peter H. Raven

Director, Missouri Botanical Garden
Professor, Washington University at St. Louis
Missouri Botanical Garden
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National Medal of Science;
National Academy of Sciences, Member;
American Association for the Advancement of Science, President;
President's Committee of Advisers on Science and Technology;
National Geographic Society, Chairman of the Committee for Research & Exploration;
Government of Japan, International Prize for Biology;
The Tyler Prize for Environmental Achievement;
Volvo Environment Prize.

Dr. Raven's primary research interests are the systematics, evolution and biogeography of the plant family Onagraceae, which has become a powerful model for understanding patterns and processes of plant evolution in general. Other interests include plant biogeography, the evolutionary history of entire biota and the individual taxa found in certain regions, and the ways in which these organisms have been influenced by continental movements. Dr. Raven has developed a leading center for botanical research, education, and horticultural display at the Missouri Botanical Garden. The major emphasis of his research is in the tropics, where much of the biotic diversity of the earth is concentrated.

Dr. Beryl B. Simpson

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Society for Economic Botany, President;
Botanical Society of America, President;
American Institute of Biological Sciences, Board of Directors;
American Society of Plant Taxonomists, President;
American Academy of Arts and Sciences, Fellow;
American Association for the Advancement of Science, Fellow.

Dr. Simpson's laboratory is engaged in an array of studies that deal with the phylogeny and biogeography of various angiosperm groups. Most biogeographic work is directed toward explaining patterns seen in the American Southwest, Mexico, and Central

and South America. Methodologies for uncovering evolutionary histories include molecular as well as traditional techniques. Other research involves relationships between native solitary bees and their New World hosts, especially plants with oil-secreting flowers.

Dr. Warren L. Wagner

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National Tropical Botanical Garden Robert Allerton Award for Excellence in Tropical Botany;
International Association for Plant Taxonomy Engler Medal in Silver;
New York Botanical Garden, Henry Allan Gleason Award.

Dr. Wagner's research focuses on systematics of various angiosperm groups, especially describing and understanding the plant diversity of Pacific oceanic islands. Morphological and molecular sequence data are used to investigate the phylogeny, biogeography and evolution of Pacific lineages to understand colonization and diversification of unique insular adaptations. A significant problem is pinpointing precise relationships of divergent insular groups to continental lineages, often necessitating study of large widespread genera or even entire plant families. Islands are naturally divided into discrete units that are less complex than continents making them convenient models for study; yet island ecosystems are among the most endangered globally. Adequate knowledge of the species that inhabit tropical ecosystems is essential to understanding and managing these complex biotic systems. Dr. Wagner is developing methods to increase the rate of synthesis and dissemination of information through Internet informatics resources.

Dr. Marvalee H. Wake

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International Union of Biological Sciences, President;
Society for Integrative and Comparative Biology, President;
American Society of Ichthyologists and Herpetologists, Past President;
American Institute of Biological Science, Board of Directors;
American Association for the Advancement of Science, Fellow;
California Academy of Sciences, Fellow and Honorary Trustee;
Guggenheim Fellow.

Dr. Wake's research emphasizes morphology, development, and reproductive biology in vertebrates with the goal of understanding evolutionary patterns and processes. The comparative method is applied to ontogenetic and adult studies of various organ systems and their integration in fishes, amphibians, and reptiles. Patterns of early development are used to understand and assess homology and homoplasy. Dr. Wake is interested in many problems in evolutionary, developmental and functional morphology and in issues of biodiversity.

Appendix B – Timetable of Science Commission Meetings

Science Commission Meeting Schedule:

- September 6-7, 2001
- November 12-13, 2001
- December 13-14, 2001
- February 28 – March 1, 2002
- April 16-17, 2002
- June 3, 2002
- September 26-27, 2002
- November 4-5, 2002
- December 9-10, 2002

Science Commission Site Visits:

Unit	Date	SC representatives
NASM-CEPS	January 22	Sabloff, Baker, Moses
NMNH	January 25	Sabloff, Wake, Baker
SERC	January 28	Allredge, Erwin, Campbell, Baker
STRI	February 1	Kirshner, Baker, Feller, Wagner
CRC	February 7	Wagner, Erwin, Fitzhugh, Baker
NZP	February 14	Erwin, Baker, Campbell, Wagner
SAO	February 15	Campbell, Baker, Fitzhugh, Levin
SCMRE	February 22	Kirshner, Moses, Fitzhugh
NMNH (cont.)	February 27	Sabloff, Baker.
SMS/CCRE	Feb. 18-22	Feller
NMNH (cont.)	April 29	Wake and Baker

Science Commission Questions for Site Visits /Town Hall Meetings

Starting the meeting: briefly state and explain the Science Commission's charges.

Among the questions posed, please include the following as a minimum:

1. What do you see as the principal strengths of your Unit/Center/Department?
2. What do you see as the principal problems/weaknesses in your center?
3. What research areas would you like to see your center tackle that it isn't currently undertaking?
4. What resources would be needed to make this possible? Where might they come from?
5. Where would you like to see your organization be in five years and why?
6. Do you have any recommendations for reorganization that would significantly strengthen science at the Smithsonian?
7. What other recommendations/suggestions do you have for the Commission?

An additional question that is probably more appropriate for individual or smaller group meetings: are there programs/research areas that are not priorities any more and could be retrenched or eliminated and why?

Finally, please prepare an executive summary of the answers to the above and other questions.

Timetable: Studies of Smithsonian Scientific Research

June 25, 2001	Regents approve Secretary Small's appointment of Science Commission and its charge.
April 12, 2002	National Academy of Sciences (NAS) and National Academy of Public Administration (NAPA) commence independent reviews of Smithsonian scientific research programs.
May 6, 2002	Science Commission presents Interim Report recommendations to Secretary Small.
June 17, 2002	Science Commission Executive Committee reviews interim recommendations with Regents.
July 10, 2002	NAS and NAPA present verbal status report to Smithsonian, Science Commission, OMB and OSTP.
September 16, 2002	NAS completes report and provides it to NAPA.
October 31, 2002	NAS and NAPA deliver final report to Smithsonian, Science Commission, OMB, and OSTP.
December 10, 2002	Science Commission delivers and discusses final report with Secretary Small.
January 6, 2003	Science Commission Executive Committee reviews final report and recommendations with Board of Regents.

Information: <http://www.si.edu/sciencecommission>

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APPENDIX C – DOCUMENTS CONSIDERED BY SCIENCE COMMISSION

- SI Science Plan (8 August 2001) by Ad Hoc NMNH Committee (K. Behrensmeyer, W. Fitzhugh, B. Huber, J. Luhr, L. Parenti, S. Wing, and M. Zeder).
- Smithsonian Origins, Governance, and Relationship to the Federal Government by Office of General Counsel.
- Smithsonian Organizational Chart (5 July 2001) by Office of the Secretary.
- Smithsonian Management Directory (10 July 2001) by Office of the Secretary.
- Smithsonian Funding and Budgeting by Office of the Secretary.
- The Smithsonian Institution in the 21st Century, the First Decade’s Work (January 2000) by Secretary Lawrence M. Small.
- Report of the Commission on the Future of the Smithsonian Institution (May 1995) by Maxine F. Singer *et al.*
- Financial Report Provided to the Smithsonian Board of Regents (May 2001) by Office of the Secretary.
- Science for the 21st Century at the Smithsonian Institution (May 2001) by Office of the Under Secretary for Science.
- New Strategic Direction for Smithsonian Science in the 21st Century: A White paper on the Process (8 May 2001) by Office of the Secretary.
- Science Structure Organizational Models (4 alternatives).
- “Scientific Research at the Smithsonian (4 November 2000) - Report of the Smithsonian Council Meeting.
- Smithsonian Research Activities (13 November 1999) – Report of the Smithsonian Council Meeting.
- Financial Data: Federal scientist staffing levels, Federal Budget Information, Federal Research Equipment Pool Allocations, Federal Program Increases, Federal Base Erosion, Permanent Pay Absorptions, Summary of SI Fund-Raising Activities by Unit, External Grant and Contract Awards by Unit, General Unrestricted trust Fellowships and Award Programs, Business Activity Income, Expense and Net Revenue, SI Fellowship Program Directory, Space Allocation by Unit, Science Units Expenses, by Office of the Under Secretary for Science.
- Report of the NMNH Integrating Committee (24 January 2000) by M. Berenbaum, J. Gibbons *et al.*
- NMNH Report on Life Sciences (9 August 1999) by L. Abele *et al.*
- NMNH Report on Departments of Mineral Sciences and Paleobiology (14 June 1999) by A. Fischer *et al.*
- NMNH Report on Human Sciences (12 August 1999) by J. Buikstra *et al.*
- Future Directions of Research at the National Museum of Natural History (2 October 2000) by NMNH Science Council.
- Report of the STRI External Review Committee (30 October 2000).
- Report of the CRC External Review Committee (15 December 1993).
- Center for Astrophysics Visiting Committee Report (12 June 2000).
- Report of the SERC Visiting Committee (4 September 1997).
- Report of the CAL (SCMRE) Advisory Committee (27 September 1995).

- Vision Statements from NZP, NMNH Systematic Biology, NMNH Mineral Sciences, NMNH Paleobiology, NMNH Anthropology, SAO, STRI, SCMRE, and SERC.
- Research Statements from 420 Smithsonian scientists.
- 1998 Strategic Plans from Departments of Vertebrate Zoology, Invertebrate Zoology, Botany and Entomology.
- Science Unit Strategic Plans FY 03-07.
- Science Unit PAEC guidelines.

NMNH Reports and Memos on Science Directions and Reorganization
Chronology and Narrative by Melinda Zeder (11.26.01)

Strategic Plan for the Science Review at NMNH - July 1998

A document compiled by the NMNH Associate Director for Research and Collections in preparation for the external review of NMNH science. Contains strategic plans for each of the 7 NMNH scientific departments (Anthropology, Entomology, Invertebrate Zoology, Mineral Sciences, Paleobiology, Vertebrate Zoology) compiled by department Chairs. Also includes reports from NMNH Biodiversity Programs, Laboratory for Systematic Zoology, and the Collections Program Office. Individual strategic plans usually include the following sections: Introduction, Vision, Internal Analysis (strengths & weaknesses), External Analysis (ties to outside science), Goals, Measurements of Success, Space, and Spending and Staffing Plans.

Research at the National Museum of Natural History: Mission, Methods, Needs, and Goals – September 1998

A report prepared by the NMNH Senate of Scientists presenting an overview of the NMNH research mandate, context of NMNH research, infrastructural concerns, and dissemination of research. The report was prepared to accompany the materials compiled by the NMNH administration for the external review. Its intention was to give a Museum-wide perspective on science goals, needs, and future challenges from the point of view of NMNH scientists.

It was written over a four-month period in which the Senate Council held focused discussions of various aspects of NMNH science, with invited input from the NMNH research community. It also includes an NMNH-wide survey on mechanisms used to disseminate research results. A draft of the report was circulated to all NMNH staff and associated researchers for comment and the final report incorporates the responses to these comments.

The NMNH Senate of Scientists is a grass-roots organization of NMNH scientists founded in 1963 with a mission of promoting better communication among NMNH scientists, representing NMNH scientist interests to NMNH and SI administrations, and promoting greater awareness of NMNH science both within and outside the Institution. The Senate consists of a dues-paying membership and an elected Council (one representative from each department, the affiliated agencies, and the Congress of Scholars – an SI wide body of researchers founded in the 1990s on the NMNH Senate of

Scientists model, and officers). It operates outside the NMNH administration and answers to its membership of dues-paying NMNH and affiliated agencies scientists.

Report of the Integrating Committee – January 2000

Report written by the chairs of three independent review committees charged with reviewing the three major areas of NMNH research (Earth, Life, and Human Sciences), plus the two chairs of the External Review committee (Jack Gibbons and May Berenbaum). This report is both a synthesis and an extension of the three independent reviews of NMNH science. It is the culmination of a two-year process in which three committees (about 6 members each) reviewed extensive briefing materials, met with various groups of NMNH and SI staff and administration, and considered various strengths and weaknesses of NMNH science and recommendations for the future. Each committee wrote independent reviews of science in their respective areas.

Redacted Comments on External Review of NMNH Science – Spring 2000

Comments on external reviews by eight anonymous readers with background in various natural science disciplines and museum based science. Also includes personal commentary of Al Fischer, Chair of the Earth Science Review Committee. The Associate Director for Research and Collections sent a select group of researchers the external reviews and asked for comments and suggestions for future directions of NMNH science.

Future Directions of Research at the National Museum for Natural History – October 2000

Report was written by the NMNH Science Council. The objective of the report was to provide a specific plan that identified target future-growth areas for NMNH science, as well as areas that should be de-emphasized or phased out.

The NMNH Science Council was created as a response to suggestions in the Integrating Committee report that recommended the formation of a body of scientists representing different branches of NMNH science to serve as a major internal advisory panel for the NMNH Director and Associate Director for Research and Collections. The Council was to look across departments for areas of integration and synergy between different branches of NMNH Science, to make specific recommendation on directions of NMNH science, to consider how science plans might be implemented, and to help represent NMNH science within the SI and to the outside science community.

