PRIORITIES FOR NATURAL HISTORY COLLECTIONS CONSERVATION RESEARCH: RESULTS OF A SURVEY OF THE SPNHC MEMBERSHIP

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Abstract.—The SPNHC membership was surveyed to develop a list of priorities for natural history collections conservation research. The survey was mailed to 548 individual and institutional members and 229 responses (42%) were analysed. Ten topics were identified by at least half of the respondents with above average priority ratings. Additional topics were rated as priorities for transfer of information, with special attention given to conservation of documentation. These priorities reflect research needs that serve multiple disciplines and complement priorities identified for conservation research in art and historical collections. This paper represents the report submitted to the agency that funded the study in fulfillment of the grant requirements.

EXECUTIVE SUMMARY

The Society for the Preservation of Natural History Collections (SPNHC) is a multidisciplinary international organization composed of individuals and institutions who are interested in the development and preservation of natural history collections. Under the direction of the SPNHC Conservation Committee and its Research Subcommittee, the project coordinator surveyed the SPNHC membership by mail to develop an updated list of priorities for natural history collections conservation research. This report summarizes background information, development and implementation of the survey instrument, results and data analysis of this project.

The survey instrument was developed with input from a core group of 40 professionals. The results from a previous multidisciplinary project on the conservation of natural science collections (Duckworth et al. 1993) and projects on conservation research needs conducted by the American Institute for Conservation (Derrick 1996, Hansen and Reedy 1994) were used as a guide for the development of topics for research and/or transfer of information. Given the variety of disciplines and job functions represented within the SPNHC membership, the survey was structured to permit analysis of respondents' most critical needs based on their job functions and type of materials.

The survey was mailed to 548 individual and institutional SPNHC members in September, 1999. From the 244 surveys returned, 229 were used for analysis, representing 42% of the membership. Responses were analysed and tables included in the report show percentages and weighted averages for research priorities. Sixteen topics were rated with an above average priority rating. Ten of these topics were selected by at least half of the respondents as the highest two ratings:

- Impact of preparation materials and methodologies on chemical and physical properties of specimens;

- Impact of preparation materials and methodologies on scientific utility of specimens;
- Development of preparation methodologies that maximize scientific utility of specimens;
- Impact of treatments on the scientific utility of specimens;
- Methods to assess systematically the condition of specimens over time;
- Methods to assess systematically the condition of a collection of specimens over time;
- Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research;
- Proper relative humidity and temperature parameters for general collection;
- Materials specifications for containers;
- Methods for repair/restoration of damaged specimens.

All of these topics should be given the highest priority for natural history collections conservation research. Additional topics were rated as priorities for transfer of information (Table 5), with special attention given to conservation of documentation (Table 8).

Background

Natural history conservation is among the newest fields of conservation even though natural history specimens are among the most common of objects found in museums, visitor centers, and interpretive sites, numbering more than 2 billion worldwide (Howie 1993). Although there are the ubiquitous mounted specimens of birds and mammals, the bulk of natural history collections consists of research material reflecting the disciplinary specialties of natural science interests and research: anatomy, botany, entomology, evolutionary biology, geology, herpetology, ichthyology, invertebrate zoology, mammalogy, mineralogy, molecular biology, ornithology, paleontology. Natural history research collections can consist of the hundreds of thousands of specimens in a single institution, with only a small percentage (usually less than 1%) of the total representing "exhibit quality" material. These specimens document variation over time and space; they are irreplaceable as one can never travel back in time to collect sites that have become interstate highways or the foundations of schools. The value of natural history collections continues to grow as habitats disappear, geological and paleontological sites are destroyed, or as species become extinct (Cato 1990).

Our ability to learn from samples of our natural history diminishes as various agents speed their decay and destruction. It is essential that the conservation profession apply its collective knowledge and skills to improve the life expectancy of natural history specimens in museum collections. The needs of natural history specimens focus on a range from the treatment of individual specimens to the issue of providing the best storage environment for whole collections consisting of thousands of specimens. Preservation requirements also must address through research the myriad of materials that comprise natural history specimens: organics, inorganics, and composites (Duckworth et al. 1993).

Professionals working in the field recognize the need for accurate, useful information to improve preservation and conservation methodologies for natural history specimens. This is evident from the results of the 1989–1993 project supported by the National Science Foundation, the National Institute for the Conservation of Cultural Property (NIC), the Association for Systematics Collections (ASC), and the Society for the Preservation of Natural History Collections (SPNHC). This project brought together at a national level representatives from various natural science disciplines with conservation and materials science experts to discuss not only the conservation needs for collections and specimens, but areas of concern that needed to be addressed through research and the transfer of existing information in other fields. Natural history disciplinary and specialty groups were contacted, and more than 12 meetings held with the following groups to discuss needs and priorities: Mineral Museums Advisory Council; U.S. Federation of Culture Collections board; American Society of Mammalogists; American Society of Ichthyologists and Herpetologists; Council of Systematics Malacologists/American Malacological Union; American Institute of Biological Sciences; Mycological Society of America/Bryological and Lichenological Society/American Fern Society; American Society of Parasitologists/Society of Nematologists; American Ornithologists' Union; Paleontological Society/Society of Vertebrate Paleontologists; Mineralogical Society of America; Entomology Collections Network/Entomological Society of America; and Material Sciences panel. It becomes obvious, just from this listing of groups, that the variety of materials found in natural history collections are the result of an enormous range of project goals, collecting methodologies and protocols. It could be predicted that the range of concerns and preservation priorities would also be substantial.

Collection care needs and issues of concern raised during the various disciplinary meetings were summarized in a series of unpublished reports. These individual reports were used by the NIC project group to develop an extensive list of needs for preservation research and technology transfer that were organized into four divisions: fluid-preserved specimens, inorganic/organic matrices, plant material, and animal material. This list of research information needs is so extensive as to be overwhelming, yet valuable in providing an organized sense of the overall needs (Appendix B. Recommended Topics for Research and Technology Transfer in Duckworth et al. 1993).

The final report from this project, "Preserving Natural Science Collections: Chronicle of Our Environmental Heritage" (Duckworth et al. 1993) provides an excellent presentation for the need for conservation, the problems faced by stewards of natural history specimens, and the need for improved training and research in the field of natural history conservation. Although it lists and organizes the needs for conservation research in a general manner, it does not concentrate sufficiently on prioritizing those needs to provide guidance for researchers or to support funding requests for research projects. In addition, there has been progress in the field of conservation since the beginning of the NIC project, and many of the research topics may have been dealt with, at least indirectly. The Research Subcommittee of the SPNHC Conservation Committee felt it important to review the issue of priorities for natural history collections conservation. Thus it initiated a project to identify current priorities, looking at changes since the initiation of the NIC project in 1989 and its final publication in 1993, and efforts to identify research priorities in the related areas of conservation of art and cultural collections.

