

Collection Forum



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PREFACE

JESSICA S. JOHNSON

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This volume contains papers and stories presented at the symposium *Contaminated Collections: Preservation, Access and Use* held at the National Conservation Training Center in Shepherdstown, West Virginia on 6–9 April 2001. The conference was hosted by the Society for the Preservation of Natural History Collections (SPNHC), the National Museum of the American Indian (NMAI) and the National Park Service (NPS) and funded primarily under a grant from the National Center for Preservation Technology and Training (NCPTT). Additional support was provided by the American Institute for Conservation of Historic and Artistic Works (AIC), the AIC Objects Specialty Group, the AIC Research and Technical Studies Group and the National Museum of Natural History, Department of Anthropology, Repatriation Office.

There are many voices in these written documents—some very academic or scientific and some very personal. They reflect the different ways people, institutions, and communities are dealing with the complicated problems caused by pesticide residues on objects housed in museums. Each voice is important and part of the difficulty of finding solutions to the problem is finding ways for people from different backgrounds, experience, knowledge and worldview to communicate. These papers document the more formal presentations of the symposium and the solutions that developed through the facilitated process.

The more informal aspects of the symposium showed us ways to effectively and creatively work together to find solutions. The program was organized to include break out sessions and work groups that were managed by professional facilitators. Using the ideas developed in these sessions the participants created the backbone of the Executive Summary which lays out a number of goals. This document was refined after the symposium, with opportunities for input from all participants, and is also included in this publication.

The participants of the symposium found a path to good, open communication based on mutual respect and careful listening. Good humor and many, many jokes helped us to understand each other in a more personal way.

It is clear there is no easy answer to the problem created by pesticide contamination of collections. Each case requires new collaborations and imaginative approaches by museums, tribal representatives and communities, and public health advisors. Longer term solutions need to be developed through research and policy development. Funding is needed for identification of pesticide residues in the short-term, and research on solutions in the long-term.

The organizing committee would like to thank the institutions who generously supported this conference. Through their commitment to developing new ideas and expanding knowledge of the problem through all affected communities we were able to bring together an incredible group of participants to work together.

Most importantly, many, many thanks to the participants who led us towards innovative solutions. We invite all readers of this publication to join with us to carry out the numerous actions identified by the participants that will allow for safe contact with objects contaminated with pesticides.

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Ildiko DeAngelis, Daphne Moffett, John Moses,
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**EXECUTIVE SUMMARY: CONTAMINATED
COLLECTIONS: PRESERVATION, ACCESS AND USE
PRESERVATION OF NATIVE AMERICAN AND
HISTORICAL NATURAL HISTORY COLLECTIONS
CONTAMINATED WITH PESTICIDE RESIDUES
6-9 APRIL 2001**

PURPOSE

On 6-9 April 2001, Native Americans and preservation professionals, scientists, public health officials, and attorneys participated in a symposium at the National Conservation Training Center in Shepherdstown, West Virginia. The purpose of the symposium was to jointly address various issues related to the use and repatriation of museum objects that may be contaminated with pesticides. This initiative was hosted by the Society for the Preservation of Natural History Collections, the National Park Service, and the Smithsonian National Museum of the American Indian. Funding was provided by the National Center for Preservation Technology and Training, with additional support from the American Institute for Conservation of Historic and Artistic Works, and the Department of Anthropology of the Smithsonian National Museum of Natural History.

The objectives of the symposium were:

- To identify current scholarship regarding collections surveys, development of testing methods, risk assessment, and treatment of contaminated collections,
- To determine additional research and training needs for safe use of historical natural history and ethnographic collections and repatriated Native American objects and create working groups to carry out the plans,
- To help develop appropriate conservation strategies for the safe handling, storage and treatment of contaminated objects,
- To encourage communication among the various stakeholders and disseminate information through publications and over the Internet.

SETTING

Participants were pre-selected based on their individual experiences and expertise, to create a "think tank" that could effectively address the symposium objectives.

G. Peter Jemison began the proceedings with an opening blessing followed by Judith Bischoff who officially convened the symposium. Douglas E. Evelyn introduced James D. Nason who gave the Keynote Address titled "A New Challenge, A New Opportunity."

Next, thirteen speakers collectively addressed topics of 1) testing, 2) tribal perspectives and training, 3) regulatory, legal, and ethical issues, 4) exposure and risk, and 5) mitigation and decontamination.

Testing

Jane Sirois, Analysis of Museum Objects For Hazardous Pesticide Residues: A Guide to Techniques.

James D. Nason, Poisoned Heritage: Curatorial Assessment and Implications of Pesticide Residues in Anthropological Collections.

Tribal Perspectives and Training

Susan Secakuku, Issues in Communication and Training Venues by Museums to Tribal Communities.

Leigh Kuwanwisiwma, The Hopi Experience.

G. Peter Jemison, Poisoning the Sacred.

Regulatory, Legal and Ethical Issues

Rebecca Tsosie, An Overview of the Legal, Ethical and Regulatory Issues.

Micah Loma'omvaya, NAGPRA Artifact Repatriation and Pesticides Contamination: Human Exposure to Pesticide Residue through Hopi Cultural Re-Use.

Exposure and Risk

Kathy Makos, Hazard Identification and Exposure Assessment.

Ana Maria Osorio, Tribal Repatriation of Sacred Objects: Health Issues.

David F. Goldsmith, Given Risks of Exposure to Pesticides on Natural History Collections, What Can and Should be Done?

Mitigation and Decontamination

Alyce Sadongei, The Concept of Use.

Nancy Odegaard, Methods to Mitigate Risks From Use of Contaminated Objects, Including Methods to Decontaminate Affected Objects.

Marian Kaminitz, A Review of Methods to Mitigate the Risks from Use of Contaminated Objects.

Over the course of two days the participants met in small groups after each topic presentation, to roughly define issues and develop recommendations. Collectively, these issues and recommendations served as the basis for creating five themes for working groups, to refine objectives and identify appropriate action steps. The five themes were 1) policy and planning, 2) historical perspective and basic principles, 3) technical communication and training, 4) testing protocols/research and development, and 5) legal and ethical. These working groups developed the recommendations that have been combined under the topics below. The participants especially liked a recommendation to "use Indian humor" in all our work and this approach was used with great success on the last evening of the symposium.

WORKING GROUP RECOMMENDATIONS

It was noted that the issue of *cost and funds procurement* runs throughout all the issues and recommendations and needs to be considered throughout.

Policy and Planning

Objective.—There is a need to establish a national agenda with regional, local and tribal flexibility based on clear short- and long-term objectives. To achieve progress in insuring contaminated artifacts can be returned to tribal communities in a manner that respects their traditional cultural use depends upon:

- Catalyst(s) to get the process started and keep it moving (individuals and agencies)
- Commitment to a set of principles to act as a moral and respectful guide
- Collaboration involving all stakeholders and agencies
- Adequate funding and resources to protect the health of tribal communities, museum staff and cultural objects (using the broadest sense of the word "health")

Action item.—Form a working group to develop a national agenda by:

- Identifying lead organizations and structures using a creative approach (combination federal and private sources) avoiding a top-down, regulatory structure (funding sources to be defined as projects are defined).
- Establishing a step-by-step protocol
- Enlisting organizations that can help to:
 - Compile (and make available) terminology and other existing information
 - Evaluate the efficacy of NAGPRA regulations
 - Articulate a model process based on best practices

Action item.—Get NPS NAGPRA to change grant criteria to include a statement that encourages work on pesticide projects.

Next steps.—NPS staff will work towards this goal.

Communication and Training

Objective.—To develop and promote cross-cultural communication for understanding that leads to mutual respect.

Action item.—Disseminate this objective by presenting information about the symposium and the results at numerous venues including conferences and newsletters.

Next steps.—All conference participants will work on this objective.

Objective.—Ensure that communication of technical information includes the presentation and interpretation of data to help explain uncertainty and allow for informed decision making.

Action item.—Promote the following protocol for interactions between tribal and non-tribal entities to support the idea that agencies and institutions need to understand that service to tribal communities should be their primary function.

- Include a mechanism for collaboration and feedback (established in writing) that defines relationships, commits personnel and funding, outlines deliverables (e.g., products, services, reports), and identifies follow-up support (e.g., consultation, outreach efforts, future research).
- Define terms, concepts, and methods for all parties including technical terms, cultural terms and pesticide information.
- Communicate medical and technical data to the affected parties so that results are honorably initiated, presented in a timely manner, focus on affected parties first, respect privacy issues, and identify the most effective communication tools.
- Use risk communication that provides meaningful interpretation and environmental and medical data to the affected parties. The information should

be presented in such a way that the affected individuals/groups gain an understanding of health risks, options for preservation, the action/steps for elimination of sources of exposure and knowledge about or sources for further information or assistance.

Action item.—Train tribal Health Care Professionals through workshops that include content such as train the trainer approaches for information transfer, information provided by tribal health and safety specialists/professionals, health effects of pesticides, and methods of assessment, management and mediation.

Action item.—Prepare kit of information and supplies (such as personal protective equipment) to be provided to tribal members when receiving repatriated materials.

Next steps.—Identify individuals and institutions to carry out the training and information communication.

Testing Protocols/Research and Development

Objective.—To provide information and knowledge support about databases, testing procedures, health assessment/exposure, and research and development.