The report represents the first task assigned to the Council by the NMNH Director. It was not framed as a response to the External Review documents, but as an extension of those reviews that provided a more detailed outline of future NMNH science. The report is the result of 6 months of discussion by the Council. In making its recommendations, the Council drew from the External Reviews, the Departmental Strategic Plans, and the Council's own understanding of science trends in natural history science. Discussions with fellow scientists also contributed to the process.

One of the specific charges to the Council was to devise a plan that preserved the diversity and depth of NMNH science (which the external panels felt were a particular strength), while identifying a more tightly drawn, clearly articulated array of research questions. Questions identified represent significant research areas where NMNH can make unique contributions and help promote greater integration across the range of NMNH sciences.

The report also included considerations of the characteristics of NMNH research that need to be addressed in planning for future science, the relationship between basic NMNH research and its application to discrete societal problems, the place of NMNH science within SI science as a whole, the place of NMNH science within the broader national and international science agenda, and problems of implementation of a science plan.

NMNH administration and Department Chairs were briefed at several junctures during the Council deliberations. Administration and Chairs were given drafts of the finished report for review and comment. In addition, the Council met with Secretary Small, Under Secretary O'Connor and Director of Scientific Research Programs Coates, as well as the science sub-committee of the NMNH National Board, to review progress. The report was completed to meet deadlines set by the Under Secretary for Science in his broader review of SI science. Vetting of the document with the broader NMNH research community was suspended pending the results of the Institution-wide science review.

Research Areas to be De-emphasized or Eliminated – October 2000

This is an addendum to the NMNH Science Council report on Future Directions of NMNH Science that outlines general characteristics and specific areas of NMNH research that should not receive enhanced support, be de-emphasized, or phased out.

These recommendations were originally to be included within the Future Directions document. They were taken out of this larger report at the request of NMNH Director Fri, who wished for strategic reasons to keep this information from general dissemination – mainly with an eye to broader SI-wide discussions with other Directors. They were also presented separately from the report to meet Castle deadlines. NMNH recommendations for future science directions were due to the Office of the Under Secretary for Science by October 2. Council deliberations on this aspect of the report were not concluded until October 4 and the report was not finished until October 13.

This report had only been shared with the NMNH Director and Associate Director for Research and Collections. It was forwarded to Acting Director O'Connor following the November Science Commission meeting with the suggestion that it be distributed to the Science Commission.

An Integrated Proposal for Smithsonian Science Reorganization – July 2001

This is a plan prepared by an *ad hoc* group of NMNH researchers. The group included officers of the NMNH Senate of Scientists, Chairs, members of the NMNH Science Council, and other interested NMNH scientists. The intention of the group was

to present a plan to the Science Commission for the structural reorganization of Smithsonian science. The goal was to devise a plan that would promote better integration among the various branches of SI science, while also recognizing the important and varied contexts and goals of the different Units in which SI science is conducted. The importance of retaining and enhancing the connection between NMNH science and its public programs was a particular concern for this group.

The plan was devised through discussion within the group, as well as through broader discussion with both NMNH and other SI researchers. A draft of the plan was circulated throughout the whole SI research community in June, and the final draft was completed in July and forwarded to the Science Commission, the SI administration and research community in early August.

APPENDIX D – CONSULTANTS

The Science Commission wishes to acknowledge the following consultants for providing expertise to the Commission's deliberations:

- Alan Dixon, San Diego Zoological Society
 - James R. Druzik, Getty Conservation Institute
 - Sarah Horrigan, Office of Management and Budget
 - Andrew Lins, Philadelphia Museum of Art
 - Craig Morris, American Museum of Natural History
 - Michael J. Novacek, American Museum of Natural History
 - Frank Preusser, Getty Museum (ret.)
 - George Rabb, Brookfield Zoo
-
- Virginia Clark, Director of External Affairs and Development
 - Anthony G. Coates, Director for Scientific Research Programs
 - David L. Evans, Under Secretary for Science
 - Michael A. Lang, Executive Officer for Scientific Programs
 - Evelyn Lieberman, Director of Communication and Public Affairs
 - J. Dennis O'Connor, Under Secretary for Science and Acting NMNH Director
 - Ira Rubinoff, STRI Director and Acting NMNH Deputy Director
 - Irwin Shapiro, SAO Director and Interim Under Secretary for Science
 - Lawrence M. Small, Smithsonian Secretary
 - Lucy H. Spelman, NZP Director

APPENDIX E – INTERIM REPORT OF THE SCIENCE COMMISSION (02 MAY 2002)

Science is an essential part of the Smithsonian mission to “increase and diffuse knowledge.” The Smithsonian has outstanding people, facilities and opportunities in scientific research. It is the Commission’s goal to help the Smithsonian achieve its potential as a scientific organization, and these interim report consensus recommendations are a small step in that direction. The final report of the Science Commission will be transmitted to Secretary Small and the Board of Regents in December 2002. The Commission has reached several unanimous conclusions, and the onset of the 2004 budget cycle and the pending departure of the Under Secretary for Science, Dennis O’Connor, make it appropriate to provide the Secretary and the Regents an interim report on our deliberations. The items discussed below are only a small subset of the many issues we have been considering, but involve issues on which we have reached consensus and which require action before submission of the final report. The latter will include a broad vision for Smithsonian science and a number of specific recommendations relating to the Commission’s charge.

LEADERSHIP

It is the consensus of the Commission that the quality of scientific leadership is the critical factor in the future success of Smithsonian science.

The Smithsonian Institution and its component science Units can neither maintain nor advance its international reputation without effective scientific leadership. Such long-term leadership is essential in the recruitment, promotion, and motivation of scientific excellence at the Smithsonian. The Institution currently faces extremely worrisome voids in leadership that must be filled as promptly as possible, with interim appointments now and the commencement of international searches for the two key vacated positions. While the science budget is under a congressional mandate to remain stable until the Science Commission issues its final report to the Regents, it clearly is under threat and new leadership is needed as soon as possible to work with the Secretary to improve the financial prospects for Smithsonian science.

- **The Commission strongly recommends that the Smithsonian Institution and Secretary Small should immediately initiate an international search for a new Under Secretary for Science.**

The Smithsonian urgently needs an individual of stellar scientific reputation, vision, leadership, and management skills to guide the science portfolio and serve as the principal spokesperson for Smithsonian Science. This individual must have a deep personal commitment to scientific excellence, and both the vision and skills to advance the cause of science. Once appointed, the Under Secretary must help the leadership at the Natural History Museum and Environmental Research Center develop their independent courses, and develop plans for the transition in leadership at the Astrophysical Observatory. This search should be entrusted to a committee composed of a diverse selection of Smithsonian scientists and management, external researchers and museum professionals.

- **The Commission also strongly recommends that Secretary Small immediately initiate an international search for an appropriate leader for the National Museum of Natural History.**

The long-term lack of stability in the Director's office has had a detrimental impact on all facets of museum activities (8 Directors and Acting Directors in the past 20 years). The frequent turnover of Directors appears to be due, in part, to the failure of previous Secretaries and Assistant/Under Secretaries for Science to delegate sufficient authority and responsibility to attract the exceptional candidates this position demands. The Associate Director for Science and Collections has extensive experience with scientific management and policy but is not a scientist and serves concurrently as Director of the Smithsonian Environmental Research Center. The Commission does not believe that "double-hatting" is, in principle, a good long-term management strategy. With the imminent departure of Drs. O'Connor and Rubinoff, there will be no museum scientists at administrative levels above the Department Chairs and until recently scientific input to the Director's Office has been lacking. As discussed in more detail below, there is a critical need to reinvigorate the Directorship of the Natural History Museum. Under the present circumstances, and given the history, we strongly urge that the individual chosen as Director of the Museum be a scientist of stature with demonstrated museum experience, a clear understanding of the special opportunities for research in a natural history museum, and the ability to pursue strongly the financial and other support needed to realize these opportunities. Whereas the Under Secretary for Science should be primarily a scientist and an administrator with a proven track record, the Director of the Natural History Museum should definitely be a museum professional who knows large institutions of this type well and accepts significant collections research and public programming responsibilities. For these reasons, we strongly recommend that two separate searches are required.

A. CRITERIA FOR SCIENTIFIC LEADERS

Personal criteria

- For the Under Secretary an international reputation as a scientist is required to provide sufficient internal and external credibility. Some Unit Directors may not be scientists, but all must have an appreciation for scholarship, a curiosity about science, and an understanding of the demands of leading a scientific organization.

Leadership criteria

- Demonstrated personal commitment to excellence, including the determination to hold scientists accountable for performance, given the freedom and support they enjoy.
- Demonstrated ability to identify and articulate clear institutional vision and goals, to communicate a vision to engage the staff, and the management skills to ensure effective implementation of this vision.
- Support for, and understanding of, basic research.

Management criteria

- Ability to communicate by speaking and listening to staff at all levels.
- Awareness of the greater Smithsonian context and knowledge, and experience working in the Washington science policy arena.
- Excellent organizational skills and multi-tasking ability.
- Willingness and ability to raise funds.

B. SELECTION OF SCIENTIFIC LEADERS

These comments are largely predicated on the need to complement the talents of the present Secretary of the Smithsonian. With the exception of Department Chairs, selection of leaders at all other levels should involve national searches by an appropriate committee of Smithsonian scientists and representatives of management; inclusion of external representatives may also be indicated.

Under Secretary for Science - The Under Secretary for Science must be an outstanding scientist of international reputation, unquestioned scholarship, and outstanding management skills.

Scientific Unit Directors - Unit Directors must increasingly focus on fund raising and successful grantsmanship. The strong preference should be for scientific leaders, although in exceptional instances non-scientists with outstanding management and development skills may come to the fore. All Directors of scientific Units must have an appreciation and curiosity about science. In the past, the Directorship of Natural History has been a term appointment; this is no longer an effective leadership strategy. Recruitment of such individuals will require the central Smithsonian administration to delegate appropriate authority and support to make these positions attractive, which has clearly not happened in previous searches for Natural History Directors. The Unit Director must be given significant budgetary authority and be a major participant in central budgetary planning.

Directors of Research within Units - Several Units are of sufficient size that the primary role of the director will be fund raising and general oversight, necessitating the delegation of primary responsibility for research. If the Unit Director is a well-respected and accomplished scientist, the Director of Research position may be primarily managerial and may not need to be filled by a scientist, although this would be desirable. If the Director lacks such qualifications, the head of research should be a noted scientist in an appropriate discipline, with management expertise and the ability to articulate the scientific goals for the Unit.

Department Chairs/Division Associate Directors - Chairs must be credible and active scientists, generally chosen from within the Unit. Scientific Divisions and Departments generally benefit from long-term stability of Chairs, but this will often require Unit senior management to provide sufficient administrative support in the form of GS12-14 Departmental Administrators to allow the Chair or Associate Director to provide

effective leadership while maintaining an active research program. This recommendation has obvious implications for effective department size.

STRUCTURE

Structural organization is not the primary problem confronting the Institution. It is the consensus of the members of the Science Commission that there is an urgent need for greater transparency in the development of research priorities and budgets.

There is no single strategic plan for Smithsonian Science, yet several plans at the Unit level are very clear and focused upon particular scientific activity. In general, scientists play little role in formulating institutional policy, and may not be well represented even at the Unit level. The lack of significant, broad-scale visibility of Smithsonian science is tied directly to the absence of direct scientific staff input to the institutional planning and "outreach" efforts. The Commission believes that these deficiencies can be remedied without sweeping structural changes. Minimal changes in structure, effective implementation of existing policies and lines of authority, and visionary leadership of key Units, are required. We are investigating a modest restructuring of the Smithsonian science efforts, with an emphasis on facilitating planning, communications, and performance assessment. The core of this new structure is a strong planning and advisory staff within the Office of the Under Secretary, in conjunction with coordinated strategic planning on the Unit and department levels, so that the visions of the scientists throughout the Smithsonian Institution can be coordinated into an overall vision. The Commission is still deliberating on the most valuable and cost-effective way to implement these goals. We will present a detailed plan in our final report. Structural aspects of the Conservation Research Center at the National Zoological Park and the Smithsonian Center for Materials Research and Education remain under study.

- The Smithsonian Environmental Research Center is a growing and vibrant organization doing excellent work at the forefront of ecological research on the coastal interface. This largely independent Unit with its own Director should report directly to the Under Secretary for Science.
- We also recommend that the scientists and scientific curators establish a committee of Unit representatives that would be available to advise the Castle on policy matters affecting science across the Institution. This committee should be proactive in raising important issues with the Smithsonian administration and in facilitating dialog on policy, budget, and organizational issues. Again, the Commission will present much more detailed considerations in this regard in its final report.
- The Science Commission has also reached consensus that better communication of scientific results and the role of science to the Secretary, the Regents, Congress, and the public is critical.

The Executive Committee of the Science Commission looks forward to the opportunity to discuss its progress at the Regents' meeting in June.