The primary objectives for this current project were to gather information through a literature search; to solicit input from active professionals working with collections care and conservation research for natural history collections; and to write a report summarizing and describing research priorities for natural history collections conservation. The literature search focused on published material relating to priorities and progress in the conservation of natural history collections with a particular emphasis on articles appearing since the 1993 publication resulting from the NIC project. Input from professionals was sought at two levels. (1) A core group of 40 individuals composed of the SPNHC Conservation Committee, SPNHC Executive Council, and several independent collection managers and researchers provided the first level of recommendations, comments and feedback through e-mail, letters, phone calls, a discussion meeting, and a pilot mail survey. (2) Using a mailed survey that had been tested by the core group, the SPNHC membership was then surveyed in order to gain a broader perspective through the input of individuals working in multiple disciplines and having differing job priorities.

Literature

Since the beginning of the NIC project in 1989, there has been an increase in the literature with respect to (1) clarifying the philosophical basis for natural history collections conservation and management; (2) formalizing the terminology and policies affecting natural history collections management; and (3) specific studies investigating the materials and methods used in natural history collections management and conservation. In addition, the American Institute for Conservation has supported and published research priorities that reflect conservator-driven needs for the specialties represented within AIC (Derrick 1996, Hansen and Reedy 1994).

The philosophical basis for the care of natural history collections was summarized in the "Guidelines for the Care of Natural History Collections" (Society for the Preservation of Natural History Collections 1994). Endorsed by the SPNHC Council, these guidelines were developed with the input of numerous professionals associated with the use and care of natural history collections. The first section of these guidelines clearly states the parameters that make these collections unique and how that uniqueness affects care and management of the collections. Part of the uniqueness of these collections originates with the idea that the inherent value of the specimen depends on *use*; the intended use dictates both the initial and the subsequent specimen preparations, and scientific research using the specimens enhances the value of the specimens. However, there is also recognition by professionals of their obligation to maximize the value of each specimen for future uses. Thus, there needs to be a balance between use and preservation, balancing the competing demands of today's use with future uses.

Another parameter is the *size* of these collections. Decisions made to conserve and manage these collections must take into account the vast size of most collections. Specimens are acquired in series and stored, handled, and used as part of a group. It is the rare exception that a single object or specimen is accorded the detailed scrutiny of a conservation assessment that might be given an object in an art or historical collection. The issue of size of the collections has been the driving force behind the growth of preventive conservation in natural history collections management, an approach discussed by Rose and Hawks (1995) and others in the volume, *Storage of Natural History Collections: A Preventive Conservation Approach* (Rose et al. 1995).

Williams and Cato (1995) emphasized the need to interweave the institutional functions of research (specimen use), collection management and conservation to maximize the long-term survival and value of natural history collections. Professionals who work in these functional areas approach the use and care of collections from differing perspectives, but it is necessary to achieve effective interaction of these different viewpoints in order to serve the long term needs of the collections. Conservation of collections can be effective only if it is inclusive and takes into consideration the perspectives of management and specimen use.

The issue of managing and caring for vast collections effectively has been approached as well using the principles of risk management. This philosophical approach, developed for natural history collections by Waller (1995), stresses the need to develop decision-making tools that are based on rational and analytical approaches. Recognizing the competitive pressures of limited critical resources and the need to preserve huge numbers of specimens, decision-making tools based on risk management can provide a more objective basis for analyzing an institutional situation. Specific examples of tools and applications reflecting this approach include those offered by Price and Fitzgerald (1996) and Williams, et al. (1996).

In addition to contributing to the philosophical basis for natural history collections management and conservation, the last few years have seen an increased emphasis in the literature on terminology and the formalization of standards and policies for various aspects of natural history collections management and care. When professionals in disparate fields begin to work together, there are frequent misunderstandings because of a lack of common definitions for a term. As an example, the terms conservation, preparation, and treatment have different definitions depending on one's perspective as a conservator, a collection manager, or a researcher in the natural science disciplines. Glossaries such as found in *Guidelines for the care of natural history collections* (Society for the Preservation of Natural History Collections 1994), and Rose et al. (1995) expand on terminology defined in Duckworth et al (1993) and Rose and de la Torre (1992). These glossaries help to improve the level of mutual understanding among conservators, collection managers and researchers, and are essential if conservation research is to play an active role in assisting the professional community to preserve natural history collections.

Standards and guidelines for developing policies for institutions housing natural history collections have been formalized and published by the Museums and Galleries Commission (1992a, 1992b, 1993), Cato and Williams (1993), and the Association for Systematics Collections (Hoagland 1994). These publications not only reflect the wide range of institutional concerns, but also particularly reflect issues that had not previously been addressed, such as sampling and destructive testing, preventive conservation, specimen treatment, and use of specimen data. Natural history collections conservation occurs within the context of both institutional and scientific discipline frameworks, and the development of professional standards and guidelines in these areas directly impacts the development of natural history conservation and its conservation research priorities.

The number of published studies investigating various aspects of natural history specimen preparation, storage, management and conservation has increased since the 1980s, but is still very small. As an example of a typical computerized bibliographic search using the Conservation Information Network on the Canadian Heritage Information Network (CHIN) for the years 1993–1999, an effort to find published research relating to the conservation of mammal collections using the keyword, mammal, resulted in 27 hits. Only 16 dealt with topics relating to conservation and/or preservation, and 5 of these were case studies. Of these 16 conservation-related articles, five were published in *Collection Forum,* two in *Geological Curator,* three in the *Journal of Archeological Sciences,* and one each in six other sources. The two in *Geological Curator* pertained to mammalian fossil material, and the three in the *Journal of Archeological Sciences* related to mammalian finds in zooarcheological sites, with minimal discussion of preservation.

During the period, 1993–1999, approximately 48% of the articles published in *Collection Forum,* the professional journal for SPNHC, reported on completed research, or on progress made in the analysis of materials, or on procedures used in the preparation and storage of specimens. This is a significant increase over the very small numbers reported in the past (Cato 1988). However, given the small size of *Collection Forum,* the total number of articles for this research arena is still quite limited.

Relevant conservation research, news and case studies have been published in a variety of other professional outlets as well, including: the *Journal of the American Institute for Conservation* (JAIC), *Geological Curator, Biological Curator, SPNHC Leaflet* series, *SPNHC Newsletter, Natural Sciences Conservation Group Newsletter, Natural History Conservation, Conserv-O-Gram, Conservation News, Journal of Archeological Science,* and the *Journal of the International Institute for Conservation-Canadian Group* (J. IIC-CG). The quantity and availability of information from conservation research reported in these other journals that is directly pertinent to natural history collections conservation through these avenues is small. Although several of these journals and newsletters focus on natural history, their circulation is small and their availability is limited. The ones that are more general, and have a larger circulation, have very few articles pertaining directly to natural history objects.