Action item.—Develop an information database (restricted) that describes each museum and federal agency's tribal collection history, treatments/conservation practices (past and current). Make this database available to each tribe and technical resources agencies as appropriate.

Action item.—Develop standardized protocols for analysis. Develop a decision tree in consultation with tribes. Develop protocols and validate new protocols. Develop terminology, create a glossary, and interpretation information.

Action item.—Conduct health studies among tribes and museum workers including health and exposure surveillance and acute and chronic disease epidemiological research.

Objective.—Develop and validate hazard control and decontamination.

Action item.—Develop chemical, biological and physical methods for mitigation. Investigate barriers, containment or encapsulation. Develop standard levels to assess effectiveness of mitigation

Next steps.—A working group will continue to meet and discuss how to carry out some of the work.

Legal and Ethical

Objective.—Development of a code of ethics regarding collections-based hazards in institutions that hold public trust collections

Action item.—Identify team to draft code (10 or less key people). Identify issues including disclosure, responsibility to research history of collections, collaborative approach, amicable resolution

Next steps.—Write draft (approx. \$10,000) with review of draft by 20–30 organizations separate from drafters. Final draft development within one year. Obtain Sponsorship: AAM, AASLH, SPNHC, major museums, etc.

CLOSING

Billy Cypress closed the proceedings with a blessing and wishes for a safe journey.

SPEAKERS AND PARTICIPANTS

SPEAKERS

- Dr. Douglas E. Evelyn, PhD, Deputy Director, National Museum of the American Indian
- Dr. David Goldsmith, MSPH, PhD, Associate Research Professor, Department of Environmental and Occupational Health, The George Washington University
- Mr. G. Peter Jemison (Seneca), NAGPRA Representative, Seneca Nation of Indians
- Ms. Marian Kaminitz, Head of Conservation, National Museum of the American Indian, Smithsonian Institution
- Mr. Leigh Kuwanwisiwma (Hopi), Director, Cultural Preservation Office, The Hopi Tribe
- Mr. Micah Loma'omvaya, (Hopi), Hopi—EPA Pesticides Program Coordinator, The Hopi Tribe
- Ms. Kathryn Makos, Senior Industrial Hygienist, Smithsonian Institution, Office of Environmental Management and Safety
- Dr. James D. Nason (Comanche), PhD, Professor/Curator of American and Pacific Ethnology, Thomas Burke Memorial Washington State Museum, University of Washington
- Dr. Nancy Odegaard, PhD, Conservator/Associate Professor, Arizona State Museum, The University of Arizona
- Dr. Ana Maria Osorio, MD, MPH, U.S. Public Health Service, on detail to: U.S. Environmental Protection Agency, Office of Pesticide Programs
- Ms. Alyce Sadongei (Kiowa/Tohono O'Odham), Assistant Curator for Native American Relations, Arizona State Museum, The University of Arizona
- Ms. Susan Secakuku (Hopi), Program Specialist—Community Services, National Museum of the American Indian, Smithsonian Institution
- Ms. P. Jane Sirois, Conservation Scientist, Canadian Conservation Institute
- Professor Rebecca Tsosie (Pascua Yaqui), Professor of Law/Executive Director, Indian Legal Program, Arizona State University College of Law

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- Ms. Natalie Firnhaber, Conservator, Anthropology Conservation Lab, National Museum of Natural History, Smithsonian Institution
- Mr. Harold Jacobs (Tlingit), Sitka, Alaska
- Ms. D. Bambi Kraus (Tlingit), President, National Association of Tribal Historic Preservation Officers
- Dr. Daphne Moffett, Environmental Health Scientist, ATSDR/Tribal Office
- Dr. Bill Peters, Director General, Canadian Conservation Institute
- Mr. Peter Reuben, (Tonawanda Band of Senecas), Student, Buffalo State College

- Dr. Timberley Roane, PhD (Lumbee/Cherokee), Assistant Professor, University of Colorado at Denver, Department of Biology
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- Mr. Terry Snowball (Ho Chunk), Museum Specialist, Collections Management Department, National Museum of the American Indian, Smithsonian Institution
- Ms. Lisa J. Watt (Allegany Seneca), Project Director, American Indian Museums Program (AIMP), American Association of State and Local History
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- Ms. Sara Wolf, Conservator, Museum Management Program, National Park Service

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- Ms. Jessica S. Johnson, Senior Objects Conservator, National Museum of the American Indian, Smithsonian Institution
- Dr. Stephen Williams, PhD, Department of Museum Studies, Strecker Museum Complex, Baylor University

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A NEW CHALLENGE, A NEW OPPORTUNITY

JAMES D. NASON

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Abstract.—This keynote address prepared for “Contaminated Collections: Preservation, Access and Use” Conference highlights several fundamental issues in dealing with pesticide contaminated collections, including: (1) legal and ethical concerns; (2) the immediate and serious impact of contamination for Native American communities; (3) the significant scale of the problem nationwide; and, (4) the need for prompt good-faith actions to maintain public trust in our institutions. A proposal to approach these challenges from a national and regional consortium perspective suggests the need for a new nationally funded research and mitigation program sponsored by the National Science Foundation or a comparable agency. It is suggested that major museum, conservation, and Native American organizations join together to support such a new program.

We can often learn a great deal from reviewing the kinds of issues that have been prominent in the history of a profession, and by taking note of how the profession responded to those issues. If we use a professional journal like *Museum News* as our guide to major issues in the museum profession, we would find that only three themes have persistently dominated much of our attention from the 1960s to the end of the century: (1) museum funding issues; (2) issues of professionalism, and (3) ethical issues.

Our collective concerns were of course more extensive. Scattered through these past four decades were more fleeting but important concerns, including: accreditation, interpretation, repatriation, community relations, new technology, and various administrative and collections management issues. For each of these we recognized that a problem existed and sought solutions to it. Often these problems were the result of changing conditions that shifted the bedrock upon which our institutions and professional lives were grounded, such as changing funding priorities of governments or new laws. Many of our solutions were national in scope, whether in new programs such as accreditation, new emphases on the training of museum staff, the adaptation of new technology to our needs, or in new and changing codes of ethics to guide our behavior and perspectives on our work.

We are here today because we now recognize that there is a major problem that must be addressed by our profession, and addressed immediately. We have known, or at least strongly suspected, that residues of highly toxic and persistent pesticides were present in our collections of cultural, historic, and natural history materials. We have known or suspected that some of these might represent potentially serious health risks for us. Our reaction thus far might be seen by others as cautious, exploratory, and limited primarily to new recommendations for handling and non-toxic approaches to pest control.

I suggest that while much yet needs to be discovered, the time for more concerted efforts directed towards detection and mitigation has clearly come. For reasons that will become clear through the papers in this conference, we are confronted by a serious challenge that needs our prompt and focused attention. I also suggest that our response to this challenge, and particularly in seeking so-

lutions to it, will require new work on our part that will likely take years and significant new resources.

There are a number of reasons why this is so. First, the reality of persistent pesticide contamination of our collections lies within the context of very specific legal, ethical, and operational concerns. These affect not only what we can and should do with our affected collections but also the ways in which our staff and others work with collections. Second, we must recognize that while there may be broad community issues here, there are even more specific and fundamentally important concerns that immediately affect our relationships with Native American communities and that impact a number of heritage issues for those communities. Third, the very persistence of many pesticide residues, combined with their likely pervasiveness in collections large and small across the nation, means that any actions we take to deal with this issue will require a long and sustained effort, if only because of the problem of scale in all respects: the size of our collections, the number of those collections, the number of tribal communities with whom we must work, and the limitations of our staff and other resources. And last, it is germane to point out that this may be a substantive public relations issue for our profession, our individual institutions, and the on-going efforts of many to build or maintain close supportive relationships with Native American and other communities—relationships where trust must be an integral component. What we do now, next week, next month, and next year in addressing these issues may well determine how we are perceived, and whether we are indeed trusted.

Anyone who has been involved in any public issue in the profession knows that it is essential to be proactive, not reactive, in our response to this. Indeed, it is my hope that the information that has been shared at this conference will clarify the different ways in which it is important for us to be not only in the forefront, but forthright, in dealing with this matter. And in this context I think it is worth pointing out the obvious: pesticides are a 'hot' press item. Within recent months a series of articles have appeared in the media about arsenic and other pesticide contamination problems, including new revelations about pesticide levels in drinking water and links to cancer. It may be one thing for the general public to read about farm laborers being poisoned by agricultural pesticides, but it's another entirely to learn that those pesticides are in the glass of water from their home's tap, or in the soil at the playground where their children play.

This kind of press is hardly surprising. By the 1990s the Environmental Protection Agency considered pesticide pollution its most urgent problem, and for good reason, with more than two billion pounds used in just 1993 in the United States (Anon. 1998). In the United States poison control centers reported 130,000 pesticide poisonings just in 1990 (Henaio et al. 1993). Equally serious are suspicions that link pesticides with cancer, hormonal change, neurological damage, and increased rates of allergies and asthma in human populations, with associated environmental and health costs estimated at \$8 billion per year range just in the US in 1990 (see, for example, EPA 1995, Jaeger and Carlson 1999, Nuttall 1999, Triendl 2001). And many of our primary culprits in museum collections are at the top of the 1999 CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) List compiled by the EPA and ATSDR (Agency for Toxic Substances and Disease Registry): 1. arsenic; 2. lead; 3. mercury; 12. DDT; 22. chlordane; 24. aldrin; and 26. cyanide (ASTDR 1999).

