APPENDICES

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
353 SH
Irvine, CA 92697-2525

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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
Philadelphia, PA 19103
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
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Campbell@nasm.si.edu

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
Richmond, Surrey, TW9 3AB
United Kingdom
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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
Washington, D.C. 20560
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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
Professor of Botany
2502 Plant Sciences
University of Georgia
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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
Scripps Institution of Oceanography
University of California at San Diego
La Jolla, CA 92093-0244
jbjackson@ucsd.edu

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
Harvard-Smithsonian Center for Astrophysics
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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
Department of Ecology and Evolutionary Biology
Princeton University
Princeton, NJ 08544-1003

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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
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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, ABlack 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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St. Louis, MO 63166-0299
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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 C the evolutionary history of entire biota and the individual taxa found in certain regions C 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
C.L. Lundell Professor & Director, Plant Resources Center
Department of Botany
The University of Texas at Austin
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beryl@mail.utexas.edu

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
Curator of Pacific Botany
Department of Systematic Biology
National Museum of Natural History, MRC 166
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Washington, DC 20013-7012
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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
Professor of Biology and Chair
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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	Alldredge, 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

Michael A. Lang
Executive Officer for Scientific Programs
Office of the Under Secretary for Science
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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 NMMH 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 Dixson, 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 cosponsored 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. SAO=s educational successes resemble those of NSRC=s 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 Aambassadorial@ 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 AHow 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