There also has been an increased effort to publish books reviewing the state of knowledge, and workshop proceedings on topics pertaining to areas of natural history collections conservation (e.g., Metsger and Byers 1999, Collins 1995, Rose et al. 1995, Child 1994a, 1994b). Williams (1999) reviews the effects of standard preservation techniques, concluding that many are in fact destructive and interfere with the potential scientific value of the specimens. These publications are particularly useful for the wider dissemination of information and for increasing the awareness of professionals to areas of need and concern. Most highlight or discuss areas of natural history collections conservation that need further research to determine the effectiveness or impact of existing procedures and techniques on the long-term preservation and scientific utility of specimens.

Finally, the fastest growing tool for dissemination of information has been web sites such as CoOL (Conservation OnLine; <http//palimpsest.stanford.edu/>) and the Heritage Forum: Resources section of the Canadian Heritage Information Network (<www.chin.gc.ca>). Not restricted to a single discipline, sites such as these encourage transfer of information among disciplines.

Development and Implementation of the Survey

Development of the survey instrument followed standard procedures for questionnaire design, beginning with input by the core group to focus the content and approach. This group received copies of relevant sections of three publications (Duckworth et al. 1993, Hansen and Reedy 1994, Derrick 1996) to initiate discussion; members were asked to consider terminology, gaps and areas of overlap in the framework presented by Duckworth et al. (1993), and how to best identify top priorities. Comments were received by e-mail, mail, and during a discussion at the Conservation Committee meeting (June 1999, annual SPNHC meeting).

The initial comments were varied. There was general support for the approach taken in Duckworth et al. (1993) because the categories were relevant to those who manage and use the collections. It was noted that priorities need to be defined in the context of the needs of the profession, and how the collections are to be used. Because a basic premise in the development of natural history collections is for the use of specimens, it was felt that the terminology of this survey would need to be different from that used by the AIC surveys which emphasized art and cultural materials collections. Several individuals noted that in the Duckworth et al. (1993) listing, many of the topics listed for research were very specific, too much so to be considered a profession-wide priority. A few noted that research has been done in several of the areas listed, and that the priority now should be to transfer the information to the natural history collections field.

The group's primary recommendations, therefore, were that (1) the objective of the research priorities be goal oriented not merely specific research topics; and (2) the priorities must reflect research that would have the biggest impact on the collections as a whole. The survey needed as well to indicate the primary focus of the respondent's work, such as, collection manager, curator, conservator, registrar, or administrator. An earlier survey by SPNHC (Cato 1991) identified these categories as distinct, relevant functional areas, regardless of job titles. It was also recommended that the survey be designed to permit analysis based on the perspective of the respondent given the scientific discipline(s) he/she works with and the degree to which he/she focuses on different materials. These distinctions are necessary in order to clarify the difference between the functional organization of most natural history collections (e.g., mammals vs. birds vs. fossils, etc.) from the material science approach of conservation (protein-based animal materials, inorganic materials, etc.).

With these recommendations, a four page pilot survey was designed. After review by the Chair of the Conservation Committee (D. Dicus) and the Chair of the Research and Technology Subcommittee (D. von Endt), the pilot was revised, then mailed to 32 members of the core group. The recipients were requested to (1) respond to the survey, and (2) comment on the content, wording and structure of the survey itself. Based on responses and comments from 16 individuals (8 collection managers, 8 conservators/conservation scientists), the pilot was revised and the final survey (see appendix) was prepared for mailing to the SPNHC membership.

An effort was made to balance the terminology and wording of the questions in the survey between the needs and perspectives of those who use the collections, and approach issues of collection care from the background of management or

Table 1. Percentage of respondents selecting ranking numbers 1 or 2 for listed materials.

Priority scale	1	1 + 2	Average
Animal materials	47.8%	60.1%	2.4
Fluid-preserved specimens	16.2%	32.5%	3.5
Inorganic materials	19.3%	28.9%	3.7
Plant materials	17.5%	25.9%	3.7
Inorganic/organic complexes	15.8%	23.2%	3.8

natural science-disciplines and with those who view collections from a background of materials science. The first half of the survey targeted broad priorities; the second half focused on whether a series of more specific topics should be the focus of research or transfer of information. At the end of the survey, a short series of questions asked which topics relating to conservation of documentation would be most useful for workshops or publications focusing on the perspective of natural history collections. (It was felt by the core group that most topics involving the conservation of documentation had been well researched already, but that technology transfer was critical.) In each area, respondents were given the opportunity to provide additional suggestions.

Surveys were mailed to 548 individual and institutional members of SPNHC. From the 244 surveys returned, 229 (42%) were used for analysis. The survey responses that were not used for analysis included five returned due to wrong addresses, and five from individuals who indicated they were not directly involved with natural history collections conservation and did not feel adequately informed to respond. Some questions were not answered by all respondents; results were analysed on the basis of the number of responses to the particular question.

Results

Almost half of the respondents (47%) work primarily with only one discipline, whereas 25% work with five or more disciplines. The majority of respondents (57%) described their work as collection manager, 22% as curator, 10% as conservator, and 11% marked the "other" category. The latter included 19 different job titles; five listed "registrar" and five listed administrator-type titles (e.g., director, administrator).

Respondents were requested to indicate the degree to which their priorities focused on each of five categories of materials. These categories were not intended to be exclusive, recognizing that the majority of respondents work with multiple types of materials. Using a relative scale (1 to 5, greatest to least priority) almost half indicated animal materials comprised a significant priority, with a priority ranking of 1 (Table 1). The other types of materials were considered to have a high priority by at least 15–20% of the respondents. When the top two priority rankings are considered, fluid-preserved specimens are rated by almost one-third of the respondents as a high priority; as this category might include animal, plant, or geological samples, it reflects a broad interest. The weighted average for each material was also calculated; a lower number means a higher priority, and the value of 3 is considered to be a moderate priority.

Table 2 summarizes responses to the survey questions to assign a priority rating for each of 30 topics in the areas of specimen preparation, post-preparation treat-

Table 2. Summary of priority ratings for 30 topics (n = 229). Sixteen above average priorities are indicated by an asterisk (*).