Whether the public at large will view our problems with contaminated collections with much alarm remains to be seen, although it's hard to believe that such news will encourage visitorship, or hands-on education programs so common today in our museums and interpretive sites. It is easy to imagine that a public sensitized by media coverage of the broader range of pesticide problems will react negatively to news that our collections are hazardous. But if public reaction is uncertain, there can be absolutely no question about many of the reactions we can expect from our colleagues in Native American museums and centers, tribal governments and religious organizations, and others in the community. Based on conversations I've had with friends over the past two years we'll see deep concern, outrage, anger, fear and consternation, just for a start.

It is vital that we recognize just how important, and potentially devastating, this issue is for the Native American community. Thirty years ago the first article I ever wrote in the museum profession appeared in *Museum News*, and dealt with why Native Americans so distrusted, disliked, and often wouldn't go into museums. I suggested then that we had to begin working towards the repatriation of collections. Many others across Native North America were working then on this basic civil rights and heritage problem—and in the blink of an eye, a quarter century later, we finally had a national law that at last dealt with the repatriation of truly significant objects of cultural heritage as well as the remains of ancestors.

To now discover that objects of high regard which are being returned contain poisonous residues is almost too terrible to contemplate. I have thought about this quite a lot as I've met with tribal representatives to go over what we've found, especially in sacred objects—many of which are intended for active use. My thoughts often go back to my great-grandfather's and grandfather's regalia—bows, shields, and other objects of great personal and spiritual importance to our family—and of my lasting sense of loss with the destruction of all of them in yet another of the so common trailer home fires that consumed my aunt's house.

I am also reminded of the words of a friend and very important elder in our Northwest Community—Vi Hilbert, an upper Skagit elder and a leader in the efforts for Lushootseed language and heritage, who recently said:

“The sacred will ever be sacred. What is the definition of sacred? Very simply and profoundly it is this: That which can be destroyed but not created” (Hilbert 1999).

Here is the heart of it: Have the actions of our predecessors destroyed those many sacred and other objects of heritage now in our collections? Will those things of importance being repatriated to their home communities ever be used again as they were intended? Can they ever be used for anything—or must they be only distantly seen and rarely handled objects secured behind glass, in bags, or sealed in some storage array?

This is the nature of our challenge, and its consequences demand that we find answers. I hope, as I am sure you do, that those answers will include effective solutions that will return contaminated objects to a state their original makers intended, and their contemporary inheritors both need and deserve. Finally, I would urge you to consider a proposal for at least one part of this puzzle. We recognize that dealing with this is going to be very costly—costly in time, in staff, and in equipment at the very least. It is also clear that this is an urgent

problem that also, beyond repatriation, directly affects the potential future uses to which we can safely put the objects in our collections, including research and education. We have, in our recent history, dealt with a similarly serious collections issue on a national scale. In 1976, eleven nationally prominent museum directors and curators met in Santa Fe both to discuss the significance of systematic research collections of anthropological materials in our nation's museums, and to address the imminent threats to those collections by virtue of the wretched storage conditions that were severely impacting them, and thus all future research on them.

From the report that resulted from this meeting came a special grant program funded by the National Science Foundation (Ford 1977). The 'Systematics' program supported, throughout the nation, new and important advances in the modern storage, computer documentation, and preventive conservation handling of significant collections. I think we can agree that the upgrades made possible through this program were of great importance not only in the preservation of these irreplaceable resources, but also in making them more accessible for research and educational uses.

I suggest to you that pesticide residue contamination of these same collections is a major national problem of the same scale, and is clearly a related issue—expanded significantly by the impact of NAGPRA implications. It certainly falls well within the Priorities and Recommendations of the AAM Collections Needs Project from 1984 (AAM 1984). I propose that we enlist the services of our national professional organizations and the leadership of our major museum and heritage institutions, including most notably the AAM, AASLH, the National Museum of the American Indian, and the National Park Service, to develop by the end of this year a programmatic strategy that can provide, hopefully with NSF or other funding support, the critical resources that will be required nationally and regionally to deal with the testing, mitigation, and other concerns that form the basis of this meeting's discussions. We should also actively enlist the support and involvement of the National Congress of American Indians, individual tribal leaders, the American Indian Museums Program at AASLH, Keepers of the Treasures, and other relevant parties from the Native American community. What needs to be done can't be done quickly or cheaply—we have more than 2,000 museums alone in Canada, and an estimated 15,000 in the United States, comprising 100s of millions of objects in their collections. This challenge requires that we approach solutions on a highly collaborative and collective basis. I am confident that, with the active support of our major institutions, we can find ways to effectively meet this challenge.

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CONTAMINATED COLLECTIONS: AN OVERVIEW OF THE LEGAL, ETHICAL AND REGULATORY ISSUES

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Abstract.—Repatriation of contaminated objects to Native Nations poses at least two distinct issues: first, the need to identify whether dangerous chemicals exist on an object prior to repatriation; and second, for those objects that are contaminated, the need to identify the particular health risk posed by the contamination. These issues fall within a complex legal framework, governed by at least two separate statutory regimes—cultural resources statutes and environmental statutes—as well as by principles of tort law. Although these legal principles influence the respective rights and duties of Native people and of museums, they are not dispositive of the issues. Rather, the issue of repatriation of contaminated objects requires a restructuring of existing law and policy directives to achieve a coherent legal solution. However, before such a restructuring is possible, it is necessary to examine the legal and ethical dimensions of the problem through an intercultural lens. The nature of the problem is one that threatens human health and safety, requiring scientific study of the health effects of such contamination given the patterns of use employed by Native people. However, it is also one that requires recognition of cultural harm and the inadequacy of existing tort law to quantify the damages that are being suffered by Native people.

INTRODUCTION

The 1990 Native American Graves Protection and Repatriation Act (NAGPRA) facilitated the return of sacred objects and objects of cultural patrimony to many Native American groups. A year earlier, the National Museum of the American Indian Act was passed, facilitating repatriation of such objects held within the collection of the Smithsonian Institution. These statutes were intended to remedy the cultural harm perpetuated by the removal of these objects from Native communities. As a result, Native American practitioners would once again enjoy use of the sacred objects vital to their continued religious practice, and Native people would enjoy access to the objects of cultural patrimony which embody the essence of their distinctive cultural communities. These objects, however, had in many cases been retained in museum collections for several decades. While within those collections, many of these objects were treated with pesticides and other chemicals to ensure preservation. It is possible that these treatments now pose a significant health risk to the Native American community members who come into contact with the objects through their cultural use. This paper explores the legal, regulatory and ethical issues involved with the repatriation of contaminated objects to Native communities.

STATUTORY FRAMEWORK

The issue of repatriation of contaminated objects poses at least two distinct issues: first, the need to identify whether dangerous chemicals exist on an object prior to repatriation; and second, for those objects that are contaminated, the need to identify the particular health risk posed by the contamination. These issues, in turn, fall within the intersection of two separate statutory regimes, each of which has some bearing on the respective rights and duties of Native people and of museums and agencies. First, to the extent that objects are repatriated pursuant

to the requirements of NAGPRA or the NMAI Act, those statutes govern the issue. Notably, some repatriations took place prior to the effective date of these statutes. Moreover, objects from private collections have in some cases been returned to Native groups for ethical reasons. These objects may also be contaminated, yet would fall outside the scope of NAGPRA or the NMAI Act. Secondly, because these objects were treated with pesticides and other chemicals, the regulatory framework applicable to these dangerous substances under federal environmental statutes may also apply. Finally, it is also necessary to evaluate the tort law implications of this issue, which are largely governed by common law principles, but are also impacted by the federal statutory framework.

NAGPRA

NAGPRA protects the rights of Native American people (inclusive of American Indians, Alaska Natives, and Native Hawaiians) to four categories of items: (1) human remains, (2) funerary objects (both "associated" with remains, and those that are "unassociated"); (3) "sacred objects"; and (4) "objects of cultural patrimony." Due to the pervasive cultural constraints against handling remains or funerary objects, it may be less likely that the repatriation of these items, if contaminated by pesticide or chemical residue, would pose a significant risk to human health. In fact, most Native cultures specify that individuals should exercise a high degree of caution when touching the dead, or things that are related to the dead. However, there may be some environmental risks to human health posed by a particular disposition of the remains which brings the toxic substances in proximity to air or water resources.

The categories of contaminated objects that are of greatest concern because of cultural use patterns are sacred objects and objects of cultural patrimony. NAGPRA defines "sacred objects" as "specific ceremonial objects needed by traditional Native American religious leaders for the practice of these traditional religions by their present-day adherents." Thus, by definition, the statute requires such objects to be actively used in contemporary practice of the traditional Native religions. Active use of contaminated objects obviously poses a significant risk to human health.

NAGPRA defines "objects of cultural patrimony" as those objects having "ongoing historical, traditional, or cultural importance central to the Native American group or culture itself." These objects exemplify group identity and are of vital importance to each generation. They are considered by the group to be inalienable and not suitable for individual ownership. The level of human contact may vary with such objects, but it seems plausible that the nature of these objects requires members of the group to have continuing access to these objects to ensure cultural survival.