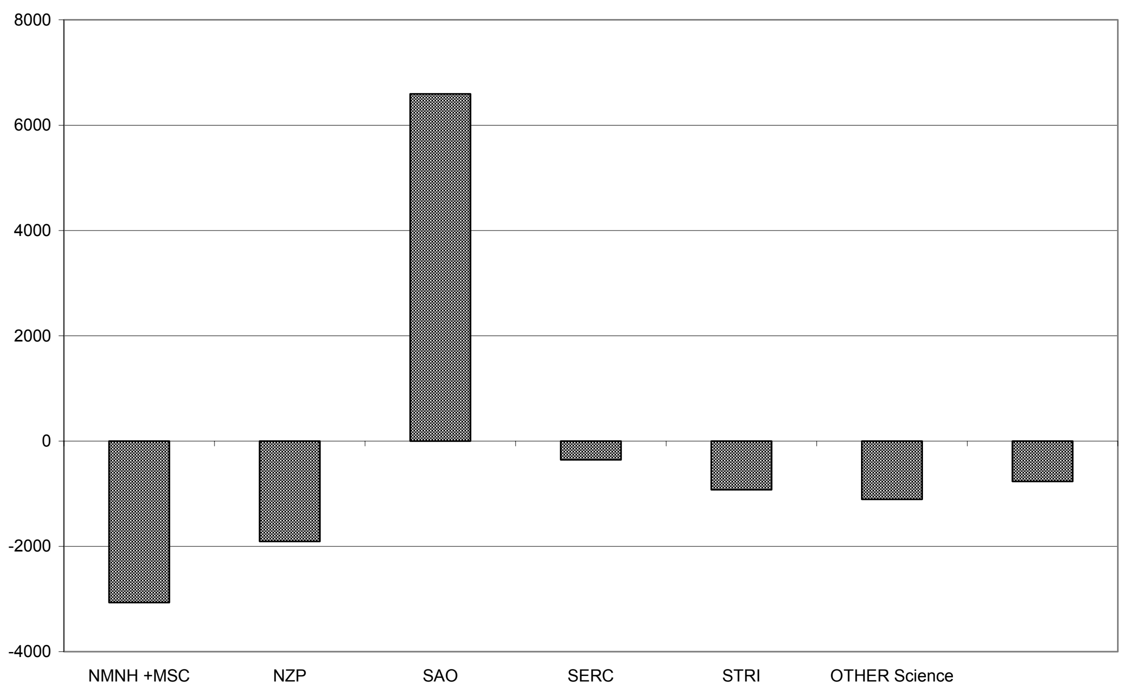

Figure 1. Net change in science funding 1990-2002

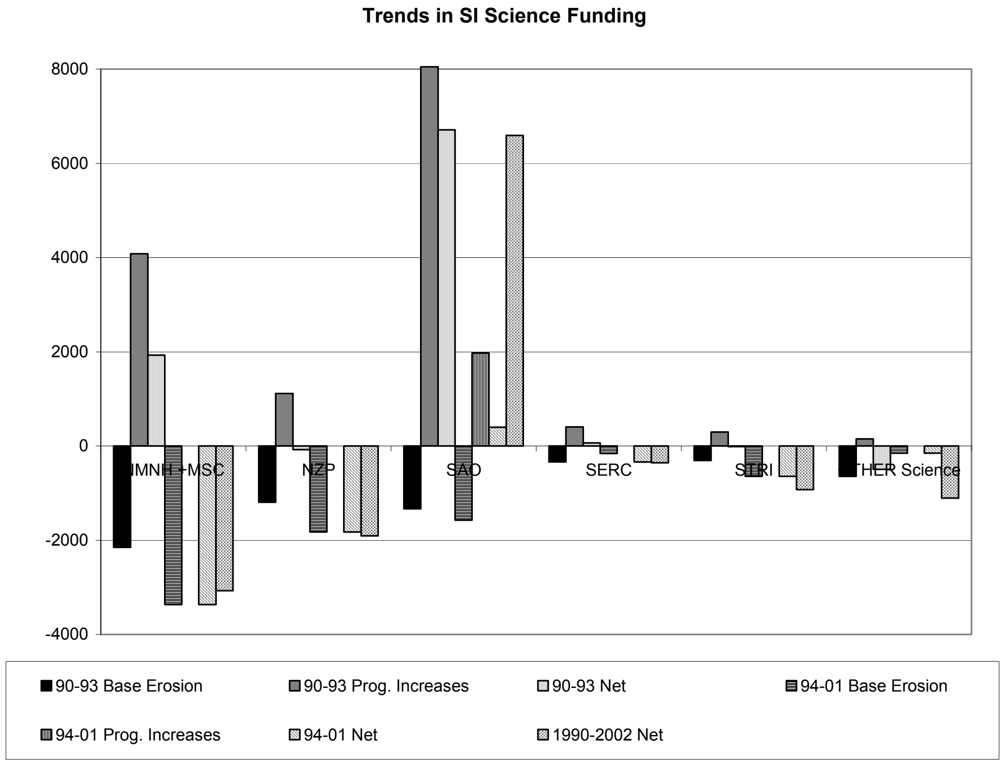

Figure 2. Trends in Smithsonian science funding.

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 (NZP) 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.

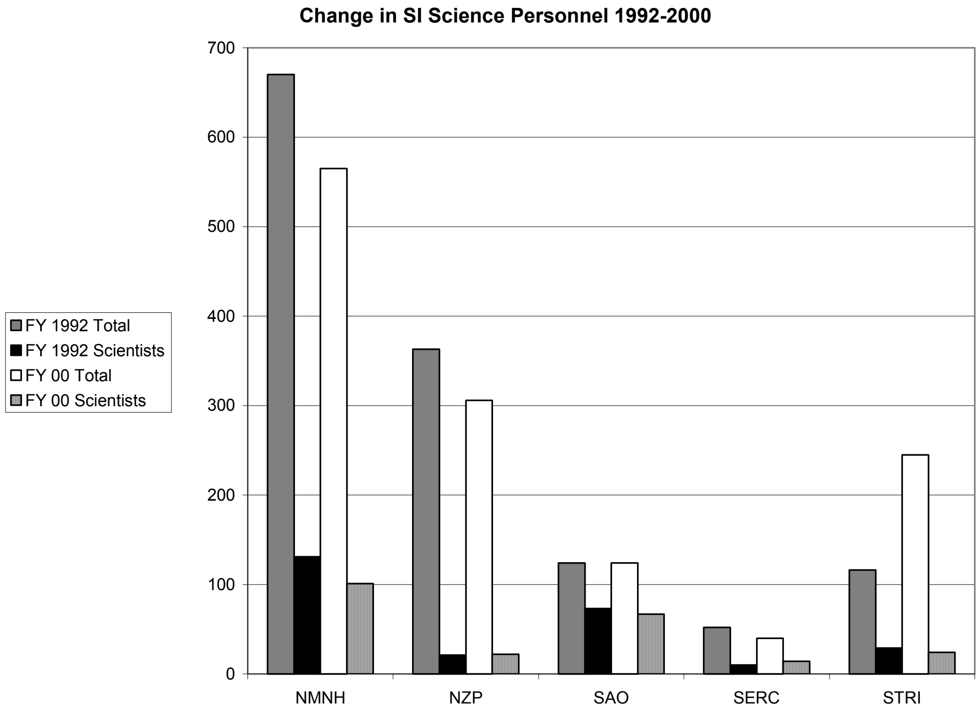

Figure 3. Change in Science Personnel 1992-2000.