Research topics	% respondents Rating = 1	Rating = 1 + 2	Weighted average
Specimen preparation			
Impact of preparation materials and methodologies on chemical and physical properties of specimens	33.0	56.2	2.5*
Impact of preparation materials and methodologies on scientific utility of specimens	33.8	62.3	2.3*
Development of preparation methodologies that maximize scientific utility of specimens	28.1	57.0	2.4*
Post-preparation treatments			
Methods to assess systematically the condition of specimens over time	24.8	53.1	2.5*
Methods to assess systematically the condition of a collection of specimens over time	24.8	50.5	2.6*
Effect on specimens of adding and/or changing storage fluids	11.9	26.0	3.4
Techniques to clean specimens (e.g., greasy bone; specimens stained by pollutants, mold)	17.5	42.9	2.9*
Mechanisms of oxidation reactions	8.3	19.2	3.6
Methods to mitigate sampling of specimens for discipline-based research	7.4	27.5	3.3
Methods for repair/restoration of damaged specimens	26.2	58.5	2.5*
Impact of treatments on the scientific utility of specimens	20.1	56.3	2.5*
Understanding specimen/collection damage & functions			
Impact of pest control methods on chemical and physical properties of specimens	19.3	46.9	2.9*
Long-term impact of pest control residues on scientific utility of specimens	11.4	40.8	3.1
Proper relative humidity and temperature parameters for general collection	36.7	69.0	2.1*
Optimal parameters for particularly sensitive materials	10.9	30.1	3.1
Effects of visible light, infrared, and ultraviolet radiation on specimens	13.5	42.3	2.9*
Optimal environments for materials taken from or stored in extreme environments	6.5	24.2	4.0
Effects on specimens of glycerin, buffers and other additives to storage fluids	10.4	25.7	3.6
Impact of storage materials on histological and chemical analyses of specimens	10.4	23.9	3.6
Impact of currently used environments on the scientific utility of specimens	14.8	41.4	2.8*
Specifications for collection housing & use			
Methods to identify pest control residues on specimens	14.4	36.7	3.2
Impact of pest control residues relative to human safety	20.1	45.0	3.0
Materials specifications for containers (e.g., jars, lids, unit trays)	27.1	56.8	2.5*
Materials specifications for storage furniture	18.3	46.2	2.8*
Design specifications for specialized collections (e.g., marine core)	6.5	16.5	3.8
Cost-effective methods to create microclimates	13.5	30.5	3.3
Management of collections conservation and conservation research			
Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research	29.7	61.6	2.3*
Methods to balance conservation parameters with specimen use for identified collections of like material or discipline (e.g., collections organized by strata rather than material; mammal collection)	13.1	41.9	2.8*
Methods to mitigate impact of inherent specimen properties (e.g., radon; oxidation of naturally occurring elements; water content of minerals)	10.4	23.5	3.4
Methods to integrate conservation research with other discipline-based analytical research	11.4	32.8	3.1

ments, understanding specimen and collection damages and functions, specifications for collection housing and use, and management of collections conservation and conservation research. The responses were summarized for both the top priority rating (1), and the top two ratings together (1+2); a weighted average was also calculated. The seven topics that were selected by at least one-quarter of the respondents as the highest priority (rating #1) were:

- Proper relative humidity and temperature parameters for general collection (36.7%);
- Impact of preparation materials and methodologies on chemical and physical properties of specimens (33.0%);
- Impact of preparation materials and methodologies on scientific utility of specimens (33.8%);
- Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research (29.7%);
- Development of preparation methodologies that maximize scientific utility of specimens (28.1%);
- Materials specifications for containers (e.g., jars, lids, unit trays, etc.) (27.1%);
- Methods for repair/restoration of damaged specimens (26.2%).

When the top two ratings are combined, at least 50% of respondents selected the seven above, plus three additional topics:

- Methods to assess systematically the condition of specimens over time;
- Methods to assess systematically the condition of a collection of specimens over time;
- Impact of treatments on the scientific utility of specimens.

Using the weighted averages, there are 16 topics that were rated as above average (i.e., having less than a value of 3 which is average) in priority (Table 2). Thus, the choices with above average priority ratings include all three topics in the specimen preparation grouping; five from the post-preparation treatments group; four from the grouping, understanding specimen/collection damage and functions, and two each from the other two groups (specifications for collection housing and use, and management of collections conservation and conservation research).

Having reviewed this list of 30 topics, respondents were then requested to select the three areas that are the most critical of all these; for each of the three areas, respondents were asked to select a type of material for the research topic. The top seven responses, all of which were included in the top seven listed in Table 2, were:

- Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research;
- Impact of preparation materials and methodologies on scientific utility of specimens;
- Proper relative humidity and temperature parameters for general collection;
- Impact of preparation materials and methodologies on chemical and physical properties of specimens;

Table 3. Top 3 priorities listed by respondents for a category of materials.

Category of materials	Topic	Number of responses
Fluid-preserved specimens	Effect on specimens of adding and/or changing storage fluids	17
	Impact of preparation materials and methodologies on chemical and physical properties of specimens	12
	Materials specifications for containers	12
Plant materials	Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research	11
	Proper relative humidity and temperature parameters for general collection	9
	Impact of pest control residues relative to human safety	8
Animal materials	Techniques to clean specimens	21
	Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research	18
	Impact of preparation materials and methodologies on scientific utility of specimens	17
	Methods for repair/restoration of damaged specimens	17
Inorganic materials	Methods to mitigate impact of inherent specimen properties	6
	Impact of preparation materials and methodologies on chemical and physical properties of specimens	5
	Impact of preparation materials and methodologies on scientific utility of specimens	5
	Proper relative humidity and temperature parameters for general collection	5
Inorganic/organic complexes	Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research	8
	Methods to assess systematically the condition of specimens over time	7
	Proper relative humidity and temperature parameters for general collection	7

- Development of preparation methodologies that maximize scientific utility of specimens;
- Materials specifications for containers (e.g., jars, lids, unit trays, etc.);
- Methods for repair/restoration of damaged specimens.

Analysis by the type of material selected indicated a broader range of priorities. The top three responses according to material type are summarized in Table 3. (Many respondents chose to circle multiple types of materials rather than just one, and these responses are not included in Table 3.) There is overlap with the seven topics listed above, but more discipline- or material-specific topics were selected for each of the categories.

Respondents were given the opportunity to suggest additional, broad priorities

Table 4. Suggestions by respondents of "broad research priorities," grouped for analysis.