As enacted, NAGPRA sought to accomplish several specific objectives related to its general purpose to protect and preserve Native cultures. First of all, the statute increased the protections for Indian graves located on federal and tribal lands, and provided for Native control over cultural items obtained from such lands after the effective date of the statute. Secondly, the statute specifically outlawed commercial traffic in Native American human remains and cultural objects. Finally, the statute imposed detailed requirements on all federal agencies and federally funded institutions (including museums and universities) to assess their

collections of Native American remains and cultural objects through "inventories" and "summaries," to provide written notice to Native American groups as to the identity of these objects, and to repatriate them to lineal descendants and culturally affiliated groups according to specific standards and procedures.

The information provided to Native peoples through the inventories and summaries was intended to document the cultural affiliation of these objects. The statute does not contemplate the necessity for information regarding the treatment of these items by pesticides and other chemicals while in the custody of museums and agencies. It is likely that Congress did not consider the issue because it was not until fairly recently that certain Indian Nations who had received contaminated objects discovered the contamination and brought the issue to public attention.

The 1996 version of the NAGPRA regulations governing repatriation does mention the issue of contaminated objects. Section 10.10(e) provides that the "museum official or Federal agency official must inform the recipients of repatriations of any presently known treatment of the human remains, funerary objects, sacred objects, or objects of cultural patrimony with pesticides, preservatives, or other substances that represent a potential hazard to the objects or to persons handling the objects." Under this regulation, the custodian of the objects apparently has a duty to notify the Native claimants if (1) the custodian *knows* that the objects were treated; and (2) if the treatment represents a "*potential hazard*" either to the objects themselves or to persons handling the objects.

It is unclear whether the language requires the custodian to have *actual* knowledge, or whether such knowledge may be implied based on the industry pattern or practice of such treatments. It is likely that the custodian is held to have knowledge of treatments to the extent that the museum or agency itself keeps records of treatments or has had regulations in place requiring treatments of specific categories of objects (e.g., those containing feathers, fiber, or hair). It may be instructive to examine the regulations for Curation of Federally-Owned and Administered Archaeological Collections (36 CFR 79). These regulations discuss various aspects of preservation of the objects, and specifically require the custodian to retain untreated samples from material remains that are treated with "chemical solutions or preservatives that will permanently alter the remains." (36 CFR 79.9[b][5][iii]). In such cases, there would clearly be knowledge of the chemical treatment.

The requirement that the substance be one that is potentially hazardous to the objects or persons handling the objects is one that may likely be met by reference to the federal or state regulatory frameworks that apply to toxic and hazardous substances, or to public health studies.

Pesticide and Chemical Regulation

The objects held in museum or agency collections may have been treated with pesticides, preservatives, or "other substances" that pose a hazard to human health. Hazardous substances are regulated by a series of federal statutes and by state statutes. It is unclear that this regulatory scheme has a direct application to the issue of repatriation of contaminated objects to Native Nations. However, the problem fits within the intent of the statutes to protect public health and the environment, and thus the statutory framework has an important bearing on the issue.

The Federal Insecticide, Fungicide and Rodenticide Act.—The federal government has regulated pesticides since passage of the Federal Insecticide Act of 1910. (Bergeson 2000b) Today, pesticides are governed by a comprehensive federal statute, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), which was initially passed in 1947 to require registration of pesticides with the United States Department of Agriculture. All three types of biocides are intended to be hazardous to plants or animals that are destructive to valuable resources, but they often impose substantial health risks to human beings as well. The EPA has the authority to regulate under FIFRA to protect human health. FIFRA primarily imposes registration and labeling requirements on pesticide manufacturers, and these requirements are enforceable by civil and criminal sanctions. However, the statute also attempts to ensure the safe use of the product when placed in commerce.

Under FIFRA, no pesticide, as defined by the statute, may be sold or distributed unless it is first registered with the EPA. The EPA may not register a pesticide unless it first determines that the product will not cause any “unreasonable adverse effects on the environment.” As of 1947, FIFRA required registration of pesticides with the U.S. Department of Agriculture. Thus, the potentially hazardous effect of specific substances can be determined by their registration as pesticides with the USDA.

FIFRA also imposes labeling requirements on pesticides, which extend to the product itself, as well as writings that accompany the product. The statute requires the product to be accompanied by adequate directions for safe use, and warnings adequate to protect health and the environment. If a pesticide contains any ingredient highly toxic to humans, the label must reflect this, and must prominently show the word “poison” as well as an antidote or other practical treatment. Thus, persons who apply pesticides should be on notice of the potentially hazardous effects of the product, and the need to use specific precautions (e.g., avoiding contact with skin) that could be harmful to human health. The EPA has also adopted a Worker Protection Standard (WPS), along with a set of implementing regulations, which regulates workplace practices to reduce or eliminate exposure to pesticides, and establishes procedures to respond to exposure-related emergencies. (FIFRA Regulation 40 CFR 156, 170).

Pesticide products are also subject to regulation under the Occupational Safety and Health Act to control occupational hazards posed by pesticide products. The Occupational Safety and Health Administration (OSHA) has established a “hazard communication standard” (HCS) under which chemical manufacturers and importers are required to analyze the hazards of their chemical products and provide downstream users with detailed material safety data sheets (MSDSs) for hazardous substances, or materials containing hazardous substances. (29 CFR 1910.1200) The HCS applies to all hazardous chemicals, including pesticides, determined to be a health or physical hazard under the HCS. (Bergeson 2000b). Although pesticide products must be labeled in accordance with Part 156 of EPA’s pesticide regulations, pesticide manufacturers must also prepare MSDSs for pesticides that pose a physical or health hazard. EPA considers the MSDS to be part of the “labeling” for a pesticide. (Bergeson 2000b).

FIFRA does not clearly speak to the issue of repatriation of pesticide-contaminated objects to Native Nations. One question is whether these objects are “pes-

ticide-treated articles" within the meaning of FIFRA. The EPA exempts "pesticide-treated articles" from the registration requirements of FIFRA so long as the object meets two criteria: first, the object must be "treated with, or contain a pesticide to protect the article or substance itself"; and second, the pesticide must be registered for such use. (40 CFR 152.25a). According to a Draft Notice issued by the EPA, such articles may be subject to registration if they have certain use patterns that would pose a public health risk. (Bergeson 2000b). So, for example, treated bedding may require registration even if other objects (e.g., treated lumber) would not. This opinion indicates the EPA's primary intent to protect public health.

Of course, the application of pesticides to the objects while in the museum collection likely *was* regulated by FIFRA, at least since 1947. Moreover, because pesticides have been regulated since 1910, it is likely that museum personnel were on notice of the hazardous effects of these pesticides and the need to avoid direct or prolonged contact with them. Native people, on the other hand, are quite removed from the application process. It is not clear whether FIFRA applies to the Native claimants who are now receiving contaminated objects. However, if the statute has been interpreted to require registration of bedding treated with microbial agents in order to protect public health, it is at least possible that the statute should be construed to protect the Native people who will be receiving these objects and using them in daily life.

Toxic Substances Control Act.—The Toxic Substances Control Act (TSCA) of 1976 regulates the importation, manufacture, processing and distribution of toxic substances. TSCA is primarily intended to provide information about toxic substances to assist the EPA in regulating such substances in an effort to minimize the risk of injury to human health or the environment. The statute requires manufacturers to develop adequate data on the chemicals they produce, and to provide this information to the EPA. Violations of the statute occur when the manufacturer fails to provide the required information or violates an order seeking information, although producing or distributing chemicals without providing notice may also be a violation. (Bergeson 2000b).

Importantly, TSCA excludes from its scope pesticides regulated under FIFRA. Thus, TSCA is only potentially applicable to chemicals (e.g., certain preservatives such as alcohol and formalin) that were applied to the objects and which do not fall within FIFRA's definition of "pesticide." TSCA applies to "any person" (broadly defined to include corporations and government entities) who "manufactures, processes, distributes in commerce, uses, or disposes of a chemical substance." TSCA defines "chemical substance" broadly, and in terms which cover microorganisms as well as traditional chemicals. Although TSCA has a relatively broad scope, this paper will focus on three aspects of the statute which have important public policy implications for the question of repatriation of contaminated objects. First, section 8(b) of TSCA requires the EPA to "compile, keep current, and publish a list of each chemical substance which is manufactured or processed in the United States." This list is known as the "TSCA Chemical Substance Inventory." The first TSCA Inventory was compiled in 1977, and it has been continually updated since then. Thus, the EPA maintains a current list of all such substances, which would likely include most of the chemicals used as preservatives.

Secondly, the EPA can require manufacturers to test chemical substances for their effects on human health and the environment. This is where the informational part of TSCA comes in. To the extent that the EPA finds that there is insufficient data upon which to predict the effect of such activities on health or the environment," the EPA may require manufacturers, importers, and processors (all responsible parties) to conduct tests to provide such information. Importantly, the necessity for such testing may arise from inadequate data on a susceptible group within the general population. For example, in 1993, the National Academy of Sciences (NAS) published a study entitled "Pesticides in the Diets of Infants and Children," which noted that pesticide risk assessments may not adequately take children into account when evaluating human health hazards associated with exposure to agricultural chemicals. (Bergeson 2000b). The study garnered the attention of state and federal regulators, as well as international entities, raising a number of questions relating to the effectiveness of existing environmental laws to protect children's health. In response to these concerns, the EPA announced its intention to propose test rules under TSCA Section 4 to require testing of approximately 100 chemicals to which children may be disproportionately exposed. Currently, the EPA is gathering data through a voluntary program.