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).

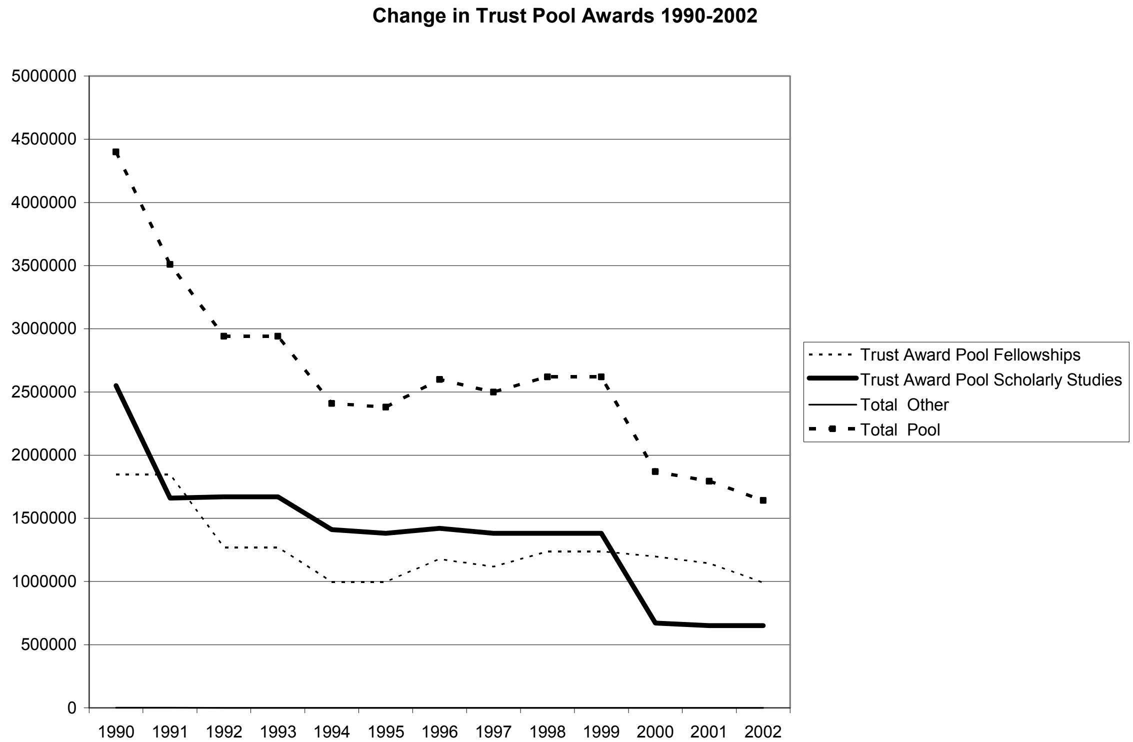

Figure 4. Change in trust fund pool awards: 1990-2002.

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 Commitee) 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 idiosyncracy 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 posses 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 cataloguing.

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, volacanism, 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.

<u>Applications of Basic Research to Societal Needs</u>

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:

- **Large Scale Structure of the Universe**: *SAO*
- **Earth and Planetary Systems**: *NMNH, SAO, NASM, SERC*
- **Evolution, Diversity, and Dynamics of Life**: *NMNH, STRI, SERC, NZP, CRC*
- **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:

- Expanding our collaborative research networks outside the Institution;
- Building on our research and service relationships with other federal agencies;
- Increasing our role in shaping national and international policy; and,
- 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:

- Enhanced instrumentation, computational, and analytical capacities;
- A robust bioinformatics network;
- Collections development and support;
- Expansion and professional development of research support staff; and,
- 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 though 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