APPENDIX F - UNIT EDUCATION PROGRAM SUMMARIES

National Museum of Natural History

Assisted by its huge collections, large staff, and extensive exhibit facilities, Natural History has a correspondingly large and diverse set of education and outreach offerings, organized through its public programs and its research and collection departments. Public Programs prepares long-term and special exhibits for museum audiences, augmented by lecture and film programs, docent tours and hands-on learning, symposia, an extensive museum web site, publications, and curricular materials. The Voyager after school program has been collaborating with NMNH to produce science-based school programs for elementary age children. The Natural Partners program, in cooperation with Ball State University, has been developing a national network of schools and universities that are connected electronically to NMNH for distribution of interactive field trips and expeditions, curricular offerings, teacher training, and summer school programs. Support for these programs has come from a variety of federal and private sources, including major university systems and several state school districts.

NMNH science departments and research programs have educational programs, supervising interns, trainees, fellows, and visiting researchers; producing web sites and educational materials for public distribution and teacher training; and preparing materials and collection information for professional researchers, students, teachers, and amateur science groups. Some sub-department programs and Units (divisions) also have their own public program activities that prepare traveling exhibits, popular literature, newsletters, websites and other materials for off-mall distribution, and a few of these maintain offices and staff in locations outside D.C. For example, in Alaska the Arctic Studies Center maintains an Anchorage Office in the Anchorage Museum of History and Art and the NMNH Department of Anthropology has a strong relationship with Mexico-North, a consortium with offices in Mexico and San Antonio that support regional educational programming and research. The scientific departments could do much more, particularly in the arena of publishing outreach materials. Absence of a museum publication office severely curtails the museum's ability to promote and integrate its educational and scholarly programs.

Smithsonian Astrophysical Observatory

SAO, which lacks its own exhibition space, has developed a dynamic pre-college education and public outreach program directed at local and national audiences largely through print and electronic media, and through local community offerings. Its impressive Science Education Department, largely supported by outside grants and contracts such as from the NSF, makes major contributions to science education by developing curricula distributed nationwide to schools, teacher training workshops and courses, video production, and traveling exhibits. Specific projects include the Annenberg/CPB Channel web service that brings astrophysical education to more than 44,000 schools and 43 million homes 24-hours a day; interactive workshops conducted on the web for K-12 teachers and principals; remote micro-observatory programs on the web in which users can simulate telescopic investigations; video instructional programs on astronomy and geosciences for teachers; collaborative educational forums co-

sponsored with NASA; and programs dealing with specific instrumentation like the Chandra X-ray telescope, as well as intern and fellowship training, facility tours, and community events. SAOs' educational successes resemble those of NSRCs in their major national impact on off-mall national audiences.

National Air and Space Museum

The NASM Educational Services (ES) is very active in two major areas: museum support and museum outreach. Museum support is particularly important because educational personnel serve in many Ambassadorial roles between the museum and its visitors. ES manages the NASM Docent program, recruiting and training docents and scheduling regular, school, and VIP tours. ES also manages the highly-interactive and very popular How Things Fly gallery, including the recruitment, training, and scheduling of presenters, who provide demonstrations and interpretation. ES also developed a broad menu of interpretive Discovery Stations and recruits and trains a team of volunteers to staff them. ES provides support for the development of new galleries and the updating of older ones, and regularly contributes to ongoing operations. Finally, ES is deeply involved with the development of all educational programs related to the new Udvar-Hazy Center.

ES is also very active on many NASM outreach fronts. ES coordinates a variety of educational events in support of the NASM Family Days, the Exploring Space lecture series, Mars Day, and other museum promotions. An intern program, teacher workshops, and other professional development opportunities are examples of ES support for museum outreach, as are school trips and tours, especially in conjunction with local partner schools, and the creation and distribution of teaching posters and other educational materials. ES works to leverage its reach by establishing educational web-based programming and the use of distance learning technology.

Smithsonian Center for Materials Research and Education

This specialized research laboratory began as an object and preventative conservation laboratory in the 1960s and gradually expanded its mission into archaeometry, ancient technology, and educational programming in recent decades. It sees its primary mission as research in materials, conservation, and preservation sciences. Education was explicitly added to its mission at the direction of Congress in 1992. Without its own exhibit facilities, SCMRE recently produced a successful traveling exhibition (*Santos: Substance and Soul*), which opened at the Arts & Industries Building. Its core educational programs include courses, workshops, internships, and fellowships supplemented by video, web-based, and literature instruction programs in such topics as preventative conservation, preservation and conservation science, paper and photographic conservation, microscopy, metallurgy, furniture restoration, wood identification, and other fields. Target audiences vary according to subject and include professional conservators, museum technicians, and increasingly, the general public. While SI museums and archives depend on SCMRE's technical services, many educational programs are conducted outside of Washington at other museums and conservation training centers nationwide. A technical information office with extensive search

capabilities answers inquiries, archives data, and distributes copies of reprints and reports nationwide.

Smithsonian Environmental Research Center

SERC's education and professional training programs focus on distance learning, teacher-development courses, video instruction, and hands-on participatory activities in watershed ecology tours for groups of school children and students who visit SERC field stations to gather biological data. A central theme of SERC's education programs is aquatic and coastal biodiversity and conservation awareness training. In cooperation with NMNH, video-conferencing and electronic field-trips are conducted with national school networks. Internships provide undergraduate and graduate students with field training, and SERC has a share of the SI fellowship pool, maintaining a web site for dissemination of research and educational materials. SERC also produced a traveling exhibition on the blue crab, as well as a newsletter, brochures and research reports.

National Zoological Park

The Zoo and its Conservation Research Center at the Front Royal facility conduct a variety of exhibit- and web-based education programs, many in collaboration with its public outreach arm, the Friends of the National Zoo (FONZ). Like SERC and NMNH, these programs promote understanding of conservation biology and ecosystem health. In addition to programming relating to its resident animals and exhibits, the NZP conducts GIS and conservation workshops in selected locations around the world. Recently it has emphasized programs to enhance conservation awareness of endangered hotspots using iconic species like the giant panda, tiger, and elephant, to draw special attention to regional conservation problems. It also promotes urban ecology and conservation programs directed at local neighborhoods situated near the zoo and in the Front Royal region. The CRC's educational programs are largely directed at research training, conservation, and biodiversity issues through training programs and workshops overseas.

National Museum of American History

American History's science education programs are centered in the Lemelson Center and the Hands-On Science Center, an adjunct to the exhibition, *Science in American Life*. The Lemelson Center concentrates on the study of invention and innovation and their role, historically and in the present, in American society, and offers innovative educational programs, many scholarly symposia and lectures for the general public, and a fine web site. The Hands-On Science Center provides museum visitors with a chance to conduct scientific experiments and measurements on objects and materials of everyday life and is funded by trust sources (ca. \$400K annually). As an example, a materials research project enabled visitors to conduct conservation tests in connection with the *Santos: Substance and Soul* exhibition. The Lemelson Center recently created the exhibition, *Invention and Play*, growing out of a symposium that explored the connection between these two human phenomena.

Smithsonian Tropical Research Institute

STRI scientists engage in educational activities at a variety of levels advising undergraduates, graduate students, post-Doctoral fellows and visiting scientists. Formal

educational programs include: a joint Ph.D./M.S. program with McGill University where both course work and thesis research and supervision are performed at STRI with faculty from McGill and STRI scientists who have been accredited by McGill; undergraduate programs for a semester abroad with Princeton and McGill Universities, with instruction performed by scientists from those institutions and STRI; and, a joint OTS-STRI graduate course in marine ecology at Bocas del Toro, with instruction given by STRI, SERC and outside scientists. STRI facilities in Gamboa, Bocas del Toro and Barro Colorado Island are used for field courses by Florida International University and Michigan State University. STRI's participation in the Jason project will be based on Barro Colorado, introducing by satellite transmission more than 1 million intermediate level school children in 25,000 school rooms in the United States to the rainforest research based on Barro Colorado Island. STRI also maintains educational facilities at Barro Colorado Island, Culebra Island and Galeta Island. These stations serve to introduce more than 100,000 visitors annually to research conducted at the marine and terrestrial habitats under our custodianship. Most of these visitors are school children. In addition, STRI provides support to many natural history documentary television and radio programs by the BBC, Oxford Scientific Films, Discovery Channel, Animal Planet and the National Geographic Society, as well as productions by television companies in Japan, Australia, Germany, and Venezuela.

APPENDIX G – BUDGET INFORMATION

The financial setbacks for Smithsonian Institution science in recent years have been particularly devastating. Since 1990, science has experienced a steady erosion of base support, partially offset by targeted programmatic increases in selected areas. According to the information provided to the Science Commission, during this period the Smithsonian absorbed a permanent base reduction of \$14.2 million in federally appropriated funds for required pay raises that were not fully funded. Total base erosion of Smithsonian science during this period due to the science allocation of required pay raises, as well as other reductions in operating (S&E) funds, was \$13.5 million. Mandated reductions in established positions (FTE's) eliminated 163 positions, with further positions lost to pay for mandatory (but not fully-funded) pay increases and other mandatory costs. Some of the impact of these base reductions was mitigated by programmatic increases funded by Congress in selected areas, but these targeted increases did little to stem the net reduction (Fig. 1) in the Institution's science capabilities. Between 1990 and 1993, there was a net increase to science of \$8.1 million, largely due to a net \$6.7 million increase to the Smithsonian Astrophysical Observatory (SAO). From 1994-2001 there was a net drop of \$5.9 million across science Units. As shown in Figure 2, these changes were spread differentially across the Institution. All Units other than SAO had a net reduction over the period 1990-2001. In 2002, there was a further \$2.905 million cut to Smithsonian science activities.

1990-2002 Net change in Science funding

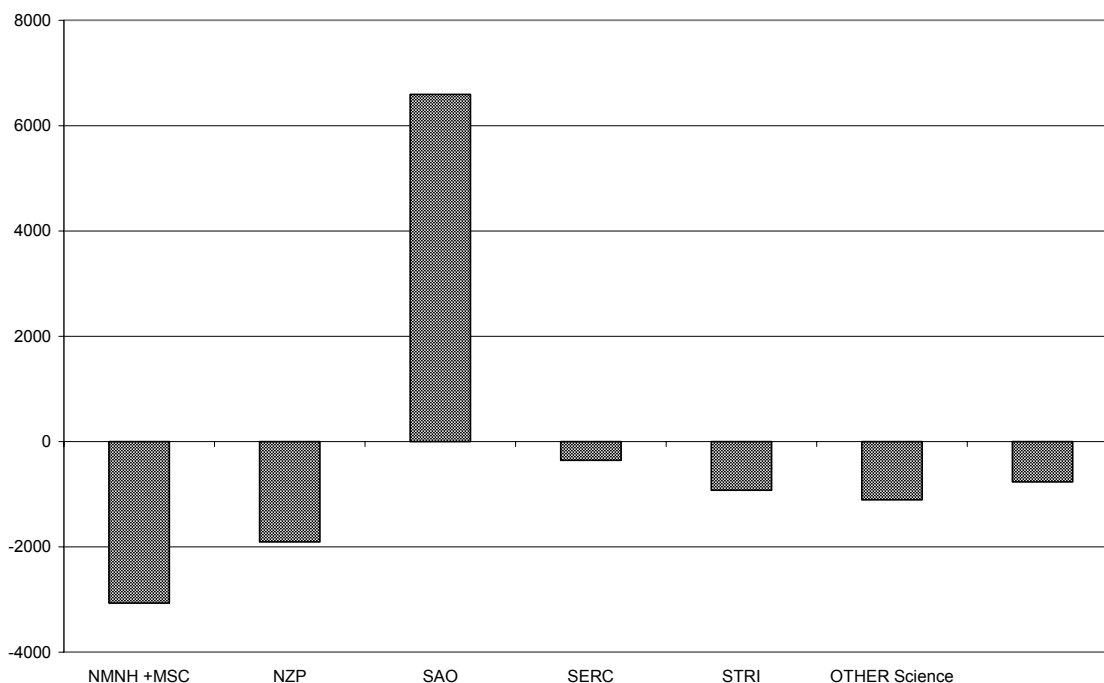


Figure 1. Net change in science funding 1990-2002

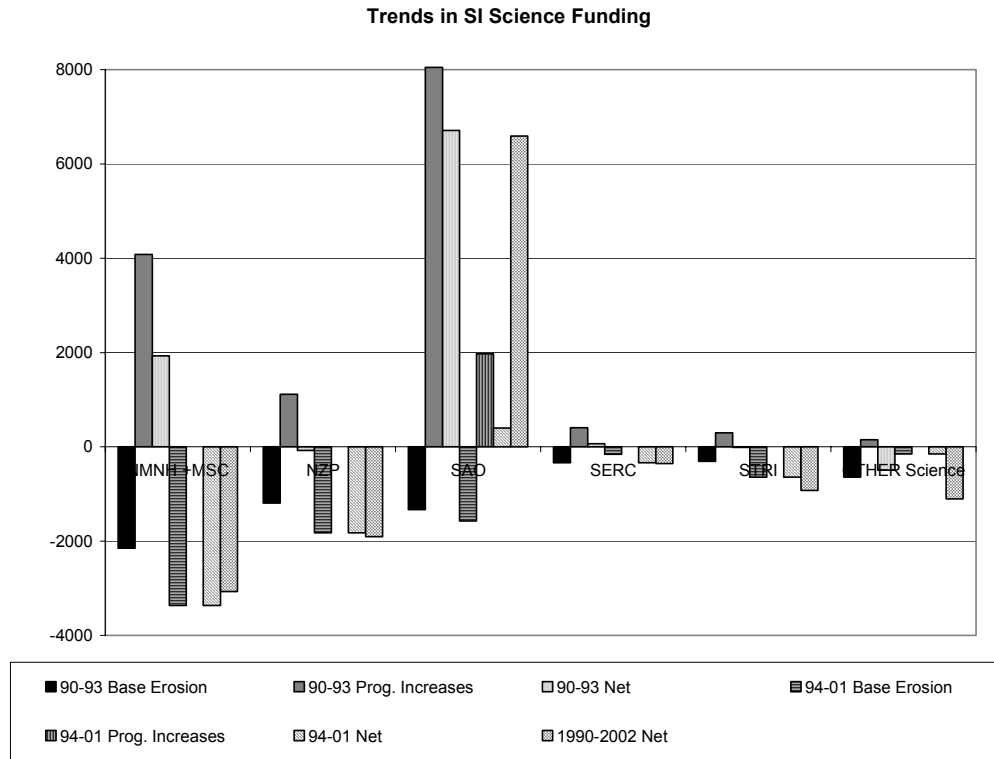


Figure 2. Trends in Smithsonian science funding.