Finally, the entire statute is directed at identifying and controlling public health risks posed by chemical use. Thus, manufacturers are required to supplement their reports with information about "significant adverse reactions" caused by the chemicals (e.g., those causing serious or irreversible damage to human health or the environment)," and must submit any unpublished health and safety studies (whether in their possession or not, or whether in process or completed) that have been conducted on the chemical. If any of this information indicates that the chemical substance "presents an unreasonable risk to human health or the environment," then the EPA may seize the substance and prevent its further transfer in commerce. Moreover, Congress has amended the statute to address toxic substances that pose special regulatory problems, such as asbestos, radon, and lead.

TSCA has some bearing on the policy issues underlying repatriation of contaminated objects. Although the issue is not directly addressed by the statute, and museums are not the manufacturers of the chemicals, there is now evidence of a health risk to a susceptible, and previously unidentified, group within the population that may necessitate further testing of these chemicals to ascertain their effect on human health given particular uses. Congress was quite cognizant of the expense of conducting these studies and that is why the EPA can initiate voluntary testing before moving to mandatory testing. However, in no case has the cost of testing been assessed to the victims of contamination. According to the statute, the cost should be borne by the manufacturing industry or those persons responsible for distributing the chemical in commerce.

The question of "responsibility" is very important to the issue of repatriation of contaminated objects. This paper will discuss that issue in the context of the tort questions raised by this problem.

POTENTIAL TORT LIABILITY

In cases where one party causes harm to the person or property of another party, tort law generally guides the resolution of the parties' respective rights, duties and obligations. Thus, tort law is potentially applicable to the issue of

repatriation of contaminated objects. The best way to discuss the potential applicability of this complex body of law is by evaluating some hypothetical scenarios, all of which involve the possibility of harm to human health or cultural harm. These are two distinct injuries that might be compensable under tort principles, but they are analyzed together in the text that follows.

First, assume that prior to the enactment of NAGPRA, a museum voluntarily repatriated sacred objects to a tribe, which were contaminated with a poisonous substance, and have either caused or posed a substantial likelihood of causing adverse health impacts *or* destruction of the object.

Second, assume the same scenario, but this time the act was accomplished pursuant to the repatriation requirements of NAGPRA or the NMAI Act.

Finally, consider the situation of a tribe that would like to repatriate an item, suspects that it may be contaminated, but is not sure with what or to what extent, and equally important, whether the item can be decontaminated.

Pre-NAGPRA Repatriation

For those repatriations that took place before NAGPRA, there obviously is no statutory or regulatory duty to warn Native people of pesticide contamination prior to repatriating the object. However, under common law tort standards, a defendant may be held liable for injury to plaintiffs' person or property interests if there is proof of (1) duty of care owed by defendant to plaintiff; (2) breach of the duty of care by defendant; (3) causation; and (4) damages suffered by plaintiff. As a byproduct of industrialization, there is now an entire category of case law devoted to "toxic tort litigation": that is, defendants' liability for damages based on plaintiff's exposure to toxic substances which cause or may cause diseases with long latency periods (Weinberg and Reilly 1998). Such litigation is complex and highly problematic for a number of reasons. First, the standard for finding liability (e.g., fault) may vary. Courts may apply the usual "negligence" standard, strict liability (e.g., for "abnormally dangerous conduct"), or standards specially applicable to product liability and failure-to-warn cases. In addition, causation is particularly difficult to prove where diseases have a long latency period or where there is serious scientific dispute about causation. Where multiple causes for disease are possible (e.g., tobacco use, chemical exposure from other sources) there may be insufficient proof of liability in a particular defendant. This factor is particularly relevant in this case, because the pesticides and chemicals may have been applied to the objects by private collectors prior to the time that the museum acquired ownership.

A third problem is in calculating damages. Tort law is set up to award damages for economic loss or noneconomic loss (e.g., pain and suffering) caused by injuries to personal or property interests. The property interests here are difficult to quantify through the normal standard for "economic loss." Although tort actions are available for invasions of property interests (e.g., nuisance, trespass, conversion), the standards are not developed in such a way that cultural interests are protected. So, for example, if a defendant destroys plaintiff's property, thereby precluding plaintiff from use and enjoyment, this would be compensable. The damages, however, would be for loss of the economic value of the property, rather than its cultural value. However, if plaintiff could still "use and enjoy" the property (e.g., on display under glass), but cannot make cultural use of the object, it

is more difficult to assess the damage. This problem occurs in other legal contexts, as well. For example, in criminal prosecutions under the Archaeological Resources Protections Act, it is often necessary to place a monetary value on the damage to the resources. In such cases, the amount of the damage measured in market terms may be minimal, but the damage to the resource's cultural value may be profound.

One of the only cases to ever test out a claim for non-economic damage as "cultural damage" is *In re: The Exxon Valdez*. That case involved a class action suit by Alaska Native individuals and organizations against the Exxon Corporation and other defendants for the damage to their culturally-based subsistence lifestyle (including natural resources and cultural resources) caused by the massive oil spill. The plaintiffs brought the action as a public nuisance claim, but the court applied the "special injury rule" and found that the plaintiffs had not suffered an injury greater in kind than any other Alaskan. Rather, the court held that all members of the public have the right to obtain food, enjoy nature and "cultivate traditional, spiritual, and psychological benefits in pristine natural surroundings." Although the court decided the case on the basis of standing, it necessarily had to reject the argument that plaintiffs had suffered injury to their *distinctive* cultural practices and beliefs. Thus, the practical result of the case was to preclude plaintiffs from recovering compensation for the cultural harm they suffered.

Museums will likely claim that their treatments with pesticides and preservatives were intended to *avoid* destruction of the property as an economic commodity. They may rightfully point out that, as the curators of collections which included these objects, they had legal and ethical duties to preserve the objects. Because the actions the museums took in fact preserved the physical condition of the objects, they were legally appropriate. Assuming that this argument prevails, the next question would be whether they acted appropriately in *repatriating* the objects to tribal governments without warning them of the contamination. Although the museum's intent is largely irrelevant under a strict liability theory, it is relevant in a negligence cause of action, such as a failure-to-warn case. The requirements imposed by FIFRA and TSCA indicate that the museums should have been on notice that these chemicals are potentially hazardous to human health and the environment and their use is heavily regulated. Arguably, this is sufficient to impose a duty to warn subsequent transferees of the museum's use of toxic substances, particularly because the museums were clearly on notice that the Native people intended to use the objects in daily life. The failure to warn issue has arisen in toxic tort actions based on ingestion of foods exposed to pesticide residue, as well as exposure to asbestos and other toxic substances. (Weinberg and Reilly 1998)

Recovery for noneconomic damages related to personal injury are more difficult to secure, but may be awarded in some cases. (Kole and Espel 1991). If these damages are viewed as highly speculative (e.g., damages for the "increased risk of future disease") courts are reluctant to award them. To the extent that the fear of disease is considered "reasonable," and there is proof of mental distress, damages may be awarded by some courts. Moreover, the courts have increasingly awarded damages for future medical monitoring, screening or surveillance to plaintiffs who have been exposed to toxic substances at significant levels. (Kole and Espel 1991).

A final issue in this area is whether or not common law tort actions have been preempted by the federal environmental laws. Preemption is a complex and technical area of the law. However, the general idea is that in some cases, pervasive federal regulation actually preempts state regulation or adjudication that would impair the purpose of the federal statutes. There are many cases dealing with the preemptive effect of these statutes, including FIFRA, some of which find the federal statute preemptive of state regulation or private tort actions, and some which find no preemption. Thus, the issue could be decided either way depending upon the facts of a given case or the standards imposed by a particular court. However, a couple of general points are in order. First, when a statute fails to specify whether it preempts state law, there is a presumption against preemption. (Weinberg and Reilly 1998). This is especially the case when the topic, such as tort law, is one traditionally controlled by state law. For example, in *Silkwood v. Kerr-McGee Corporation*, the Supreme Court ruled that the Atomic Energy Act did not preempt an award of punitive damages under state law for radioactive contamination. Second, compliance with the requirements or standards of a statute or regulation does not preclude a finding of negligence where a reasonable person would take additional precautions. (Grad 2000). In some cases, courts will hold a person to a higher standard of care than that required by the statute. Thus, even to the extent that a defendant asserts that there was compliance with the basic requirements of FIFRA or TSCA, it may still be the case that additional precautions (e.g., a duty to warn) were required before repatriating an object to a Native group.

Post-NAGPRA Repatriation

Assuming that the objects have been repatriated according to NAGPRA, it would appear that the regulations currently impose a duty to notify the tribe of contamination known to the museum and likely to be hazardous to humans. Although there is not a similar regulation under the NMAI Act, the two statutes track one another in their purpose and policies, and thus, the same duty likely applies to the Smithsonian. A failure to notify (at least of known facts) would therefore appear to establish a breach of a statutory duty of care to the plaintiff, enhancing the chances for success of a tort action. However, building on the discussion above, merely meeting the statutory duty may not be sufficient. For example, suppose that a museum official claims that he did not have "actual knowledge" of the chemical use. If he could have known of the contamination through existing museum records, or, because of industry practice he should have made some further inquiry to obtain knowledge, the defendant may be liable.