Preparation of sample/specimen; impact of materials, methods used.
- Ability to prepare (remove rock matrix from) ever smaller, more detailed morphologies in vertebrate fossils
- Impact of field collection techniques on scientific utility (e.g., tropical collection with ethanol in field for pest control interferes with DNA isolation from herbarium material)
- Most interested in consolidants/adhesives in paleontology
- Preparation techniques for skeletal materials
- Specific effects of freezing on skeletal material before and after preparation

Understanding specimen/collection damage
- Determination of the best storage media for fluid amphibian larvae with regard to concentration, pH, buffers, and maintaining neutrality. Is commonly used 10% formalin better for larval storage than 70% ethanol?
- Long-term effect of lipids present in specimens (bones and fluid-preserved specimens)
- Methods of pest control
- Methods to prevent/reduce/eliminate insect pests
- Protection of all specimens from pests (insects)

Specifications for collection housing and use
- Impacts of visitor handling of specimens on long-term preservation and on future scientific value
- Earthquake & fire ratings for available storage equipment
- Packing methods and materials used for transport of collection for loans, etc.
- Proper storage and handling of color photographs and slides
- Providing access to all elements of a collection (biological specimen, photograph, DNA sequence, etc.)
- Destructive sampling of collection material
- Use of tissue & frozen samples, DNA codes and relationship to vouchers
- Specimen labeling

Policies and decision-making protocols (a component of management of collections)
- Developing protocols for sample sizes & integrating storage problems with scientific or research use of such things as fossil tusks
- Development of a template for risk management and disaster mitigation of natural history collections
- Policies on consumptive/destructive sampling
- Uses of collections objects in public programs (exhibits, teaching, imaging) and related conservation priorities
- Valuation of collections by means of scientific parameters
- Impact of databasing a collection vs. future use (patterns) of the collection

Communication; education; information transfer
- Education of discipline-based researchers in best collection/preservation/storage methods for material they collect, research, and turn over to museums for long-term care
- Is there an area where curators and conservators can move together? There is a necessity to educate curators and museum managers to start thinking of the long-term life of their collections.

Other
- Paleontology has many problems not applicable to 'inorganic' in general
- Anthropology (ethnographic & archeological)
- Dried specimens of invertebrates

that were not already listed. Twenty-nine suggestions were made and then grouped for analysis (Table 4). The wording of some of the suggestions made interpretation difficult, so these groupings might change if the suggestion had been more fully described. The majority of additional suggestions fall within three categories:

preparation of samples/specimens and the impact of the methods and materials used; understanding specimen/collection damage and functions; and specifications for collection housing and use. Six suggestions relate to the development of policies and decision-making protocols or framework, a process that is an aspect of the management of collections. Two relate to the need for communication of information among fields.

The second major section of the survey questionnaire included a listing of 40 specific research topics; many of these were discipline-specific and some had been listed in Duckworth et al. (1993). Respondents were asked to indicate for each topic whether this should be a priority for research or for the transfer of information from allied fields (the term "technology transfer" was used in the pilot, but replaced as being field-specific jargon and too unclear for the majority of respondents.). A "don't know" option was also provided; respondents indicated this option was used as well when they felt the topic was not applicable to their discipline. Table 5 summarizes the responses for this section; the number of responses for each topic varied between 206 and 229.

The ten topics with the highest percentage response for *research priority* were:

- Quality of newer preparation methods and materials;
- Methods of assessing the impact of past and current preparation techniques on both long-term preservation and biochemical analyses of specimens;
- Quality of traditional preparation methods and materials;
- Impact of methods of removing flesh, fats and oils from bone on the long-term stability of skeletal material;
- Preservation of color in biological specimens;
- Impact of molding and casting materials on specimen preservation and specimen-based research;
- Impact of various consolidants and adhesives on the chemical and physical stability of specimens;
- Substitutes for formalin in the fixation of plant and animal material;
- Effects of cleaning and staining on the stability of bone;
- Impact of acid preparation on long-term stability and on biochemical analyses of paleontological bone and shell.

The ten topics with the highest percentage response for *transfer of information* were:

- Educating researchers in specific disciplines about best practices for specimen preparation;
- Understanding how specimens are used;
- Methods of packing and shipping field-prepared specimens;
- Understanding of technological applications;
- Development of integrated information system to share conservation research data;
- Methods of preparing specimens for specialized uses, such as educational programming;
- Specifications for materials used in specimen preparation;
- Methods of testing the alkalinity, acidity and general composition of the papers used in herbaria collections;

Table 5. Summary of responses indicating for each specific topic: a need for research, transfer of information from an allied field, or "don't know" (shown as %).

Specific topic	Research priority (%)	Transfer of information (%)	Don't know or not applicable
Substitute(s) for formalin in the fixation of plant and animal material	34.8	23.3	41.9
Appropriate buffers for fixatives	22.3	30.2	47.4
Methods of determining when fixation is complete	24.8	22.9	52.3
Preservation of color in biological specimens	36.9	26.2	37.4
Preservation of color in geological specimens	12.6	17.3	70.1
Mounting media for microscope slide preparations	18.2	26.2	55.6
Methods of ringing microscope slides to prevent deterioration of the mounting media	14.0	22.9	63.1
Clearing and staining agents for use in microscopic and macroscopic preparations	10.3	27.6	62.1
Impact of fixatives and clearing and staining agents on histological and biochemical analyses of specimens	23.8	17.8	58.4
Impact of methods of removing flesh, fats and oils from bone on the long-term stability of skeletal material	45.1	15.3	39.5
Effects of clearing and staining on the stability of bone	27.9	15.3	56.7
Impact of preparation chemicals such as formaldehyde, glacial acetic acid and other acidic preparation chemicals on the development of soluble efflorescent salts on calcareous specimens	24.8	21.0	54.2
Impact of various insecticides on the development of soluble efflorescent salts on calcareous specimens	18.2	18.2	63.6
Impact of acid preparation on long-term stability and on biochemical analyses of paleontological bone and shell	26.0	14.4	59.5
Impact of various consolidants and adhesives on the chemical and physical stability of specimens	34.9	25.6	39.5
Impact of molding and casting materials on specimen preservation and specimen-based research	35.3	22.8	41.9
Materials for temporary storage of specimens awaiting processing	20.9	41.4	37.7
Methods of testing the alkalinity, acidity and general composition of the papers used in herbaria collections	8.9	45.3	45.8
Optimum methods of attaching specimens to herbaria sheets	18.7	29.4	52.3
Cryopreservation methods for algae and slime molds	7.9	8.9	83.2
Methods of preserving plant tissue cultures that do not remain viable with current cryopreservation techniques	14.0	8.9	77.1
Effects of freeze-drying on plant materials	25.6	17.7	56.7
Methods of assessing the impact of past and current preparation techniques on both long-term preservation and biochemical analyses of specimens	51.2	21.4	27.4
New methods of field capture/killing	26.5	28.8	44.7
Specifications for materials used in specimen preparation (e.g., metal insect pins, support wires)	22.9	47.7	29.4
Specifications for adhesives and pointing materials for use in mounting insect specimens	14.0	31.3	54.7
Specifications for herbarium mounting and packet paper	14.9	36.3	48.8
Specifications for adhesives and consolidants for geological specimens	20.6	27.1	52.3
Methods of drying specimens in the field, particularly in tropical environments	20.6	31.8	47.6
Methods of packing and shipping field-prepared specimens	22.3	58.1	19.5

Table 5. Continued.