These budgetary constraints have had a predictable impact on both total staff and the number of scientists. The actual number of SI science staff dropped by 174, and the number of scientists by 36 (13.6%). The impact of this decline was highly unequal across Units (Fig. 3). The National Museum of Natural History (NMNH) lost 8% of total staff, but 23% of scientists; the National Zoological Park (NRP) lost 16% total staff, but 5% of scientists; SAO had no net loss of staff but did suffer an 8% drop among federally-funded scientists. These changes in staff numbers do not reflect a strategic plan, but simply staff retirements and departures that were not filled. Staff turnover in non-scientist positions (collections, exhibits, facilities) is generally higher than among scientists.

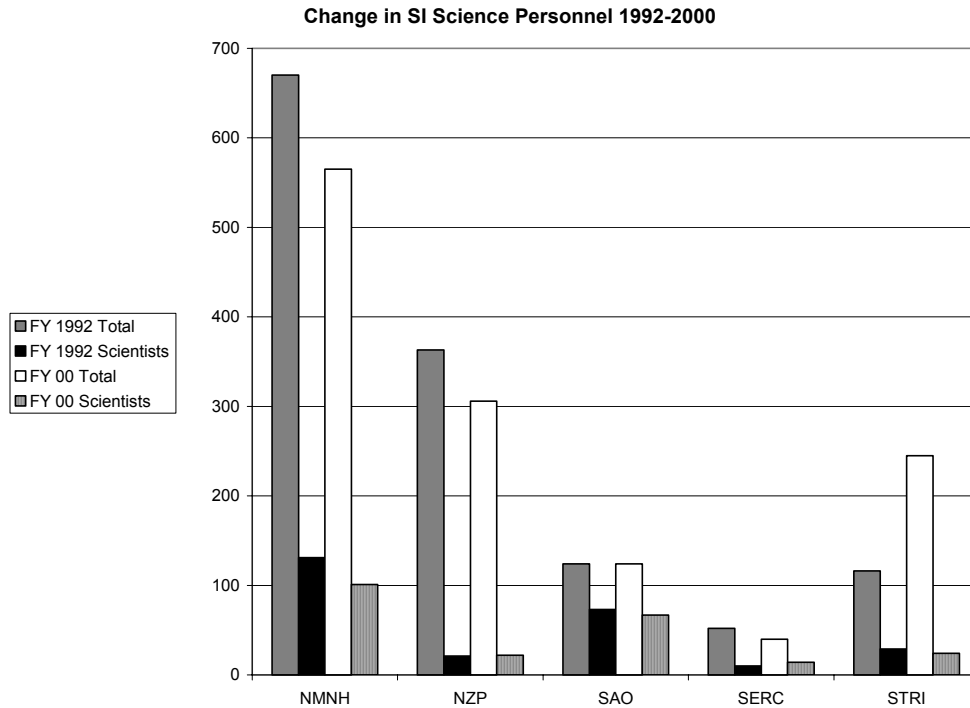


Figure 3. Change in Science Personnel 1992-2000.

The vitality of SI science has suffered in other ways from this decline in federal support: the average age of SI scientists has increased, and the relative lack of new hires has prevented Units from incorporating critical new research areas. Declining support for the Smithsonian Institution Libraries (SIL), coupled with rising subscription costs, has forced the Libraries to cancel hundreds of journals and reduce book purchases. Steady erosion in trust-funded allocations for fellowships, internal Scholarly Studies Program grants (essential seed funds for attracting external support), and other activities has been catastrophic. Between 1990 and 2002, the total award pool plummeted from \$4.4 million to \$1.64 million (Fig. 4).

Change in Trust Pool Awards 1990-2002

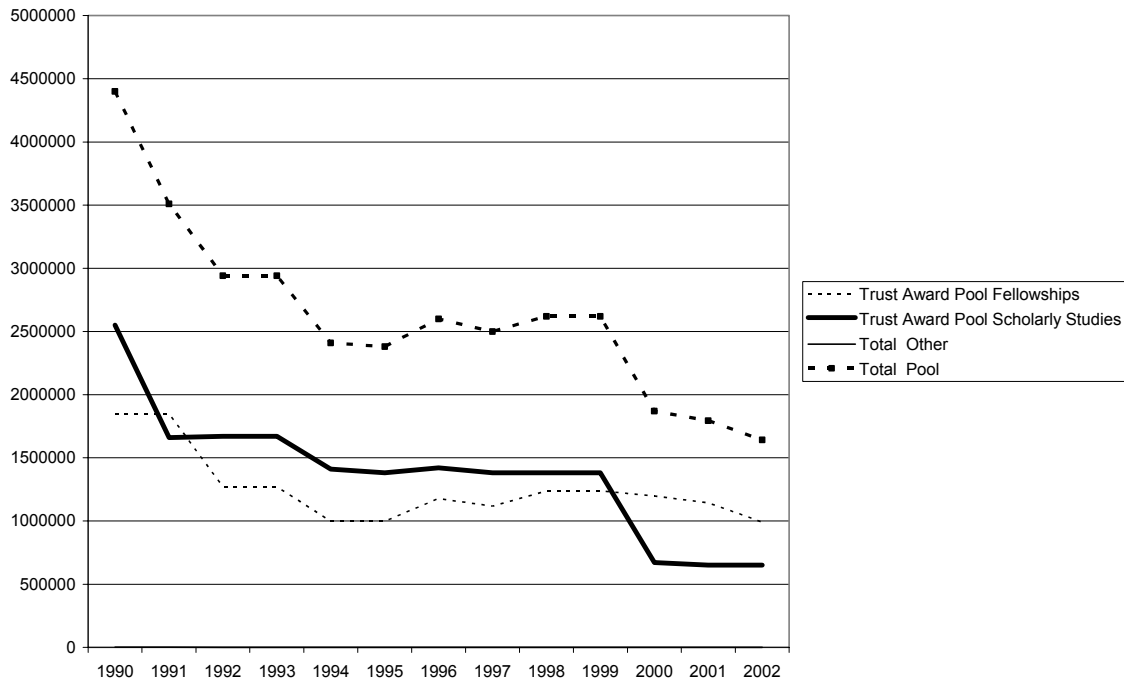


Figure 4. Change in trust fund pool awards: 1990-2002.

While the overall SI budget increased significantly during this 12-year period, most budgetary increases have been directed towards capital construction and deferred maintenance. Thus, despite a rising budget for the Smithsonian as a whole, the overall science budget has steadily declined. The NMNH has been especially hard hit in this regard. In spite of these problems, it is important to note the success of SAO and the STRI in maintaining quality staff and research. The lessons learned from these successes must be part of the strategic planning.

APPENDIX H - NMNH INTEGRATING COMMITTEE REPORT
Drs. May Berenbaum and Jack Gibbons, Co-Chairs (January 24, 2000)

The Integrating Review Committee (IRC), consisting of two co-chairs, May Berenbaum and Jack Gibbons, and the chairs of the three independent review committees, Larry Abele (Biology Review Committee), Jane Buikstra (Human Sciences Review Committee) and Alfred Fischer (Earth Processes Review Committee) met 4 times over a 10 month period. Sources of information for the integrating review included the three independent reviews, documents provided by the Director from past reviews, interviews with the Director, Associate Director for Research and Collections, and staff, and information gathered from other contacts and from published sources.

The IRC has carefully evaluated the three independent reviews and the recommendations contained within them, and we have concluded that these recommendations deserve consideration by NMNH management. The function of this document is not, however, to reiterate or elaborate upon those recommendations but rather is to extract overarching themes and to recommend an action plan for the Museum as a whole.

Introduction

The National Museum of Natural History can rightly be regarded as a national treasure. Home to the largest assemblage of scientists dedicated to the study of natural and cultural history, the Museum houses over 140 million geological, biological, archaeological, and ethnological specimens. These collections of plants, animals, fossils, minerals, and human artifacts represent our past and current environment, ecology, and history of the land and waters. For example, these critical collections have provided essential evidence of biodiversity impacts of climate changes in the past and will continue to do so in the future. The federal government has a legal obligation to its citizens not only to care for and protect these collections, but also to thoughtfully enlarge them and provide resources for managing and utilizing them in the future. Large public museums are now more important in this regard than ever, because universities, which used to compete directly, are dwindling in importance as only a few universities with large Museum endowments can maintain collections. Thus, the training of systematists as well comes to be increasingly a museum function.

The research enterprise at NMNH associated with these collections has greatly enriched the collective world body of knowledge. Within life sciences, systematists have produced a series of superb monographs on a wide range of taxa. NMNH life scientists have significantly contributed to our fundamental knowledge of numbers and kinds of macroorganisms on earth. The geological and paleontological collections are second to none in the world and the mineral and gem collection, and the scholarship associated with that collection, are particularly notable. Work on volcanism sets a standard for excellence and the NMNH's designation as the official repository for all governmentally supported collecting activities, including meteorites, makes it a unique world resource for the study of extraterrestrial geology. Within the human sciences, for more than a century,

the collections and scholars have developed an incomparable resource documenting the history of humankind in North America; part of the archival collection has in fact been designated a National Treasure. Exemplary interdisciplinary programs anchored by the human sciences have advanced our knowledge of significant issues ranging from the origins of agriculture to human origins.

The large body of description and classification that has come out of this Museum (and out of all of the others) remains only a dent in the totality of nature and culture: much more remains to be done, and even the present collections could keep investigators busy for a generation or two. Not only must previously unstudied material be identified, described and classified by conventional methods, but old, long-studied material must be reexamined with new tools and techniques, must be reinterpreted in the light of new insights, and may take on new meaning in the light of new hypotheses. This work, which requires long-term stability, is basic to our understanding of nature, and should continue to be the core of museum activity.

But this leads us directly to a problem that besets museums and science in general and the NMNH in particular. To become an expert in the description and classification of some particular group of organisms has historically required an ever greater degree of specialization, and with this comes the problem of insularity. It becomes important to have curators who can not only describe new species and arrange them in new and better systematic systems, but who also can reap the intellectual rewards of discovering new principles about how nature functions. Systematics as a discipline is changing and some recent hires reflect the changes but the overall process at NMNH has been slow.

And this brings us to another problem. Natural history developed out of the desire to classify organisms, and thus museums came to be compartmentalized along a taxonomic structure. But while the members of a biological taxon are related by ancestry, they live dispersed among and interacting in complex ways with thousands of other species. This ecological and evolutionary side of natural history came along much later and is assuming greater importance. At the dawning of the second millennium, the concept of "natural history" of the earth is taking on a new perspective. Throughout its past, the earth has evolved and changed dramatically under such forces as volcanism, plate tectonics, collisions with astronomical bodies, oscillations in earth's orbit, and the evolution of life forms. The exponential growth of human populations and economic activity, especially over the last century, has introduced an entirely new element in the process of evolution in that human activities are now not only discernible on a global scale but actually dominate some key changes in the ocean, terrestrial biosphere and atmosphere. For example, nitrogen fixation by human activity has, over the past several decades, increased from a minor fraction of "natural" fixation processes to a point where it dominates global nitrogen fixation and is still growing rapidly. The totality of the impacts of human activities on the earth has been aptly compared to the impact of an asteroid--only stretched out over several centuries--in terms of loss of biological diversity, and change in atmospheric composition and climate.

Thus, the study of "natural history," so vital to our future, must refocus to this new reality and more explicitly address its implications and opportunities to ameliorate the negative effects of human activities. Such a synthesis of physical, biological, and human knowledge seems unusually well suited as an organizing principle for research at the NMNH. Thus the research challenge at NMNH is to not only maintain its commitment to long-term fundamental research, but to integrate specialized knowledge in ways that advance our capability to understand the complexities of real systems so that we can more intelligently address global change and sustainable futures. It might be argued that to address explicitly issues of anthropogenic change might be politically risky, but as a national museum it is the responsibility of the NMNH to function as an objective, unimpeachable source of data to contribute to discussions of potentially sensitive issues in a larger arena.