Pending Repatriations

Finally, consider the situation of a tribe that would like to repatriate an item, suspects that it may be contaminated, but is not sure with what or to what extent, or whether the item can be decontaminated. The Tribe has a legal right to repatriation, which it may have exercised, but is unwilling to take physical possession until the nature and extent of contamination can be determined. In this case, there is clearly no potential or present danger to health of tribal members. However, the tribe is unable to obtain enjoyment of its legal right because of the potential for contamination.

The questions in this case are: Who has the responsibility to test the object to ascertain the level of contamination? If the object is found to be contaminated, what should be done with it? Should the museum have a duty to test the object? Should the museum have a duty to decontaminate the object, if possible? Do Native claimants have a legal cause of action to compel testing or decontamination? What happens to objects that cannot be decontaminated? Do Native claimants have a cause of action for damages caused by the loss of use and enjoyment of the object?

Unfortunately, none of these questions has a clear legal answer. As a starting place, one might attempt to reconcile the policies behind NAGPRA and the environmental statutes to determine what the overall intent of policymakers would be. Based on NAGPRA, the only thing we know is that museums have a duty to notify tribes of known contamination. Based on FIFRA and TSCA, it is plausible that tribes could claim that manufacturers and museums (as users and distributors) must pay the cost of testing to detect the presence of chemicals on the objects, or to assess the health risk posed by known contamination. The federal environmental statutory framework indicates that tribes are the victims of this contamination and should not have to shoulder the burden of testing. Beyond that, these issues require careful thought into the ethical considerations that shape the respective duties and responsibilities of the various parties to the objects and to one another.

ETHICAL ISSUES

In broad terms, the ethical dimensions of this problem require determination of what the respective duties and obligations of the museums and the Native people are with respect to the items and with respect to one another. However, it is very important that this ethical framework is culturally consistent with Native peoples' ways of understanding this problem, as well as those of the non-Native museum and legal communities. In other words, we ought to take an *intercultural* approach to resolving the ethical questions raised by this issue. This paper suggests a few thoughts on this by first examining existing structures to see what ethical implications they hold, and then raising certain fundamental ethical problems.

Law and Ethics

The ethical implications of this problem are not driven by the legal framework. However, it is important to examine the existing law to see what policies should be served in this situation to effectuate the broader goals of the statutes. NAGPRA, of course, is specifically intended to ensure that Native Americans obtain the return of their Ancestor's remains and of their cultural property. Under NAGPRA, Native people hold both the moral right and the legal right to repatriation. The museum is merely a custodian who holds the property before it is returned to the rightful owner pursuant to the statutory procedures. In many cases, the conduct of the museum caused the contamination of the objects. As the legal custodian of the object, the museum had the authority to apply pesticide treatments. But there is an argument in these cases that the museum should assume responsibility for the actual consequences of its actions, even if they were unintentional. In other cases, the conduct of a previous owner caused the contami-

nation of the objects. However, the museum, as current custodian, has a legal duty to repatriate the objects to their rightful owners. Arguably, the museum has a corresponding moral duty to ensure that the repatriation is done in a safe manner. Therefore, the question is whether the museum now has a duty to conduct testing of the object and seek to mitigate the harm to the extent possible prior to repatriating the items. A related consideration is who should bear the cost of the testing and decontamination?

NAGPRA indicates Congress's intent that the tribes *use* their sacred objects and objects of cultural patrimony within the course of their daily lives. In fact, the statute *requires* tribes to use the sacred objects in their active traditional religious practice in order to maintain an action for repatriation. Thus, it is foreseeable to museums that tribes will be repatriating items that they will come in active contact with, and the museums should have a duty to ensure the safety of the objects and those who will use the objects prior to repatriation. Those costs may be significant, however, and it may seem unfair to assess the museums with the full cost of testing and decontamination. However, it also seems unfair to assess the cost to the tribes, who have already been deprived of the use and enjoyment of these objects for several generations and who had no hand in the chemical contamination of their sacred objects. I will discuss the fairness considerations below.

The environmental statutes indicate that Congress has placed a paramount value on public health and safety, and that chemical manufacturers and distributors should bear the responsibility for continuous testing to ensure public health. The chemicals that were used on these objects are the subject of extensive federal regulation. Their use by museum professionals as well as by tribal members poses a risk to public health. The manufacturers may be in the best position to access the existing health data on the risks posed to human health by these chemicals. And the use of the objects by museums and, now by Indian Nations, needs to be factored into those public health assessments. In sum, the environmental framework indicates that the manufacturers and museums share a joint responsibility to identify the risk to human health posed by these chemicals, and to conduct the further testing necessary to ensure the safety of the Indian people who will be exposed to those chemicals (and the environment, to the extent that they will be buried or otherwise disposed of in the natural environment).

The EPA has the capability to require such testing, and in the exercise of the federal government's trust responsibility to Indian Nations, it ought to make this one of its priorities. In fact, the structure is already in place to coordinate such an effort. The EPA has established a Tribal division within its "Office of Pollution and Prevention and Toxics," which is "committed to working in partnership with tribal governments to safeguard and protect the environment from toxic hazards and to promote pollution prevention in Indian country." One of the responsibilities of this Program is to improve communication and "better exchange information regarding environmental concerns and issues in Indian country today." Thus, this Program could serve an important function by facilitating dissemination of information to Indian Nations, Alaska Native governments, and Native Hawaiians about the potential health risk of repatriating contaminated remains, and to coordinate support for EPA action requiring testing of objects and decontamination, where possible.

Ethics of Conservators

The primary goal of most museums is to preserve and exhibit the materials and provide information about those materials in their collections. Thus, museums have detailed regulations in place regarding the need to preserve objects. Traditionally, museum practices focused on the need to control pests through use of dangerous chemicals in order to preserve the objects (USDOJ 1993). However, today, museum policy acknowledges that "contemporary studies have shown that these chemicals can damage the objects and pose health risks to staff." This has inspired museums to adopt the contemporary practice of "integrated pest management," an "ecosystem approach to the control of pests" that employs a variety of approaches to prevent and solve pest problems in the most efficient and ecologically sound manner. This policy shift acknowledges that museums not only have a duty to preserve the objects in their collections, but a duty to safeguard the health of their staff members. The problems caused by repatriation of contaminated objects to Indian tribes indicate a third duty: one that extends to the living people and cultures that belong to the objects and will receive the rightful physical possession of them.

Museums are bound by their own professional codes of ethics to consider the concerns of Native peoples. For example, the American Institute for Conservation has developed a Code of Ethics for Conservators (AIC 1994). The Code identifies the central goal for conservation professionals as the "preservation of cultural property," and specifies that, in meeting this goal, "conservation professionals assume certain obligations to the cultural property, to its owners and custodians, to the conservation profession, and to society as a whole." Given these multiple obligations, the Code of Ethics outlines several principles to guide the actions of conservators. These principles require conservators to have "informed respect" for the cultural property, its significance, and the "people who created it," indicating that conservators owe duties to Native people, as well as to the cultural objects themselves. The principles also acknowledge the need of conservators to minimize risks and hazards to "co-workers, the public, and the environment." The related Guidelines for Practice require conservation professionals to be aware of issues concerning the safety of the materials, and to make the information available to others, as appropriate.

Many museums have adopted specific ethical standards for the treatment of Native American collections, which stress the cultural sensitivity of these objects and the responsibility of museums to respect Native peoples' beliefs (Hill 1996). The Guidelines for Practice of the American Institute for Conservation speak of the need for "preventive conservation" through measures (including pest management) which mitigate deterioration and damage to cultural property. However, the Guidelines note that special cultural considerations may influence the preventive conservation measures to be taken, and in some cases "a decision to allow deterioration to occur by avoiding certain preservation practices may be appropriate." Thus, the ethical statements and guidelines for conservators appear to acknowledge the necessity to incorporate Native peoples' ethical beliefs about the appropriate treatment of cultural objects into their own standards of conduct. In fact, in some cases, museums consult with particular Indian Nations and jointly develop standards for the respectful treatment of sensitive cultural objects within

their custody. Thus, an intercultural notion of ethics for Native American cultural objects seems to be already in the process of developing.

Native American Ethics

In comparison to the conservation ethic of the museums, Native peoples have a cultural and spiritual ethic that often calls for different treatment of sacred objects and objects of cultural patrimony. For example, a museum might consider a mask to be an inanimate "artifact" created by a particular tribe, such as the Seneca Nation, for cultural use. According to Iroquois leaders, however, the "false face masks" embody living spirits capable of healing sickness (Case 1998). They are animate, and deserve the same respectful treatment that one would give to another human being. If a human being had been poisoned with arsenic, someone would be held accountable. Native people believe that those who poisoned the spirits within their sacred objects should also be held accountable, which is a perfectly rational understanding of tort principles—once they are considered with an intercultural perspective.

On that theory, it is impossible to determine the disposition of contaminated objects without a full consultation with the spiritual and political leaders of each Native Nation. It is likely that the appropriate means for testing and decontamination will depend on the particular Nation, the object at issue, and the Nation's belief structure. Some tribes, such as the Zuni, may believe that certain sacred objects, such as the War Gods, are destined to be returned to the earth. The effects of contamination of this type of cultural object will necessarily be different from that of objects like the Iroquois "False Face" masks or the Hopi "Kachina Friends," which will be used in close proximity to human beings on a continuous, on-going basis. However, because these objects are in fact living beings, certain types of invasive or destructive testing may not be appropriate. And certainly the ultimate disposition of the objects should be under the control of the affiliated Native Nations. In some cases, it may be productive for the Native Nations to reach agreement with local museums to create suitable holding facilities, so that the objects can have the cultural attention they require without imposing the health risk to community members that physical repatriation would entail. Such interim agreements would also be advisable because the responsibility for the contaminated objects would still reside with the museum. This means that the museum is responsible for ensuring that those coming into contact with the item are not harmed, and that the object is not harmed. Upon full physical repatriation to the tribes, the tribes assume those responsibilities.