Specific topic	Research priority (%)	Transfer of information (%)	Don't know or not applicable
Methods of preparing specimens for specialized uses, such as educational programming	23.9	51.6	24.4
Preparation of tissue samples for histological and biochemical analyses	12.7	27.2	60.1
Preparation of subfossil material	20.7	15.0	64.3
Quality of traditional preparation methods and materials	47.5	32.3	20.2
Quality of newer preparation methods and materials	53.5	28.2	18.3
Understanding of technological applications	13.1	54.5	32.4
Understanding how specimens are used	16.4	59.2	24.4
Educating researchers in specific disciplines about best practices for specimen preparation	17.4	66.6	16.0
Integration of conservation research with other types of analytical research	20.7	43.7	35.6
Development of integrated information system to share conservation research data	24.9	53.1	22.1

- Integration of conservation research with other types of analytical research;
- Materials for temporary storage of specimens awaiting processing.

The highest percentage responses for the "don't know" category are for those topics that reflect very specialized areas of interest, e.g., cryopreservation methods for algae and slime molds.

Suggestions were made by 31 respondents for additional aspects of specimen preparation that should be a research priority, and 15 for the focus of a transfer of information (Tables 6, 7). Several of these suggestions repeat topics listed in the previous section, some are so general as to provide little direction for the topic, and a few refer to other aspects of collection management.

Respondents were also requested to indicate how useful a workshop or publication might be for a series of topics relating to the conservation of documentation if the workshop or publication were oriented specifically to natural history collections. All ten topics had weighted averages less than 3, indicating an above average rating for usefulness (Table 8). At least 62% of the respondents rated seven of the ten topics with a 1 or 2. The top three topics overall were:

- Standards for equipment and materials used to produce laser-printed labels or labels via photocopy processes;
- Specifications for materials used in specimen labeling, including durable red inks;
- Guidelines for the care and handling of a variety of field records, photographs, color slides, maps, original catalogs, etc.

Summary and Conclusions

Responses to the survey reflect the diversity of disciplines and work functions represented within the SPNHC membership. Responses also reflect concern with a variety of materials. Although 60% noted animal materials as their greatest

Table 6. Suggestions by respondents of aspects of specimen preparation that should be a research priority.

Accurate data especially dates and localities.
Add complete utilization of every specimen resulting in a standard specimen but also tissues, parasites, vocalizations, photographs, notes, electronic data.
Best all around preservation techniques for maximum uses, including unknown future uses.
Computer generated labels for wet collections; can a laser label hold up in alcohol or formalin?
Cryogenic collections are fraught with problems, not the least are cost and electrical service and mechanical reliability; surely research on new preparation techniques can identify better methods.
Degreasing.
Educating curators, collection managers and researchers in specific disciplines about best practices for specimen preparation and general collections preservation.
Effect of compactor movement in storage for wet collections.
Effect of temperature fluctuations on the evaporation of solutions used in wet specimen storage.
Effect of consolidants on geological specimens; of option of slow drying of specimens to reduce need for consolidants.
Effect of freezing/low temperature on a wide range of materials.
Effects of freezing cycles on herbarium specimens and sheets.
Effects of time between death and preparation on specimen quality.
Freezing and gluing of botanical specimens. The two processes do not complement each other yet just about every botanical institution continues to do this. Why?
How to salvage specimens that were poorly or improperly prepared.
I am working with specimens that break down to produce concentrated sulfuric acid (cell wall polysaccharides undergo anolytic process)—I am looking at inherent properties.
Impact of methods for removing fat, muscle, bone, etc. from specimens.
Impact of preservation techniques on the potential viability of algal, fungal, and bryophyte spores as well as seeds of vascular plants stored in herbaria.
Investigate feasibility of multiple techniques on individual specimens; of isolating/protecting specimens from post-preparation damage/contamination; utility of traditional preparation methods.
Long-term stability of adhesives used in vertebrate fossil preparations.
Minimizing damage to DNA in various specimen preparation techniques (e.g., plants-alcohol collecting).
Non-cryogenic methods of tissue preservation for DNA extraction.
Optimal concentration of preservative (and fixatives) for long-term preservation of wet specimens.
Preparation of succulent plants (drying techniques that render specimens most useful to researchers).
Preservation of mammal skins to prevent shedding hair in sensitive specimens, e.g., deer, cats.
Preservatives used in bird skins—how to handle old specimens on which arsenic was used.
Product reviews in terms of long-term stability and effect.
Quality of preparation methods and materials.
Should be a major thrust to coordinate "autopsy" procedures (necropsy).
Simple, inexpensive tests to determine composition and concentration of fluid preservatives for specimens of unknown or uncertain preservatives and to check for changes in concentration.
Specifications and methods for adhesives and mounting of herbarium plant material.

priority, inorganic and plant materials were each noted by more than 25% of the respondents. Fluid-preserved specimens, which can include samples of animal, plant or inorganic materials, were selected by approximately one-third as a high priority. In spite of the weighting towards animal materials, it is interesting to note that all of the highest research priorities are ones that encompass the needs of all the disciplines and material types. As evidenced by additional comments made by respondents, the specific materials and methods will vary with the discipline, however, and it is important that the research reflects the uniqueness of the disciplinary requirements. This situation is similar to a statement made in

Table 7. Suggestions of aspects of specimen preparation that should be the focus of a transfer of information.

Appropriate application of adhesives in vertebrate fossil preparation.
Assessing impact of plastic coverings on plant herbarium sheets.
Automation of locality label data using GPS/GIS.
Curation of seed collections (for herbaria); containers, labeling, storing; curation techniques for library books, reprints, proper labels, attach labels with Library of Congress call numbers, etc.
Deterioration and chemical changes to mammal and/or bird feathers brought about by lux, rH and chemical (off-gasses) vapors.
Digital imaging and archival, especially minute specimens.
Gathering of data during preparation.
Have a symposium where people present various methods of preparing specimens; devote a SPNHC conference to specimen preparation techniques.
Health and safety issues concerning exposure to pesticides (fumigants such as methyl bromide, naphtha, PDB) used on specimens.
Information already available in anthropology objects conservation literature dealing with bone, shell, feather, skins/leather, ivory, etc. should be reviewed to see what can be used.
Mount making.
Placing collections "on the web" to allow exchange of information, global search capabilities and educational tools for students.
Preparation of tissue samples for histological and biochemical analysis should be well understood within the medical professions.
Standardization of skeletal preparation methods; what is best method when considering time, materials, long-term effects on specimens?
Understanding preparation strategies as they apply to various applications provided by changing technology.

Table 8. Percentage of responses rating the usefulness of each topic for a publication or workshop oriented specifically to natural history collections (rating of 1 = very useful; scale 1 to 5).