The NMNH has much to contribute to this newer focus. Systematic identifications are necessary to the study of communities, and the Museum is involved in numerous ecological and biodiversity projects. The involvement of Paleobiology and Anthropology in ecological studies and in questions of global change at various time scales is noteworthy in this regard. However, these new directions are not as yet reflected in the administrative structure and were inconspicuous in the review process. Some way must be found to legitimize them as part of the museum function. The Biodiversity Programs are a case in point; the administrative structure is not well interfaced or coordinated with the systematic science departments, despite the central importance of biodiversity to these Units.

In summary, we feel that the Museum successfully continues to fulfill the traditional collections-description-systematics function. This activity must continue. However, the NMNH is not known institutionally for having developed great principles and theory, particularly in life sciences, nor has it as yet established a noteworthy position in the ecological and environmental sides of systematics and natural history. The report of the museum Senate of Scientists shows that members of the current staff favor such activities. There are places within the Museum where such studies, of national interest, are being pursued, but the present climate retains much departmental insularity and fragmented vision, in which curators seem to be more concerned with defending their turf than in crossing departmental boundaries to pursue such matters as global change, biocomplexity and conservation - matters which should be writ large in the public displays and should have a recognized place in the research.

Above all, there is need for a greater shared pride in the institution as a whole - a pride that generates responsibility. The NMNH administration is well aware of this need, and is making changes that should ease relations between curators, the public outreach program and the administration. The Public Affairs component of the office of the director merits special attention in this regard. It seems likely that the appointment of one or more prominent and charismatic scientists to the Museum, as well as a stepped-up program of distinguished visitors, would bring a general boost in morale and would aid in generating pride in belonging to a strong team.

Basic Strategy

The first part of our charge was to advise the Museum on strategic directions for its research and collections and to define the Museum's research position in the broader scientific community. One general finding that emerged was that the Museum does not really occupy as prominent a position within the broad scientific community as should be expected based on its history, the quality of its collections, the research activities of individual scientists, and its status as a federal institution. We believe one reason for this lack of prominence is the fragmentary nature of the Museum's vision. There is little sense of institutional identity on the part of many of the professional staff, and this lack of a central sense of direction permeates the research enterprise and compromises the effectiveness of outreach and communication to the greater public. This institution, by statute, serves the public, yet there is a lack of connection to or recognition of the relevance to national needs in its research programs. For example, there is minimal acknowledgment of areas of scientific investigation within the Museum's purview that relate to matters of national concern, including biocomplexity, conservation, global climate change, land-use planning, emerging infectious diseases and commercialization of genes and gene products. There are pockets of excellence throughout the Museum--Units that have achieved international recognition and that address matters of national priority--but there is little apparent coordination among even these Units.

The elements for documenting global change and biocomplexity are currently being assessed and assembled by the scientists of the NMNH. Museums are internationally engaged in such studies, and the NMNH is uniquely positioned to assume a leadership role in this enterprise. The rapid global climate change now induced by human activities and affecting all of life must be viewed against the great changes induced by natural processes and recorded in geology. The Museum is well placed to take this essential avenue of inquiry to a new level, integrating baseline data into this new, important context. To do so, however, requires a new vision for the Museum. We recommend that the Museum ask its strategic planning committee, if appropriate, or establish a new internal working group to define a mission for the Museum that appropriately addresses national needs and priorities. Another possible mechanism is for the Museum to convene a series of "think tank" sessions structured around key issues and open to the Museum community. The IRC feels strongly that setting priorities should be an internal responsibility, accomplished by the Museum community itself through rational discourse and scientific discussion. There needs to be an ongoing science-based effort to identify themes and concerns of the future in the broader public context.

In terms of identifying this mission, there will be many resources available to the committee or working group charged with this task. Among the potentially most useful sources will be the report of the National Research Council's (NRC) Committee on Grand Challenges in Environmental Sciences, currently charged with identifying, describing and prioritizing environmental challenges with the greatest scientific importance, research potential and practical value over the next 10 to 30 years (www.nas.edu/gces). These challenges, with input from leading natural scientists, social scientists, and engineers from around the country, will be presented in a publication prepared by the NRC committee. This publication should serve as a valuable adjunct to NMNH's own

resources for identifying natural history issues of relevance to basic science and to the public at large. No less valuable is the recent publication of the President's Committee of Advisors on Science and Technology (PCAST), Teaming with Life: Investing in Science to Understand and Use America's Living Capital (March 1998, PCAST Panel on Biodiversity and Ecosystems) and the recent NRC publication Global Environmental Change: Research Pathways for the Next Decade (1999).

The IRC was asked to identify the most critical elements of the Museum that are core to its mission and, effectively, to its identity. In addition to its professional staff, the collections must be considered core; management of the collections at the NMNH serves not only the individual researchers but the broader scientific community. The Museum also serves the public at large by identifying, preserving, cataloguing, and exploring specimens to add to the international knowledge base and supplying public exhibits. The NMNH's comparative advantage among peer institutions, its niche, as it were, is the unique nature of its collections and the research based largely on its collections. Critical for the future of biology will be the development of new approaches to documenting biodiversity. These new approaches are necessitated by changing cultural practices and standards; as well as by changing biological environment, in which the pace of extinctions has increased. The national museum community should look to the NMNH for leadership here. Practices relating to collections of human artifacts, fossils, and geological specimens are evolving as well, in view of new levels of cultural, ethnic, and regional sensitivities. The NMNH may want to consider instituting formal training programs in modern curatorial practices and collections management techniques in anticipation of new national needs.

Complementing this collections-based research is the research conducted at the Museum's field stations, which form a network for gathering contemporary data in a wide range of habitat types. Collectively, the collections and field stations make for a research enterprise without parallel in the United States science community. Yet at the same time there seems to be little visible connection to the Smithsonian Tropical Research Institute or other field stations beyond as a base for additional field sites. These sites also offer as a source for intellectual collaborators. Moreover, there are underexploited resources for further networking within the SI framework. Joint programs between the NMNH and the Air and Space Museum on topics of broad public interest such as asteroids or volcanism are ripe for development and expansion, and some joint efforts have already been initiated.

Research and collections should be inextricably linked in an institution such as the NMNH. Without a thoughtfully developed and clearly defined set of criteria and priorities to guide acquisition, the utility of these collections will be diminished. Moreover, this set of priorities must be clearly articulated to the general public, to generate and maintain support. Currently, written acquisition policies are inconsistent at institution, department, and museum levels; although the acquisition process should be essentially research-driven, it is uncoordinated and highly idiosyncratic. Although such idiosyncrasy allows for exploitation of fortuitous opportunity (and thus should not be

abandoned altogether), coordination of effort will allow for building strength and international prominence.

Defining Basic Research Direction and Linkage to New Scientific Hires

The IRC was also charged with defining research directions and linkages to new scientific hires, by assessing current research domains and identifying strengths and weaknesses, and suggesting new areas of research inquiry. Across all three themes--human science, earth science, and biological science--breadth was seen as a definite strength. The NMNH is engaged in a research program that is notable for its coverage of a broad spectrum of disciplines. In human sciences, for example, expertise runs the gamut from ethnology/linguistics to human paleontology. The greatest shortcomings we perceive are in integrating across disciplines and in developing emergent principles within disciplines. The research environment at NMNH has not been conducive to integration of bodies of knowledge such as are needed to understand complex issues such as the ecosystem impacts of climate change. Instead, intentionally or not it has encouraged isolationism. There is a lack of mutual trust and a culture of entitlement that inhibits intellectual ferment and synergism. Unless corrected, this problem will grow more acute in that many of the current research initiatives across the country, reflecting national priorities, demand interdisciplinary approaches. There is a need to highlight the relevance of fundamental science to societal and national issues and to communicate significant research results to the various publics served by the Museum. Accomplishing these objectives will require considerably more entrepreneurship and attention to outreach than has been manifested by Museum staff in recent years.

The IRC was asked to identify generic criteria to drive the Museum's search for new curators. The Museum suffers from the paucity of charismatic, articulate scientific representatives capable of exciting others about research and collections of the Museum. That aptitude must be an important criterion in senior staff hiring decisions. It also should be considered in promotions and professional development. Further scientific hires must be made on the basis of scientific excellence first and foremost, but the ability to "see the big picture" and to articulate that vision are assets of particular importance at the Smithsonian among its scientists. We believe that chief among the issues noted have is an interest in interdisciplinary and integrative research; as well, the ability to communicate the excitement and relevance of museum-based science to the various publics is important. In other words, new curators must "believe" in the mission, once it is articulated by the scientific community. It should be emphasized that new hires must be made within the context of maintaining strength in the museum's tradition of collections-based research and according to "best practices" of recruitment, as applied at top academic programs at universities and museums nationally.

The Museum is experiencing a general lack of visibility and professional recognition for its individual scientists. Some hires in the past seem to have been based on criteria other than scientific promise or prominence. The loss of positions (from 390 in FY94 to 355 in FY99) and absence of substantial turnover (the number of curators over the age of 70 is three times greater today than in 1987) exacerbates this problem of achieving name recognition. A senior-level hire, of a prominent individual who can articulate the mission

of the institution, should be considered a very high priority. For some years, *e.g.*, the Museum has not had a member of the National Academy of Sciences (NAS) on its staff; election to the NAS is a form of recognition for individuals whose contributions are broad and long-lasting. Important and exemplary as NMNH researchers have been in classifying living and extinct species, it was scientists at the American Museum of Natural History and the Museum of Comparative Zoology who led the modernization of evolutionary theory and reaped the institutional honors for this work. This individual should possess the communication and leadership skills to bring together the different constituencies of the Museum in defining and carrying out its intellectual functions. A senior hire of this sort, although potentially expensive, contributes to the goal of quickly establishing (or re-establishing) the NMNH as a leading institution. However, as well, younger scientists with the potential to develop into NAS-caliber leaders in the field should be encouraged and rewarded in order to develop that potential. Such development will pay dividends over the long term.

New hires should be in areas that add to the breadth of coverage and also provide an opportunity to take advantage of new research initiatives and collaborative opportunities in fields perceived as high national priorities. The growing area of bioinformatics dovetails nicely with strengths in systematics; excellent opportunities exist for integrating computer technology with biology to create new information frameworks. As well, the growth of conservation biology places new emphasis on the field of molecular evolutionary genetics in defining new species boundaries and in evaluating prospects for preservation. Complete coverage of the biosphere should include the microbial component of diversity and its invaluable contribution to ecosystem function (including extreme environments).

Creating External Support for Science

A third major charge to the IRC was to provide advice on enhancing financial support for scientific research. This external support is needed to permit the NMNH to fulfill its social responsibility; it is also needed to allow the institution to garner new resources particularly in view of the prospect of declining federal appropriations. Mechanisms for achieving this goal recommended by IRC include:

1. Appointing a science advisor or providing senior scientific counsel and assistance to the Museum's capital campaign/development office.
2. Conducting an orchestrated disaggregation of development, fostering Unit fundraising and engaging senior researchers by promoting more extensive interaction with Congress and various publics. A special effort should be made to coordinate fundraising efforts across the institution in view of the absence of a central capital campaign. Better interaction between development officers and scientific staff is a necessity irrespective of the eventual organization of fundraising efforts.
3. Breaking down barriers to entrepreneurship and rewarding individuals who are successful in creatively accessing other forms of funding, especially access to federal agencies such as NEH, NSF, DOE and NASA via consortia and joint ventures with

NGOs (especially universities), interacting with agencies to open up eligibility, and assisting staff with information on priorities, opportunities, and mechanisms for funding.

4. Exploring new sources of external funds for research, including industry and private foundations. There is a general expectation in the fundraising community that due to a changing tax structure, the number of private philanthropic foundations will increase. Several of the proposed newly emphasized initiatives (*e.g.*, biodiversity) should be appealing to foundations.
5. Creating a dynamic Internet presence that is science-based and attractive to the general public. The current web page does not meet modern standards. Web-based communication is today an essential element of science outreach and the Museum is missing an opportunity to connect to its broader publics.

Of these initiatives, the one that can be most rapidly implemented (and the one with perhaps the greatest impact in generating public support) is upgrading the Internet presence. Given the remarkable outreach potential of internet communications, an upgrade that would make the NMNH site the "gateway" site to natural history inquiries (which, considering its status in the public mind is an achievable goal) could potentially increase the support base rapidly and substantially. We understand that some of the other recommendations (*e.g.*, appointing a science advisor and fostering Unit fundraising) are in the process of implementation and we applaud these efforts.

Recommendations for Action

Within the context of the overall charge, the IRC has several recommendations for action. These include personnel policies, infrastructure/space issues, and science administration policies.