General Ethical Considerations

Much of the discussion has concerned who must assume the responsibility to test the objects and to assure the safety of the tribal communities that will house the objects. This is far from a simple question, given the complex historical circumstances of many of these cases, and the contemporary realities of the parties. It is likely that museums and Native Nations share some of these responsibilities. For example, museums have a duty to warn tribes about potential contamination in order to protect the health of community members. But tribal governments also have a duty to ensure that repatriated objects are safe for use by members before

they are returned to the community. However, there may be a need to assign other responsibilities (e.g., financial) to a particular party.

We often think it is fair to assign responsibility to the "wrongdoer." Tribes may claim that the museums are the "wrongdoers" because in many cases they are the ones who divested the tribes of ownership, who took actions that contaminated the objects, and they are the only ones who can access the information necessary to inform the tribes as to what chemicals were used. According to this position, museums have a legal duty to repatriate the object, and they have a moral duty to ensure that the repatriation is safe for the tribal people. These are powerful arguments that militate in favor of assigning financial responsibility to the museums or federal agencies who have custody of the objects. On the other hand, the museums may argue that they had a legal right to apply the pesticides and that they could not have known that the objects would one day be used by Native people again. Therefore, if they have not done anything "illegal," they are not really "wrongdoers" and should not have any moral responsibility to "set things right."

Some scholars would assert that we should consult the historical circumstances of the parties to tell us which party could most fairly be assigned contemporary responsibility. For example, to the extent that the museum acquired an object through a voluntary transfer from a Native group, the fairness argument on behalf of the museum is strengthened because in some sense the Native people were complicit in the alienation of the object. On the other hand, to the extent that the Native group was wrongfully deprived of these objects through their acquisition on battlefields, through fraudulent conduct, or through transfer from a member who did not have the authority to convey, the fairness argument on behalf of the Native group is much stronger.

Some scholars would reject the use of historical circumstances as a way to engage the contemporary fairness of assigning responsibility to a certain group. These scholars would maintain that even if the property was originally divested from the tribe in an unfair way, that does not now justify assigning some new and different responsibility to a contemporary party who had no direct role in the wrongdoing. According to this view, the parties should focus on the fairness of assigning responsibility to one of the respective parties given their *contemporary* positions. Thus, for example, economic theorists would assert that efficiency concerns should govern, and the cost for testing and decontamination should be assigned to the party who is best able to pay the cost (e.g. the "deep pocket") or, if both parties are equally situated, to the party who cares the most about the issue. Because of the nature and extent of federal involvement in many of these cases, it may be that the government should assume some financial responsibility for ensuring the safe repatriation of these objects. Moreover, to the extent that the contamination threatens public health and safety, the federal government should step in to avoid harm to the public.

We could also evaluate the problem based on the need to accord equal concern and respect to the disadvantaged party. The historical background of the issue is quite important in assessing the respective benefits and burdens of past policy. Regardless of the circumstances surrounding the original acquisition of the objects, the museums have had the beneficial use and enjoyment of these sacred objects for many years, during which the tribes were precluded from exercising

their religious practices or maintaining the close connection to the objects that they needed to adequately maintain their cultures. In many cases, Native Nations maintained legal actions to obtain possession of their cultural objects, but were routinely denied relief based on legal doctrines that were set up to favor the dominant society. Because of the longstanding inequality of this relationship, it would be very unfair to perpetuate these inequities by now assigning financial responsibility to the tribes to secure a benefit that they were morally entitled to all along.

CONCLUSION

The issue of repatriation of contaminated objects to Native Nations requires a restructuring of existing law and policy directives to achieve a coherent legal solution. However, before such a restructuring is possible, it is necessary to examine the legal and ethical dimensions of the problem through an intercultural lens. The nature of the problem is one that threatens human health and safety, requiring scientific study of the health effects of such contamination given the patterns of use employed by Native people. However, it is also one that requires recognition of cultural harm and the inadequacy of existing tort law to quantify the damages that are being suffered by Native people.

NAGPRA was enacted in recognition of the sovereignty of Native people and their collective rights to their Ancestral remains and cultural property. The federal government enacted this statute in the exercise of its trust responsibility to protect Native people and their cultural resources. This is the policy background which ought to guide the resolution of the contamination issue.

There is a paramount need to consult with Native people in generating the specific policies that will guide the resolution of this issue. Despite the considerable challenges, there is great promise in the willingness of many contemporary museums and conservators to work cooperatively with Native Nations to resolve this issue. The lessons of history are clear. A generation ago, non-Native collectors and museums appropriated Native peoples' sacred objects and displayed them for the general public as the "culture of America." These conservators never bothered to consult with Native people to determine whether the objects were alive, whether they required care, whether they were even suitable for "public display." Today, the ethics of museum conservators counsel respect for cultural objects and for the Native people who have the moral and legal rights to those objects. The bitter cycle of colonialism may finally come to an end if museums and agencies accept responsibility for consulting with Native people to determine what policies and procedures should now be followed, and if they accept the ultimate responsibility to ensure that the objects are safely repatriated to these Native communities.

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NAGPRA ARTIFACT REPATRIATION AND PESTICIDES CONTAMINATION: THE HOPI EXPERIENCE

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Abstract.—The possible pesticides contamination of museum collections subject to the Native American Graves Protection and Repatriation Act (NAGPRA) has challenged the Hopi Tribe of Northern Arizona to reassess the procedures and protocols involved with repatriation efforts. The utilization of the NAGPRA process in rectifying the removal of integral Hopi cultural and religious objects from their proper contexts may be difficult to realize if meaningful contamination data and funding resources are not available for informed decision making. With a lack of meaningful data from museum records or treatment documentation, repatriated objects may pose unknown health risks to Hopi religious practitioners, families, and the general public. The current problems surrounding this lack of information also relate to the tribal environmental and health regulations that exist to protect those communities. Health risks may be determined through an effort to identify or develop appropriate venues within the NAGPRA statute for testing of museum collections subject to repatriation. The Hopi have established protocol that addresses the potential hazards of contaminated collections and will work to lead research into the production of meaningful test results for review. These results must also be interpreted to tribal communities in a meaningful way so that their decisions are based on detailed and explanatory information of the circumstances surrounding contaminated objects.

INTRODUCTION

In 1990, the Native American Graves Protection and Repatriation Act (NAGPRA) was passed by the 101st Congress and established Public Law 101-61 on November 16, 1990. This Act was created in hopes of rectifying years of religious and social injustice done by groups within American society towards Native American communities. This Act provides a venue wherein Native Americans may reclaim sacred objects and ancestral human remains that are integral to their history and identity. First, Section 6 of NAGPRA required Federal agencies and museums to provide written summaries on the scope of collections of Native American sacred objects and objects of cultural patrimony in their possession. After proper identification and selection, tribes can then move onto Section 7(a)(3) of NAGPRA that provides for the repatriation of candidate cultural objects by a requesting tribe or organization affiliated with a museum collection (U.S. Congress 1990). The final step in the repatriation process, the actual return of objects to Native American communities, has alerted the Hopi Tribe to the issue of museum object contamination with hazardous substances. The identification of this serious health threat and attack on the integrity of sacred objects has been partially addressed in the final regulations of NAGPRA. Effective since 3 January 1996, museums or Federal agency officials are required to inform the recipients of repatriated items of any known treatment with pesticides, preservatives, or other substances that represent a potential hazard to the objects or to the persons handling the objects (43 Code of Federal Regulations 10.10 (e)). In the early 1990s the Hopi Tribe of Arizona was actively repatriating cultural material to the Hopi reservation community but as a result of this object contamination issue, they are

now taking steps toward isolating repatriated objects and exploring possible storage alternatives in mitigating health risks to the Hopi community.

HOPI TRIBAL CULTURE

The Hopi Tribe is situated on a reservation in northeastern Arizona that covers part of an indigenous area they have occupied for over a millennium. The Hopi are a Puebloan tribe and have practiced dry farming of native crop species since ancient times, and most activities were focused on successful harvests. There are ten Hopi villages with residential settlements on the Hopi reservation situated around three prominent sandstone mesas: First, Second, and Third Mesas. Most of the major villages still maintain Hopi traditional leadership, and carry on many of the traditional ceremonies passed on since prehistoric times.

Hopi Tribal Government was created in the late 1930s following the Indian Reorganization Act which created a tribal council made up of elected representatives from villages to deal with tribal services. Currently seated with the Tribal Council representatives are tribally-elected Hopi Chairman Wayne Taylor, Jr. and Vice Chairman Phillip Quochoytewa, Sr. The Hopi Tribal Department of Natural Resources houses an exemplary program, the Office of Cultural Preservation, which has been at the forefront in covering tribal cultural issues, and is recognized as such by many other Native American tribes and governments. This office, under the direction of Leigh J. Kuwanwisiwma, has been key in the return of Hopi cultural material from museums under the provisions of NAGPRA. Cultural materials have been returned in part to their original caretakers for the benefit of the Hopi culture, religion, and future.