Topic	% respondents Rating = 1	% respondents Rating = 1 +2	Weighted average
Paper substitutes and their potential utility for specimen labeling and other specimen or collections documentation	30.1	62.6	2.1
Clarification of terminology used in paper chemistry and in the description of paper stocks	11.2	34.0	2.7
Methods to test pH, and other testing methods to verify the quality of paper stock	13.1	37.8	2.6
Guidelines for the care and handling of a variety of field records, photographs, color slides, maps, original catalogs, etc.	42.6	77.0	1.8
Proper environments for the storage and display of archival and library materials	30.0	54.1	2.3
Specifications for materials used in specimen labeling, including durable red inks	44.0	72.0	1.8
Standards for equipment and materials used to produce laser-printed labels or labels via photocopy processes	45.9	74.4	1.8
Appropriate adhesives to attach labels to a variety of substrates including paper, glass and plastics	36.2	65.2	2.0
Deterioration of labeling materials	38.5	67.8	1.9
Effects of fats, oils, and preparation and pest control chemicals on the preservation of specimen labels	33.5	62.1	2.1

Derrick (1996) with respect to the responses from the seven specialty groups in AIC, that although there were several recurring priorities among the groups, each specialty targeted unique aspects of those broader priorities as specific issues of concern.

Topics listed in the second section of the survey were intentionally more specific, reflecting the individual natural history disciplines to a greater degree. This process allowed respondents to target issues that were more directly aligned with their disciplines, or indicate a lack of familiarity with the issue by selecting the "don't know" category. The topics selected as appropriate for "transfer of information" should be further investigated to develop review articles, books or workshops as appropriate.

There are some areas of overlap between the priorities identified in this survey and those recorded in the AIC survey. In particular, studies evaluating materials might be applicable to the priorities identified within this study. Research priorities identified in Derrick (1996) that might be relevant for natural history collections conservation include: aqueous cleaning methods and solutions; consolidation methods; deterioration of synthetic resins; in-situ and low-tech examination practices and analysis methods; and removal of adhesives and consolidants. However these depend on the systems used to approach the broader research question.

One of the most distinctive characteristics of the research priorities identified as part of this study is that many are in the context of the 'scientific value' of the specimen, and/or the size and extent of a large collection. As noted in the earlier sections of this report, these are characteristics that distinguish natural history collections from other types of collections and form the context for management and conservation of the specimens within the collections.

This project, based on direct input by the SPNHC membership, provides an updated set of priorities for research in natural history collections conservation. Ten topics were selected as the highest priorities by 50% of the respondents, and comprise the most critical research priorities. Of particular concern are methods and materials used in the initial preparation and subsequent treatment of specimens particularly as they impact the scientific utility of specimens, as well as methods to guide decision-making with respect to collection management and conservation, and materials and parameters for storage of collections.

The results of this survey also provide guidance for topics that should be the subject of efforts to transfer information from allied fields. Respondents recognized a number of topics that would be useful for natural history collections conservation, particularly if oriented for the context of such collections.

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APPENDIX

BROAD RESEARCH PRIORITIES FOR NATURAL HISTORY COLLECTIONS CONSERVATION

RETURN BY OCTOBER 1, 1999

1	2	3	4	≥5	Circle the number of disciplines your focus on with your collections or research.

Circle the description that BEST fits your work:

Collection Manager **Conservator** **Curator** **Other:** ____________

greatest				least	
1	2	3	4	5	Fluid-preserved specimens
1	2	3	4	5	Plant materials
1	2	3	4	5	Animal materials
1	2	3	4	5	Inorganic materials (earth science)
1	2	3	4	5	Inorganic/organic complexes (i.e., include a biological component)

Assign a PRIORITY rating for each topic. Use the "highest" rating *only* for topics that are the most critical to your work.

greatest				least	**Specimen Preparation**
1	2	3	4	5	(a) Impact of preparation materials and methodologies on chemical and physical properties of specimens
1	2	3	4	5	(b) Impact of preparation materials and methodologies on scientific utility of specimens
1	2	3	4	5	(c) Development of preparation methodologies that maximize scientific utility of specimens
greatest				least	**Post-Preparation Treatments**
1	2	3	4	5	(d) Methods to assess systematically the condition of specimens over time
1	2	3	4	5	(e) Methods to assess systematically the condition of a collection of specimens over time
1	2	3	4	5	(f) Effect on specimens of adding and/or changing storage fluids
1	2	3	4	5	(g) Techniques to clean specimens (e.g., greasy bone; specimens stained by pollutants, mold)
1	2	3	4	5	(h) Mechanisms of oxidation reactions
1	2	3	4	5	(i) Methods to mitigate sampling of specimens for discipline-based research
1	2	3	4	5	(j) Methods for repair/restoration of damaged specimens
1	2	3	4	5	(k) Impact of treatments on the scientific utility of specimens
greatest				least	**Understanding Specimen/Collection Damage & Functions**
1	2	3	4	5	(l) Impact of pest control methods on chemical and physical properties of specimens
1	2	3	4	5	(m) Long-term impact of pest control residues on scientific utility of specimens
1	2	3	4	5	(n) Proper relative humidity and temperature parameters for general collection
1	2	3	4	5	(o) Optimal parameters for particularly sensitive materials
1	2	3	4	5	(p) Effects of visible light, infrared, and ultraviolet radiation on specimens

APPENDIX (CONTINUED)

BROAD RESEARCH PRIORITIES FOR NATURAL HISTORY COLLECTIONS CONSERVATION

RETURN BY OCTOBER 1, 1999

greatest				least	
					Understanding Specimen/Collection Damage & Functions
1	2	3	4	5	(q) Optimal environments for materials taken from or stored in extreme environments (e.g., humid tropics; Antarctic ice columns; nonterrestrial specimens)
1	2	3	4	5	(r) Effects on specimens of glycerin, buffers and other additives to storage fluids
1	2	3	4	5	(s) Impact of storage materials on histological and chemical analyses of specimens
1	2	3	4	5	(t) Impact of currently used environments on the scientific utility of specimens
greatest				least	**Specifications for Collection Housing & Use**
1	2	3	4	5	(u) Methods to identify pest control residues on specimens
1	2	3	4	5	(v) Impact of pest control residues relative to human safety
1	2	3	4	5	(w) Materials specifications for containers (e.g., jars, lids, unit trays, etc.)
1	2	3	4	5	(x) Materials specifications for storage furniture
1	2	3	4	5	(y) Design specifications for specialized collections (e.g., marine core)
1	2	3	4	5	(z) Cost-effective methods to create microclimates
greatest				least	**Management of Collections Conservation and Conservation Research**
1	2	3	4	5	(aa) Methods to assess risks to collections to rationally identify priorities for collection preservation investments and research
1	2	3	4	5	(bb) Methods to balance conservation parameters with specimen use for identified collections of like material or discipline (e.g., collections organized by strata rather than material; mammal collection)
1	2	3	4	5	(cc) Methods to mitigate impact of inherent specimen properties (e.g., radon; oxidation of naturally occurring elements; water content of minerals)
1	2	3	4	5	(dd) Methods to integrate conservation research with other discipline-based analytical research

WHAT ARE THE TOP PRIORITIES?