With respect to personnel policy, we recommend revisiting the weighty PAEC and consider replacing this formulaic mechanism with more individualized reviews, designed to fit each job description and allowing for qualitative input rather than accommodating a generalized and rigidly quantitative formula. More peer input, rather than collegial assessment exclusively, would be desirable. An evaluation system involving both internal and external examiners has considerable merit, as does integrating more effectively the PAEC with the annual performance reviews. As well, definitive actions by administrators should be taken on recommendations and results of the reviews should be communicated more effectively to personnel. The reward system is in need of reexamination; if salary rewards for excellence are constrained by budget, alternative mechanisms must be explored. Options include providing seed money for project startup, travel funds for staff, and instituting prizes, bonuses and other forms of recognition for achieving specific career goals or for major research accomplishments. Other incentives for promoting excellence include authorship for curatorial assistants and recognition for outstanding contributions with limited release time for research. Use of sabbaticals and change of duty stations should be encouraged to foster awareness of new developments in

relevant research areas nationally and internationally. We also urge management to lead efforts to nominate appropriate staff for external recognitions and awards.

One additional mechanism for speeding the process of achieving institutional improvement would be to develop incentives for retirement for eligible individuals whose productivity is in decline.

With respect to infrastructure matters, we have four recommendations:

1. We recommend that decisions on space be made systematically, not on an ad hoc basis. Long-term comprehensive planning is urgently needed and should address the needs of exhibits, collection, and personnel. Also in need of addressing are the relative merits of space assignments in the Mall vs. MSC. The Laboratory for Molecular Systematics, *e.g.*, might be more efficient at serving the needs of colleagues were its staff in closer proximity on the Mall. Connectedness between sites could be improved by increasing the frequency and accessibility of transportation between them. The NMNH also has to make plans to insure that space for collections remains adequate in both quality and quantity in the future, particularly if the level of participation in biodiversity inventory projects increases. The present facilities will not be sufficient.
2. Computing and communications should be rationalized and standardized. Data and image compatibility and formatting, particularly in the collections, should be a priority, and web interfaces should capture relational databases. The progress of collections-based science is heavily dependent upon computer access and electronic cataloging.
3. Discussion should be initiated on the advisability of developing core research service facilities, to reduce duplication and enhance efficiency. A DNA core sequencing facility is one example: at present, approximately \$777,000 is being spent annually in the Molecular Systematics Laboratory for a total of 8 staff. Shared use would better serve to justify this investment. The CT scanner in Anthropology, as well, is not presently utilized because no technical help is available within the department. A core facility, with shared use and expenses, would make this instrument a more valuable asset. Current facilities, such as the libraries, should be brought into the strategic planning discussions, to insure that their general utility to the research community is maintained.
4. Technician and budget allocation should be standardized, based on activity and need, and not historical precedent. For example, Botany, with a curatorial staff of 17, reports 13 research assistants while Entomology, with a curatorial staff of 11, has 5 research assistants. We doubt that this discrepancy reflects vastly different workloads but rather reflects different job classifications. Administrative consistency is needed in reporting line allocations. Some explicit rationale should be developed that reflect the true function of (and legitimate need for) support help as well as budget. This rationale should reflect the twin goals of collections work--maintaining the

collections in usable, accessible condition, and conducting original research with the collections materials. Merit must be of primary importance in decisions about line allocations at any level.

With respect to science administration, we have a number of recommendations:

1. There is an urgent need for a scientist presence on the Executive Committee; it is inconceivable to think that this committee can function efficiently and in a representative way without direct and continuing input from scientists. This might be effected by establishing a Science Council, representative of earth, human, and biological sciences at NMNH and having the Council Chair as a member of the Executive Committee.
2. The museum should dedicate a percentage of positions to accommodate short-term (one to three years) visitors--postdoctoral students, research associates, and senior scholars from other institutions. The Museum should consider establishing a distinguished scholar-in-residence program that could be named in honor of a major donor. These actions could serve well to keep museum scientists apprised of new developments and new approaches within their fields and could facilitate interactions among the museum staff. We understand that grant applications have been made to support this sort of activity and we applaud these efforts and encourage their continuation. In addition, we exhort the administration to resist temptations to exploit funds set aside specifically for visiting scholars and divert them to other purposes.
3. Funds and infrastructure should be restored to allow the NMNH to increase the frequency with which it hosts international conferences, workshops and colloquia. Such an investment will go far in allowing the museum to gain higher visibility in the scientific community.
4. Connectedness with the science community at large could be improved by implementing a greater number of "courtesy appointments" to NMNH of key researchers at allied institutions (USDA, USFW, NOAA) and within SI. Courtesy appointees would be invited to participate in departmental meetings and generally contribute to the intellectual atmosphere within the Unit. Where courtesy appointments have long existed but have been underutilized (*e.g.*, in vertebrate zoology), efforts should be made to include a greater number of allied researchers in museum activities on a regular basis. One mechanism for fostering such connectedness is to convene regular, informal disciplinary interest groups that cross administrative barriers. The possibility exists that NMNH staff could look inwardly at those Units that have succeeded in integrating allied scientists into their activities (*e.g.*, Entomology) and identify successful strategies that have been used to accomplish that integration.
5. An effort should be made to enhance continuing professional development. This goal can be achieved by funding regular seminars with outside speakers, newsletters, and the like, and providing regular information technology training that is affordable and

accessible. Critical, too, is leadership training for department chairs. Included in this leadership training should be an emphasis on "institutional thinking," such that chairs and other administrators act not only for the good of their Unit but for the collective good of the institution when opportunities arise.

6. The museum is to be commended for putting in place new communication mechanisms; these efforts should continue. Directors should meet regularly with senior staff on matters of common interest and meetings open for staff input should also be held on a regular basis. Informal luncheon "brown bag" luncheons with small groups of staff can be very effective. Such meetings aid rumor control and promote a sense of community and a spirit of collegiality.
7. Collections management should be informed by the curatorial staff and by periodic review. That management of and authority over the collections are now at the departmental level is an excellent step toward instilling a science-based collections strategy. The newly constituted museum-wide collections committee should play a critical role in overseeing and coordinating these efforts. The ultimate goal is to insure that the needs of individual investigators complement and reinforce institutional goals.
8. Exhibits planning and execution should be tied to staff and should take advantage of institutional strengths; doing so will advance the tripartite mission--research, collections, and outreach. As an example of failure to do so, during spring 1999 the Smithsonian, on the initiative of the Provost, presented an exhibit on microbes that was composed entirely by external experts and funded by a private corporation; apparently, no Museum input was solicited or provided. The IRC recognizes that efforts to solicit and integrate scientific staff input are underway and encourages continued support for these efforts. The Museum should be innovative in developing new models of outreach to expand its influence.

Coda

We are aware of previous efforts to evaluate certain aspects of the Museum; specifically, after completing our review, we became aware of the report of McKinsey and Co., Inc. in 1987, and are struck by the similarities between their recommendations and ours, separated by 12 years. For example, Chapter 1 of the McKinsey report "offers ideas about strategies for science and public programming." These include:

"Encourage individual initiative, but pay particular attention to fostering the growth of multimember, interdisciplinary, outward-looking research projects..."

"As a general rule, recruit the best young scientists in a field..."

"Harness compensation and personnel systems to reward productivity, defining productivity in such a way as to enhance quality and emphasize completion of the publication process."

These strategies are identical to several of those described in our report. Accordingly, we request an update from Museum management after one year to chronicle the actions taken in response to this review.

In conclusion, the IRC recognizes that the NMNH has served the nation well in the past and it is uniquely poised to play a role in the prediction and solution of problems to the nation and humanity as a result of anthropogenic global change. We hope that this report will help the staff and management to strengthen the existing programs of discovery and outreach and to prepare for the new challenges that are arising from the increasing impingement of human activities on the natural and cultural environment.

APPENDIX I – NMNH SCIENCE COUNCIL REPORT
Future Directions of Research at the National Museum of Natural History

NMNH Science Council (October 2000):

- Melinda Zeder (Chair, Anthropology)
- Kevin deQueiroz (Vertebrate Zoology)
- Douglas Erwin (Paleobiology)
- Brian Huber (Paleobiology),
- John Kress (Botany)
- Wayne Mathis (Entomology)
- Timothy McCoy (Mineral Sciences)
- William Merrill (Anthropology) and,
- David Swofford (Laboratory of Molecular Systematics)

EXECUTIVE SUMMARY

During the past three years The National Museum of Natural History (NMNH) has undergone an unprecedented process of external review and self-reflection. The ultimate goal of this process has been to chart a new research vision that would position the Museum to take a leadership role in critical 21st century issues in natural history science. Secretary Small's subsequent call for a focused Smithsonian-wide science plan was a welcome sign that the ongoing effort at Natural History could play a productive role in this critical Institutional initiative.

The NMNH Science Council was created in March 2000 as a response to recommendations of external reviewers who called for the formation of an internal advisory panel capable of looking across the breadth of NMNH research. The Council's first charge was to work with the recommendations of the external review, the internal analyses that preceded this review, and our own understanding of the strengths of NMNH science, to develop a focused strategic plan for the future of research. This report presents this plan. The report also outlines the plan's relationship to the broader scientific enterprise in the NMNH, the Smithsonian, and the nation, and considers some aspects of its implementation.

A Plan for NMNH Basic Research

Over the past six months Council discussions have centered on developing a unifying mission for NMNH basic research. We have been mindful of the external reviewers' recommendations that the Museum must retain the breadth of research essential for synthetic, integrative perspectives on natural history. We have also been cognizant of the Secretary's call for greater focus in Smithsonian science. In developing our plan for NMNH research, we evaluated potential growth areas against three criteria:

1. Does the research have resonance with the strategic recommendations of the external review and the broader global science agenda?
2. Is it consistent with our own research mission, which we have identified as:

To increase understanding of geological, biological, and cultural patterns and processes that shape our world from the beginning of the solar system into the future.

3. Does it take maximum advantage of the unique attributes of the NMNH research environment, which include:
 - a. The potential for long-term basic research;
 - b. The potential for integrative research;
 - c. The value of our unparalleled collections in pursuing research objectives; and,
 - d. The diverse avenues open to us for dissemination of research to serve large and varied constituent audiences?

Using these criteria, we have identified nine cross-cutting themes within the three primary NMNH research domains. These themes make the most of the Museum's breadth and potential for integrative science, while giving our research enterprise new direction and focus. Within each of these nine research themes we have also developed a number of sub-themes (stated in question form) that, in turn, give more focus to our research vision. Exemplar research questions are presented within each sub-theme to provide even greater clarity on these research directions. A schematic presentation of the domains, themes, sub-themes, and related questions identified as future growth areas follows.

NMNH research domains, themes, sub-themes, and questions targeted for future growth.

I. EARTH AND OTHER PLANETARY SYSTEMS

A. Geological Processes that Shape Planetary Systems

1. What are the processes that lead to the birth of solar systems and that shape their subsequent evolution?
 - \$ What was the range of materials and processes operating in the solar nebula during the birth of our solar system?
 - \$ How much time elapsed from collapse of the solar nebula to the formation of planets?
2. How did planets, such as the Earth, differentiate to form a core, mantle, and crust?
 - \$ Did the Earth accrete from differentiated small bodies, or did it accrete cold and then melt and differentiate?
 - \$ What are the physical and chemical processes operating, and on what timescale, during planetary melting and differentiation?
 - \$ Why did these processes operate efficiently on larger planets, such as Earth, but not on many small asteroids?

B. Lithosphere, Climate, and Ocean Dynamics and their Interactions with Biological Systems

1. What is the role of perturbations in climate and oceans on major transitions in the evolution of life?
 - \$ How have changes in the tilt of Earth's axis and its orbit affected climate and the evolution of life?

- \$ How have extra-terrestrial impacts, climate change, anoxic oceans, and other environmental perturbations affected Earth's biota?
- 2. How do minerals near or at the surface of the Earth influence the climate and biota of Earth?
 - \$ How do minerals interact with the atmosphere and hydrosphere in Earth's surface environment?
 - \$ What role have mineral/microbial interactions played in the origin and persistence of life on Earth and the possibility of life on other planets?

C. Tectonic and Volcanic Processes and their Impact on the Biosphere and Atmosphere

1. What processes create the range of observed volcanic activity?
 - \$ How do variations in plate tectonic processes affect the compositions, textures, and mineralogies of associated rocks?
 - \$ Why do volcanic eruptions involving magmas of similar composition range from relatively gentle outpourings of lava to violent ejections of ash and pumice into the atmosphere?
2. What are the space/time patterns and consequences of volcanic activity?
 - \$ What is the relative difference in edifice size, eruption frequency, and eruption magnitude of volcanoes on land versus those under the sea?
 - \$ Can analysis of global patterns of eruption precursors be used to forecast the style, magnitude, and timing of eruptions in their early stages, mitigating their hazards?
 - \$ Is there a causal link between large igneous flood basalt eruptions and biotic extinction?
 - \$ What are the effects of volcanic eruptions on Earth's climate?

II. EVOLUTION, DIVERSITY, AND DYNAMICS OF LIFE

A. Biotic Diversity and Phylogenetic Patterns

1. What are the evolutionary relationships among groups (clades) of organisms at various taxonomic levels?
 - \$ What is the variety of the Earth's species, and how did it evolve?
 - \$ How are major groups of organisms related to one another?
2. How do developmental and evolutionary processes influence morphological, behavioral, and genetic characters?
 - \$ What does a comparative approach to developmental processes reveal about morphological evolution?
 - \$ How can evolutionary processes be understood through a comparative phylogenetic analysis of morphological, behavioral, and genetic characters?
 - \$ What are the phylogenetic, structural, developmental, and other constraints on adaptive evolution?
3. How do environmental, ecological, and phylogenetic factors influence the distribution of organisms?
 - \$ What factors influence past and present biogeographical distributions of plants and animals?

- \$ How does the physical and biotic environment of a species influence its distribution?
- \$ How have human activities affected the distribution of species?

B. Evolutionary Processes that Shape the Diversity of Life

1. What are the ecological and developmental contexts for the origins of various groups (clades) of organisms, from microbes to humans?
 - \$ To what extent are changes in the physical environment (geochemical cycles, ocean chemistry, climate, etc.) responsible or permissive for major evolutionary innovations, including the divergence of clades?
 - \$ What is the relative significance of ecological opportunity versus evolutionary innovation in the origin of clades at a variety of hierarchical scales?
 - \$ How do developmental innovations interact with changes in the physical environment and with ecological interactions in the establishment of new clades?
 - \$ How do environmental and ecological interactions among species and individuals influence biological diversification?
2. What are the processes that drive extinctions and recoveries at a variety of scales, particularly at the level of mass extinctions and recoveries?
 - \$ How do mass extinctions differ from background extinctions, including recent human-influenced extinctions?
 - \$ What factors control post-extinction biotic recoveries?
 - \$ What is the linkage between mass extinctions and significant transformations in the history of life?

C. Ecological Dynamics and Conservation Biology

1. What is the relationship between biodiversity and ecosystem dynamics?
 - \$ How do we measure biodiversity and how do these measures relate to the identification and preservation of endangered habitats?
 - \$ Does phylogenetic position have relevance to the conservation of species and habitats?
 - \$ What are the characteristics of invasive species and how does their phylogenetic distribution help to identify other potentially invasive species?
 - \$ What is the role of biodiversity in ecosystem dynamics over time, and how has this changed since the origin of humans?

III. HUMAN DIMENSIONS OF DIVERSITY AND CHANGE

A. Human Interaction with the Natural Environment

1. What role did adaptation to environmental change play in human evolution and increasing cultural complexity?
 - \$ What is the relationship between environmental change, the evolution of the human lineage, and the development of human locomotion, technology, social behavior, cognitive skills, and language?
 - \$ What factors influenced human movement into new environments, and

- what were the environmental and cultural consequences?
 - \$ What role did changing environmental conditions play in the domestication of plants and animals, and what was the subsequent impact of agriculture on global ecosystems and human societies?
- 2. What are the relationships between biological, cultural, and linguistic diversity on local, regional, and global levels?
 - \$ Do factors that threaten or promote diversity in one of these spheres have an impact on the others?
 - \$ How do language and other cultural traditions serve in the acquisition and transmission of environmental knowledge?
 - \$ How do humans use their understanding of the natural world to develop strategies for the use of natural resources, and how does increasing globalization influence this process?

B. Human Biology and Cultural Process

1. How have cultural and evolutionary processes shaped human genetic and morphological diversity?
 - \$ To what extent does human morphology, especially in skeletal morphology, reflect differences in environment, diet, occupational activities, socio-economic status, and other cultural factors?
 - \$ What is the impact of human migrations, on cultural, linguistic and genetic diversification?
2. How have changes in culture and environment affected human health and population structure?
 - \$ How have major cultural developments (e.g. agriculture, urbanism, and occupational specialization) influenced patterns of health and disease in human populations?
 - \$ How have these changes affected human population size, demography, and distribution?

C. Human Communities in a Changing World

1. How do members of human communities develop, maintain, and transform distinct cultural identities, traditions, and languages?
 - \$ How does cultural and linguistic variation affect the formation of cultural identities, and what is the significance of this variation for understanding fundamental features of culture and language?
 - \$ What role do expressive culture (e.g., ritual, dance, theater), material artifacts (e.g. pottery, textiles, art), and language play in the formation of cultural identities?
2. What processes direct cultural and linguistic change when communities are integrated into more encompassing political and economic systems?
 - \$ How do the members of a society sustain a sense of community and shared identity under conditions of diaspora, domination, and globalization?
 - \$ Under what circumstances do humans either emphasize or downplay their cultural and linguistic differences with respect to other human

communities?

- \$ How has the changing pace and breadth of the global expansion of economic, political, and communication networks affected cultural diversity over time?

Many of these themes represent current strengths which we should build upon. Existing high profile research programs in meteoritics, paleoclimatology, volcanism, systematics, extinctions of life, the history of human/environmental interactions, and human skeletal biology all represent traditional strengths of NMNH science that must be featured in any plan for our future.

Other themes highlight new or currently underdeveloped research areas that we believe the Museum should move into energetically. The study of microbial/mineral interactions in shaping the Earth's atmosphere and in the origins of life is an emergent research area that the Council (and external reviewers) highlighted as presenting special opportunities for future NMNH science. Our strengths in the study of phylogenetic patterns and evolutionary processes, coupled with our outstanding taxonomic capabilities, represent a special opportunity for the Museum to make significant contributions in the area of environmental conservation. Centering our studies of human cultures on questions of culture change within the context of globalization allows us to re-channel traditional anthropological strengths toward understanding the loss of cultural, linguistic, and biological diversity world wide.

We have also tried to identify areas that are no longer central to our research mission. This has been a difficult task, and while we have made considerable headway, we have not yet been able to reach final consensus. Instead of holding back our report until these discussions have been concluded, we have decided to forward our vision for future research growth to aid the Museum's and the Institution's ongoing discussions on Smithsonian science.

Other Considerations in Realizing the NMNH Research Vision

Although our primary task has been the development of a strategic plan for NMNH basic research, we needed to acknowledge other key issues that must be considered in realizing this vision. We offer our perspectives and initial recommendations on these critical topics, expecting that each of these areas will be the focus of future Council deliberations.

Applications of Basic Research to Societal Needs

The applications of NMNH research to meeting the needs and interests of our diverse constituent audiences are immense. Our ability to reach varied audiences, ranging from school children to scientific colleagues, is a special opportunity and responsibility we all share as museum-based researchers. While certain members of the NMNH community are more active in these areas than others, it is important to recognize that research across the whole spectrum of NMNH science has important applications to public education, governmental policy formulation and implementation, criminal investigation, and even to the use of our science to help prevent hazards to aviation.

The close and mutually supporting linkage between our basic research and its application to real life problems is critical. Our strong basic natural history science provides the authority needed to make substantial contributions to national and international needs. In turn, active engagement in these activities brings our basic research an information base, scope, and recognition found in few other research institutions. It is essential that planning for the future of NMNH research be undertaken with an understanding of the linkage between basic research and its direct applications to society, their respective financial and infrastructural needs, and the different potential funding streams that might support them.

NMNH in Broader Smithsonian and Global Science Networks

The place of NMNH research in the broader Smithsonian and global science agenda is another important topic that must be taken into consideration in planning for the future of NMNH research. Indeed, while our research plan is directed at providing a coherent museum-scale blueprint to guide future internal resource allocation, we have made constant reference to these larger science contexts and networks in identifying areas that represent promising niches for NMNH science.

With the addition of a fourth focal research domain that concentrates on the origins and structure of the universe, we believe that the focal domains of research highlighted in our plan encompass the entire range of scientific enterprise at in the Smithsonian:

- C **Large Scale Structure of the Universe:** *SAO*
- C **Earth and Planetary Systems:** *NMNH, SAO, NASM, SERC*
- C **Evolution, Diversity, and Dynamics of Life:** *NMNH, STRI, SERC, NZP, CRC*
- C **Human Dimensions of Diversity and Change:** *NMNH, SCMRE, STRI, SERC, NZP, NASM, and NMAH, NMAI, Folk Life, Anacostia, Art Museums.*

Different bureaus bring different strengths, emphases, and perspectives to research conducted within these broad domains, and each bureau must seek to define its special strengths in this larger science milieu. One of the challenges that faces the Smithsonian as it charts its larger Institutional vision is how to maximize opportunities for inter-bureau synergy in a way that brings added depth and cross-illumination to Smithsonian science. It is important not to mistake areas of complementary overlap between bureaus for examples of wasteful duplication or redundancy.

We also feel that the Museum and the Institution must connect our research with the broader national and international science community. This includes:

- C Expanding our collaborative research networks outside the Institution;
- C Building on our research and service relationships with other federal agencies;
- C Increasing our role in shaping national and international policy; and,
- C Capitalizing on the increasingly central place of our research strengths in major science funding initiatives.

Implementation

Finally, we offer several recommendations for the critical phase of implementation. Specifically, we mention several infrastructural improvements needed if the Museum is truly to lead in the areas identified here. These needs include:

- C Enhanced instrumentation, computational, and analytical capacities;
- C A robust bioinformatics network;
- C Collections development and support;
- C Expansion and professional development of research support staff; and,
- C Support for library facilities and services.

We also touch on the challenge the Museum faces over the next five to ten years to further our research objectives by wisely and creatively allocating resources freed by anticipated staff retirements. In addition, we hope that the Museum can use its more clearly articulated and focused research vision to seek additional sources of funding.

On the issue of new hires the Museum must be prepared to pay the price to recruit rising stars working on research that complements our research vision. We also recommend that the Institution expand its outstanding pre- and post-doctoral fellowship program, and that the Museum create a number of (preferably endowed) post-doctoral positions in targeted research areas and other “non-traditional” short-term, training, and post-doctoral appointments.

Above all we urge the Museum to make a commitment to the implementation of its science vision, whether it be the plan put forward by the Council or some other plan. The past three years of introspection, critique, review, discussion and debate is unprecedented in the entire history of the Museum. All of the laudable efforts of Museum staff and outside scholars will be for naught, however, if we do not move surely and decisively into this next phase of implementation.

APPENDIX J - NATIONAL ACADEMY OF SCIENCES
Executive Summary, Findings, and Recommendations (October 31, 2002)

EXECUTIVE SUMMARY

The Smithsonian Institution (SI) was established as an independent trust instrumentality in 1846 dedicated to “the increase and diffusion of knowledge among men” as laid out in John Smithson’s bequest to the US government. To accomplish its mission, the Smithsonian throughout its history has combined high quality research conducted by its scientific research centers with public outreach through exhibitions of its collections in museums. Although the Smithsonian’s science centers and their research are highly regarded by the scientific community, they are much less well known to the general public than their museums.

The Smithsonian Institution receives an annual federal appropriation toward its operating costs, which includes funds in support of research at the Smithsonian. In the FY 2003 presidential budget, the Office of Management and Budget (OMB) called for a review “to recommend how much of the funds directly appropriated to the Smithsonian for scientific research should be awarded competitively,” and proposed to transfer these funds to the National Science Foundation (NSF). Specifically, OMB expressed concern about the Smithsonian’s classification of its allocation of federal research funds as “inherently unique”—that is, research programs that are funded without competition.

The apparent absence of competition in the Smithsonian science centers raises concerns about a lack of quality assurance in Smithsonian research. Moreover, it is fair to ask whether the federal support given to the Smithsonian’s science programs could be used more effectively for science if the funds were awarded through a competitive process open to all researchers. After the release of the budget document, the Smithsonian commissioned reviews by the National Academy of Sciences (NAS) and the National Academy of Public Administration (NAPA) to address the questions raised by the OMB. This is the report of the NAS review; the NAPA study will be the subject of a separate report.

The Committee on Smithsonian Scientific Research was charged to provide specific recommendations and a rationale with criteria on what parts of the Smithsonian’s research portfolio should continue to be exempt from priority setting through competitive peer reviewed grant programs because of uniqueness or special contributions. The charge to the Committee called for a review of the scientific research centers that report to the Smithsonian’s Under Secretary for Science - the National Museum of Natural History, the Smithsonian Astrophysical Observatory, the National Zoological Park, the Smithsonian Tropical Research Institute, the Smithsonian Center for Materials Research and Education, and the Smithsonian Environmental Research Center. The Committee was also charged to consider the effects on the Smithsonian, the research centers, and the relevant scientific fields of re-allocating the current federal support to a competitive process. Finally, the Committee was asked to make recommendations on how any Smithsonian science programs that continued to receive direct federal appropriations

should be regularly evaluated and compared with other research in the relevant fields. The Committee was not asked to review the funding of SI research centers that report to the Smithsonian's Under Secretary for American Museums and National Programs.

To respond to its charge, the Committee examined the research programs and the funding structure at the six Smithsonian scientific research centers. It also considered possible consequences of removing direct federal appropriations to the Smithsonian science programs and reallocating the funds to open competition.

In carrying out its review, the Committee established a framework of criteria to be applied to its review of the Smithsonian research centers in the execution of its task. The Committee considered

- The nature of the Smithsonian as a scientific institution.
- How uniqueness and special contribution apply to each of the six science centers covered by the study. In the context of this study, uniqueness and special contribution may have many meanings that refer to special attributes associated with a particular research center.
- How opening some of or all the support now given to each of the centers to a competitive process would affect the science involved.
- How the centers might be evaluated regularly to ensure that the quality of their science is maintained if any of the six are deemed to be unique and to warrant continuation of the current system of support.