Which 3 areas of the 30 listed above are the **most critical** of all the research priorities?
List the 3 areas below and circle the type of material that is most critical to you for that priority.

LETTER	**MATERIAL (circle one material)**				
1. ( )	fluid-preserved	plant	animal	inorganic	inorganic/organic
2. ( )	fluid-preserved	plant	animal	inorganic	inorganic/organic
3. ( )	fluid-preserved	plant	animal	inorganic	inorganic/organic

Is there a BROAD research priority you would add that is not included in the list above? Please describe.

APPENDIX (CONTINUED)

RESEARCH OR TRANSFER OF INFORMATION?

Specimen preparation varies greatly among disciplines and materials. The previous 2 pages dealt with *broad* priorities for the field at large. On these pages, we would like to identify *specific* areas that are research priorities. We also want to distinguish the need for research from the need to transfer information from allied fields.

Indicate which areas reflect primarily a **Research Priority (R)** and which are a priority for **Transfer of Information (T).**

Res. Priority	**Transfer of Info.**	**Don't Know**	
R	T	D	Substitute(s) for formalin in the fixation of plant and animal material
R	T	D	Appropriate buffers for fixatives
R	T	D	Methods of determining when fixation is complete
R	T	D	Preservation of color in biological specimens
R	T	D	Preservation of color in geological specimens
R	T	D	Mounting media for microscope slide preparations
R	T	D	Methods of ringing microscope slides to prevent deterioration of the mounting media
R	T	D	Clearing and staining agents for use in microscopic and macroscopic preparations
R	T	D	Impact of fixatives and clearing and staining agents on histological and biochemical analyses of specimens
R	T	D	Impact of methods of removing flesh, fats and oils from bone on the long-term stability of skeletal material
R	T	D	Effects of clearing and staining on the stability of bone
R	T	D	Impact of preparation chemicals such as formaldehyde, glacial acetic acid and other acidic preparation chemicals on the development of soluble efforescent salts on calcareous specimens
R	T	D	Impact of various insecticides on the development of soluble efflorescent salts on calcareous specimens
R	T	D	Impact of acid preparation on long-term stability and on biochemical analyses of paleontological bone and shell
R	T	D	Impact of various consolidants and adhesives on the chemical and physical stability of specimens
R	T	D	Impact of molding and casting materials on specimen preservation and specimen preservation and specimen-based research
R	T	D	Materials for temporary storage of specimens awaiting processing
R	T	D	Methods of testing the alkalinity, acidity and general composition of the papers used in herbaria collections
R	T	D	Optimum methods of attaching specimens to herbaria sheets
R	T	D	Cryopreservation methods for algae and slime molds
R	T	D	Methods of preserving plant tissue cultures that do not remain viable with current cryopreservation techniques
R	T	D	Effects of freeze-drying on plant materials
R	T	D	Methods of assessing the impact of past and current preparation techniques on both long-term preservation and biochemical analyses of specimens
R	T	D	New methods of field capture/killing
R	T	D	Specifications for materials used in specimen preparation (e.g., metal insect pins, support wires)

APPENDIX (CONTINUED)

RESEARCH OR TRANSFER OF INFORMATION?

Specimen preparation varies greatly among disciplines and materials. The previous 2 pages dealt with broad *priorities for the field at large. On these pages, we would like to identify* specific *areas that are research priorities. We also want to distinguish the need for research from the need to transfer information from allied fields.*

Indicate which areas reflect primarily a **Research Priority (R)** and which are a priority for **Transfer of Information (T).**

R	T	D	Specifications for adhesives and pointing materials for use in mounting insect specimens
R	T	D	Specifications for herbarium mounting and packet paper
R	T	D	Specifications for adhesives and consolidants for geological specimens
R	T	D	Methods of drying specimens in the field, particularly in tropical environments
R	T	D	Methods of packing and shipping field-prepared specimens
R	T	D	Methods of preparing specimens for specialized uses, such as educational programming
R	T	D	Preparation of tissue samples for histological and biochemical analyses
R	T	D	Preparation of subfossil material
R	T	D	Quality of traditional preparation methods and materials
R	T	D	Quality of newer preparation methods and materials
R	T	D	Understanding of technological applications
R	T	D	Understanding how specimens are used
R	T	D	Educating researchers in specific disciplines about best practices for specimen preparation
R	T	D	Integration of conservation research with other types of analytical research
R	T	D	Development of integrated information system to share conservation research data

Is there another aspect of specimen preparation that should be a *research priority*?

Is there another aspect of specimen preparation that should be the focus of a *transfer of information*?

APPENDIX (CONTINUED)

RESEARCH OR TRANSFER OF INFORMATION?

Specimen preparation varies greatly among disciplines and materials. The previous 2 pages dealt with *broad* priorities for the field at large. On these pages, we would like to identify *specific* areas that are research priorities. We also want to distinguish the need for research from the need to transfer information from allied fields.

Transfer of information occurs through publications, workshops, etc. Much information about documentation media exists in the conservation literature. To what degree would a publication or workshop *oriented specifically* to natural history collections be useful for the following topics?

Very useful				Not useful	
1	**2**	**3**	**4**	**5**	Paper substitutes and their potential utllity for specimen labeling and other specimen or collections documentation
1	**2**	**3**	**4**	**5**	Clarification of terminology used in paper chemistry and in the description of paper stocks
1	**2**	**3**	**4**	**5**	Methods to test pH, and other testing methods to verify the quality of paper stock
1	**2**	**3**	**4**	**5**	Guidelines for the care and handling of a variety of field records, photographs, color slides, maps, original catalogs, etc.
1	**2**	**3**	**4**	**5**	Proper environments for the storage and display of archival and library materials
1	**2**	**3**	**4**	**5**	Specifications for materials used in specimen labeling, including durable red inks
1	**2**	**3**	**4**	**5**	Standards for equipment and materials used to produce laser-printed labels or labels via photocopy processes
1	**2**	**3**	**4**	**5**	Appropriate adhesives to attach lables to a variety of substrates including paper, glass and plastics
1	**2**	**3**	**4**	**5**	Deterioration of labeling materials
1	**2**	**3**	**4**	**5**	Effects of fats, oils, and preparation and pest control chemicals on the preservation of specimen labels

Thank you for your time and effort!
Please return this survey by mail using the enclosed label, or by fax to: Paisley S. Cato, 619-232-0248.