The six research centers, taken together, embody SI's research program and constitute the mechanism whereby SI carries out its charter to increase and diffuse knowledge. The Committee considered the work of each SI Unit, its role and status in the scientific enterprise, and whether the terms uniqueness and special contribution should be applied to its research. In arriving at its findings, conclusions, and recommendations, the Committee drew on information received from, and interviews with, representatives of the central offices of the Smithsonian and the research centers, on the expertise and relevant knowledge of the Committee members themselves, and on informal contact with members of the wider scientific community.

FINDINGS AND CONCLUSIONS

A: The research performed by the National Museum of Natural History, the National Zoological Park, and the Smithsonian Center for Materials Research and Education is inextricable from their missions and is appropriately characterized by the terms unique and special contributions.

B: The Smithsonian Astrophysical Observatory, the Smithsonian Environmental Research Center, and the Smithsonian Tropical Research Institute are world-class scientific institutions that combine facilities, personnel, and opportunities for specialized long-term research that is enabled by the stability of federal support. These Units are engaged in research that supports the mission of the Smithsonian

Institution as a whole - increasing knowledge and providing supporting expertise for the activities of other SI Units, including educational activities.

- C: Funding for research at the Smithsonian's research centers comes from a mix of sources, including a substantial fraction received through open competitive programs.
- D: The Smithsonian Institution plays an important role in the overall US research enterprise and contributes to the healthy diversity of the nation's scientific enterprise.
- E: Mechanisms at the Smithsonian scientific research centers for evaluating overall scientific productivity and for evaluating the productivity of individual scientists are variable and inconsistent.
- F: Communication between the research centers and the central management of the Smithsonian Institution appears to be weak.

CONSEQUENCES OF TRANSFERRING FEDERALLY APPROPRIATED RESEARCH FUNDS FROM THE SMITHSONIAN

The following findings and conclusions stem from the Committee's consideration of the consequences of reallocating the federal funds appropriated currently to the Smithsonian to a competitively peer-reviewed program at NSF.

- G: In general, transfer of all federal research funds (including salary and, in some cases, infrastructure support) would greatly reduce and possibly eliminate the role of the federal government in the long-term support of the core scientific research staff who provide the foundation of the Smithsonian research program. A withdrawal of federal support of this magnitude would make maintaining the staff and programs of the centers extremely difficult and would very likely lead to the demise of much of the Smithsonian's scientific research program.
- H: Transferring the federally appropriated research funds for the National Museum of Natural History and the National Zoological Park to competitive programs at the National Science Foundation is likely to jeopardize their standing in the museum and zoo communities and could seriously damage aspects of their nonresearch roles. If the fund transfer were large and included salary support, the positions of critical museum and zoo personnel could be threatened. Loss of core funds could also lead to the closure of the Smithsonian Center for Materials Research and Education.
- I: Transferring directly appropriated funds from the Smithsonian Astrophysical Observatory, the Smithsonian Environmental Research Center, and the Smithsonian Tropical Research Institute to a competitive mechanism while trying to maintain the centers in the Smithsonian could produce consequences ranging from moderately or seriously deleterious to termination of their operations.

- J: The Committee could not identify any substantial advantages with respect to organization, management, or quality assurance that would accrue from changing the current system of federally appropriated research funding for the Smithsonian Astrophysical Observatory, the Smithsonian Environmental Research Center, and the Smithsonian Tropical Research Institute.
- K: The Committee identified little or no scientific benefit of transferring federal funds away from the Smithsonian. The implications for the relevant scientific fields are likely to be adverse.
- L: The broad mission of the Smithsonian Institution would be compromised if the links between the Smithsonian and its research centers were broken by transferring sponsorship of the centers to the National Science Foundation.

RECOMMENDATIONS

1. Research is an intrinsic part of the mission of the National Museum of Natural History and the National Zoological Park. These centers should continue to be exempt from open competition for research funding because of the uniqueness and special contributions conferred by association with their collections.
2. The Smithsonian Center for Materials Research and Education occupies a highly specialized research niche that is of unique and major value to museums of the Smithsonian Institution and to the museum community at large. Hence, the Committee believes that the center should continue to be exempt from open competition for research funding because of its uniqueness and special contributions to the museum community.
3. The Committee believes that the Smithsonian Astrophysical Observatory, the Smithsonian Tropical Research Institute, and the Smithsonian Environmental Research Center should continue to receive federally appropriated research funding. Use of public funds by these facilities is already producing science of the highest quality. Much of the “research funding” (for other than salary and infrastructure costs) is already obtained via competition. Any benefits of shifting these three facilities to the jurisdiction of another organization would be greatly outweighed by the harm done to their contributions to the relevant scientific fields.
4. Regular in-depth reviews by external advisory committees are essential for maintaining the health, vitality, and scientific excellence of the Smithsonian Institution. Although details of the nature and processes of the reviews may vary to accommodate differences among the six centers, such institutional reviews should be uniformly required for all six Smithsonian science centers and for their individual departments, if warranted by their size. Retrospective external peer review is especially important for areas not routinely engaging in competition for grants and contracts. Regular cycles of review followed by strategic planning offer the best means of ensuring that the quality of SI’s science is maintained.

5. The research programs at the Smithsonian Institution provide essential support to the museums and collections, make substantial contributions to the relevant scientific fields, and fulfill the broader Smithsonian mission to “increase and diffuse knowledge.” The Committee urges a stronger sense of institutional stewardship for these research programs as integral components of the Smithsonian. The Secretary and the Board of Regents should improve communication with the research centers and become strong advocates for their goals and achievements in a manner that is compelling to the Executive Branch, Congress, and the public.

APPENDIX K - NATIONAL ACADEMY OF PUBLIC ADMINISTRATION
Executive Summary, Conclusions, and Recommendations (October 31, 2002)

The Smithsonian Institution is a unique organization, established in 1846 “for the increase and diffusion of knowledge among men.” It has grown over the years and is now composed of 16 museums and galleries, the National Zoo, and numerous research facilities in the United States and abroad. The Smithsonian participates in the annual federal budget process to receive funding through the federal appropriations process. In Fiscal Year (FY) 2001, it received 57 percent of its funding through federal appropriation. The remainder came from government grants and contracts, contributions and private grants, business ventures, and investment earnings.

During development of the FY 2003 budget, several issues arose concerning funding of scientific research in the Smithsonian. The President’s FY 2003 budget indicated that, of all the research “agencies” listed, only the Smithsonian did not subject its research to any form of competition. The budget proposed to increase competition by transferring some of the Smithsonian budget to the National Science Foundation (NSF) where it could be used to fund research for which Smithsonian and other organizations researchers could compete. The Smithsonian objected to the characterization of its research and the transfer.

The National Academy of Public Administration (NAPA) and the National Research Council (NRC) of the National Academy of Sciences were jointly commissioned to study this issue. NRC’s assignment was to determine whether there are research programs at the Smithsonian where funding should be awarded through a competitive grant process open to all public and private sector researchers. NAPA’s assignment focused on determining Smithsonian research program costs; examining research management models used by other academic institutions, museums, and private organizations; and identifying factors that might give the Smithsonian scientists an unfair advantage over others when competing for funds.

The studies’ scope includes the six science centers that report to the Smithsonian’s Under Secretary for Science:

- the National Museum of Natural History
- the Smithsonian Astrophysical Observatory
- the National Zoological Park
- the Smithsonian Tropical Research Institute
- the Smithsonian Center for Materials Research and Education
- the Smithsonian Environmental Research Center

In carrying out its assignment, the NAPA Panel looked at various topics, including the reliability of budget figures for Smithsonian research, the degree to which competition is a factor in Smithsonian research funding, and factors that may produce an uneven “playing field” in the competitive processes. Because of the organization of the study, some of NAPA’s work in these areas was dependent on the NRC findings. NRC’s

five recommendations are referenced in this report, and the NRC report's executive summary, "Funding Smithsonian Scientific Research," is included as Appendix B.

CONCLUSIONS AND RECOMMENDATIONS

The NAPA Panel finds that:

- Data for Smithsonian scientific research, included in the budget and accompanying explanatory material, engender a low level of confidence. Data for the science centers were found to be more reliable, although there are problems at that level, as well. **THE PANEL RECOMMENDS THAT FUNDING DECISIONS AND RELATED ANALYSES RELY ON THE ACTUAL COST OF RUNNING THE SCIENCE CENTERS, WITH APPROPRIATE ADJUSTMENTS, RATHER THAN THE RESEARCH ESTIMATES CURRENTLY PRESENTED IN THE BUDGET.**
- Appropriations provide the Smithsonian with funds for core support functions and salaries of researchers who develop proposals. Contrary to the impression given in the FY 2003 special budget analysis, Smithsonian researchers compete for (and obtain) a significant proportion of their research funds through competitive grants and contracts. The appropriations provide a continuity of core support that makes it possible for Smithsonian scientists to maintain the requisite capacity to compete for grants and contracts. In turn, these grants and contracts provide the necessary funding for associates, post-doctoral researchers, travel, equipment, and other costs for conducting research. **THE PANEL RECOMMENDS THE CONTINUATION OF CORE SUPPORT APPROPRIATIONS FOR ALL SMITHSONIAN SCIENCE CENTERS CONSISTENT WITH THE NRC REPORT RECOMMENDATIONS.**
- Numerous factors may tilt a competitive process toward different organizations competing for grants and contracts, but Smithsonian researchers do not have a consistent advantage when they seek competitive funding. It is widely held that scientific merit is, and should be, the primary determinant of competitive decisions, although other factors sometimes influence the outcome. The Smithsonian has a lower overhead rate than many other institutions, but this does not appear to provide a significant advantage as grant review panels focus almost entirely on the scientific merit of proposals. Overhead only is a factor when discussing bottom line funding. In addition, some believe that the Smithsonian has an advantage because its researchers receive 12-month salaries under federal appropriations, in contrast to academic year salaries paid by some universities. The NAPA Panel found that this is only one of several compensation and resource factors that may give the Smithsonian or other competitors a theoretical advantage in a given situation. Yet, the Panel found evidence that the Smithsonian is disadvantaged when applying for NSF funds. The situation is not clear, and it appears that perceptions—both at NSF and the Smithsonian—may be creating barriers. The Panel recommends that the Under Secretary for Science examine the perceptions and practices of the science centers' researchers and managers regarding NSF grants, and establish a mechanism for keeping them informed of changes and best practices. **THE PANEL RECOMMENDS THAT THE UNDER**

SECRETARY FOR SCIENCE MEET WITH THE NSF DIRECTOR TO CLARIFY AND EXPLORE REFORMULATING THE SMITHSONIAN-NSF RELATIONSHIP CONCERNING THE ELIGIBILITY OF SMITHSONIAN SCIENTISTS TO COMPETE FOR NSF FUNDING.

CONCLUDING COMMENTS

The NAPA Panel reviewed and concurs with the NRC Committee's findings and recommendations. Both the Panel and Committee noted some weaknesses in communications between the Smithsonian's central management and the science centers. The NRC report recommends that the Secretary and Board of Regents improve these communications and become strong advocates for the science centers goals and achievements. The NAPA Panel found that scientific staff are seriously concerned that science is no longer recognized as a critical component of the Smithsonian agenda.

The NAPA Panel believes that the Secretary has an opportunity to demonstrate support for the "increase of knowledge" by tying specific institution level fundraising initiatives to scientific endeavors as part of the strategic planning process. The Panel urges the Secretary to seek ways to demonstrate that science is an important priority of the Smithsonian—possibly by making the Smithsonian's scientific research activities and their results more public.

LIST OF ACRONYMS (LOA)

ASC	Arctic Studies Center
CAL	Conservation Analytical Laboratory
CEPS	Center for Earth and Planetary Studies
CfA	Harvard-Smithsonian Center for Astrophysics
CRC	Conservation and Research Center
CTPA	Center for Tropical Paleoecology and Archeology
GSA	General Services Administration
MSN	Marine Science Network
NAPA	National Academy of Public Administration
NAS	National Academy of Sciences
NASM	National Air and Space Museum
NMAH	National Museum of American History
NMNH	National Museum of Natural History
NSF	National Science Foundation
NSRC	National Science Resources Center
NZP	National Zoological Park
OGR	Smithsonian Office of Government Relations
OMB	Office of Management and Budget
OPA	Smithsonian Office of Public Affairs
OPM	Office of Personnel Management
PAEC	Professional Accomplishment and Evaluation Committee
SAO	Smithsonian Astrophysical Observatory
SCMRE	Smithsonian Center for Materials Research and Education
SERC	Smithsonian Environmental Research Center
SI	Smithsonian Institution
SIAO	Smithsonian Institution Affiliations Office
SIOE	Smithsonian Office of Education
SIOF	Smithsonian Institution Office of Fellowships
SITES	Smithsonian Institution Traveling Exhibition Services
STRI	Smithsonian Tropical Research Institute
TSA	The Smithsonian Associates