The Hopi continue ancient Puebloan traditions that derive their ancestry from many of the major prehistoric peoples of the greater southwest. The *Hisatsinom* (Ancient Ones), or prehistoric cultures known as the *Anasazi*, *Sinagua*, *Salado*, *Cohonina*, *Mogollon*, and *Hohokam*, were predecessors of the multi-faceted Hopi religion and culture of today. As an agrarian society then and now, the main focus of Hopi religion was the propitiation of rain from the cloud spirits and the growth of bountiful crops which followed abundant moisture levels. To serve this focus, various religious ceremonies are held throughout the year following an orderly succession with different ceremonial groups conducting prescribed rituals. Each ceremony is headed by ceremonial society leaders and members who are initiated into any one of those societies. Societies are comprised of Hopi village members and have prerequisites that may include age, clan membership, gender, family, and reviews of social character. Ritual activity entails the use of various forms of religious paraphernalia that are imbued with highly symbolic meanings and sacredness. Religious paraphernalia are of varied forms and functions, from simple objects found in nature to items which are carved, woven, and painted with esoteric symbolism. Many of these Hopi items are in worldwide collections, and these items of religious and cultural importance are necessary for the continued practice of Hopi religion and are vital to cultural ideology.

INADEQUACIES OF NAGPRA REGULATION AND FUNDING

The Hopi experience with NAGPRA has been a successful one, if measured by the goal of returning sacred objects to their appropriate contexts. Yet, with the more recent awareness of contamination after collection, this success could be

undone and reverted to a series of misunderstandings of Native American culture in general. Though recognition of possible pesticides contamination has expanded because of the January 1996 addition 10.10(e) that requires museums and federal agencies to report on pesticides treatment histories, tribes are left with an inconclusive response to this hazardous situation. First, we are not given a specific detail of *when* in the repatriation process this information will be available to tribes nor *what* level of research into treatment histories is sufficient to meet this new requirement. Secondly, no specific funding resources are identified for *how* tribes who wish to pursue independent laboratory testing of sacred objects may do so, in light of already limited museum and federal agency resources in addressing this issue. Thirdly, in no expressed terms is there a recognition of the educational needs of tribes *who* will need to interpret this technical information to tribal members and communities. To this point the desire to understand the contamination hazards that may be present on sacred objects are being pursued by tribes themselves, who through their initiatives, hope to protect the health of their tribal members and communities.

THE NAGPRA REPATRIATION OF HOPI SACRED OBJECTS

The Hopi Tribe's Office of Cultural Preservation, directed by Leigh Kuwan-wisiwma, has been active in the NAGPRA repatriation process since the time of the Act's inception. The repatriation of Hopi sacred objects from the vaults and exhibits of museums across the country is still an ongoing process. Historically, major museums and researchers conducted material culture collection expeditions to the Hopi villages in the mid-1800s to early 1900s and collection continues today partly due to black market demand. These 'exotic artifacts' have been prized by collectors who may have believed that Native American culture would cease to exist, thereby increasing the value of the artifacts. The Hopi culture has been a target of abuse with large amounts of religious paraphernalia being alienated from their appropriate contexts.

The amount of Hopi material culture in U.S. museums and federal collections is large. The Office of Cultural Preservation has to this point identified more than 400 artifacts in the U.S. that may meet NAGPRA repatriation criteria. Currently, there are more than 60 sacred objects that have been returned to the Hopi villages through the NAGPRA process. This repatriation was done prior to an awareness of possible pesticides contamination. During the first steps of repatriation efforts, possible exposure to pesticide residues by many Hopi cultural advisors, usually elders, occurred on trips to museums where they examined collections for identification. In some instances of artifact handling, cultural advisors were not warned by museum staff about the possibility of pesticide residues, nor were they provided with personal protective equipment.

Most of the Hopi artifacts that come into question for pesticide residues are made of organic materials, such as leather, feathers, organic paints, fur, and grass which are subject to pest attack. Historically collection staffs, in a need to preserve such items into "perpetuity," took on many methods and experiments that today could negatively affect the health of the Hopi community. The use of many preservatives has been discontinued in current collections management and has also been cancelled by the EPA for such uses. The more common historic museum pesticides include *arsenic trioxide*, *mercuric chloride*, and *dichlorodiphenyl tri-*

chlorethane (DDT) which, among many preservatives used throughout museum history, are listed in the U.S. Agency for Toxic Substances and Disease Registry/ U.S. Environmental Protection Agency list of *Top 20 Hazardous Substances in 1999*.

A major factor in dealing with the overall pesticides contamination issue is that most museums and their collections managers have limited or no records of objects and pesticide treatments. Therefore unknown types and quantities of pesticides may be present on an object. Also, indirect contamination may occur when untreated objects are stored with treated objects. Because we know organic materials have the potential to absorb some liquids, powders, and other forms of pesticide applications, these substances essentially become a part of the object itself. This creates another difficulty if residue testing requires destructive analysis of *sacred* objects. What is and has been a vital concern of NAGPRA tribal stakeholders is protection of the integrity and sanctity of sacred objects for the respective tribal groups. Overall, invasive testing processes will perpetuate a series of injustices because of the further compromises to religious beliefs and practices surrounding repatriated objects.

All objects repatriated by the Hopi Tribe are sacred elements of the Hopi religion. In some cases, observances of rituals have ceased or partially ceased with the removal and absence of these sacred elements. For instance, *Hopi Katsina kwaatsi* or 'friends', were some of the more visible and identifiable objects that were immediately targeted for repatriation. These museum "objects" are considered to be living entities by the Hopi, thus are treated with community respect and prescribed care. Hopi tribal staff understood the happiness of a Katsina priest who was able to regain the ability to care for sacred beings for which he is responsible, a tradition that has been handed down for almost a thousand years. In contrast, tribal staff must also understand the sad response when the same Katsina priest is told that these 'friends' may be contaminated with pesticides that actually poison rather than promote good health and happiness in the ceremonies conducted with them.

HOPI COMMUNITY HEALTH RISKS AND REPATRIATED OBJECTS

In 1999, a scientific investigation of the possible pesticide contamination of artifacts was completed by the Office of Cultural Preservation with a team of researchers from the University of Arizona—Arizona Poison Control Center and conservators from the Arizona State Museum utilizing NAGPRA Grant 04-98-GP-167. A research letter published in the 24–30 May 2000 issue of the *Journal of the American Medical Association (JAMA)* reports on the findings of high levels of arsenic on two of three Hopi artifacts tested (Siefert et. al. 2000). The report conclusion elicited a tribal declaration from Chairman Taylor establishing a moratorium on further physical repatriation of Hopi artifacts to the reservation through NAGPRA processes. This moratorium reflects the desire to protect the Hopi people. By examining the following pesticide residue exposure scenarios we find that indirect and direct contact occurs with potential health risks involved.

Initial Object Return, Handling, and Storage

Over 60 sacred objects were repatriated to the Hopi reservation and had been returned to their appropriate Hopi communities or individuals prior to the mora-

torium. Upon the initial return of the sacred objects, certain steps were taken to re-sanctify an object prior to its appropriate cultural use. In one case, a group of sacred objects was placed in a ceremonial room then, with proper blessings, any qualified person wishing to accept the responsibility for an object was allowed to take it. This distribution leaves limited information to search out individuals who have objects. In most cases, objects would be handled extensively for initial cleaning, repair, and preparation for storage, and in some cases shared with others.

These potentially contaminated objects are stored in the same manner as other common Hopi religious items are stored in family homes or activity rooms. The sacred objects often are cared for almost daily by certain family members, who may experience chronic exposure to pesticide residues. Objects are also stored in *kivas*, underground ceremonial chambers known for their lack of ventilation and crowded spaces. At other times they are stored in *Piiki* houses where corn, squashes, flour or beans are kept and daily activities take place. These storage places are used by most family members including newborns to elders, who may also be more susceptible to pesticide exposures from objects.

Direct Exposure to Objects with Pesticide Residues

Almost any age group or gender may come into contact with these objects directly or indirectly. Participation in Hopi ceremonies may begin as early as two or three years of age and extends into the senior years. Individuals also share these objects when requested for certain ceremonial performances, thereby increasing the chances for exposure beyond the primary user. Because younger individuals may need to borrow items for participation in ceremonies their exposure to contaminated objects may be increased. Although both males and females participate in performances throughout the year, males may be more at risk due to their higher level of privileged participation in Hopi religion. The handling of an object during the course of a ceremony is extensive as this example shows as discussed in the Hopi Cultural Resources Advisory Task Team February 2001 meeting:

First, an individual would potentially inhale, ingest, and absorb pesticide residues from objects they are to utilize in ceremonial/ritual performances, or contaminate other individuals, items or environments simply by preparing a contaminated object for a performance. Repairing, altering, painting and other preparations done by hand are done over several days at a time prior to the performance of a specific ceremony. No gloves are used and regular hand washing is usually not exercised during this busy preparation. For example, a person works on an object in a *Kiva*, eats a meal in an adjacent area, and then returns home for a tool, meanwhile touching various surfaces, objects or individuals after handling a contaminated object.

Secondly, the ceremonial performance can be conducted over multiple days. Most of these ceremonies involve physical exertion, which may lead to increased absorption through sweat glands, bodily fluids, and increased respiration. Many of these ceremonies are held in higher temperatures with sacred objects in direct contact with unprotected skin, eyes, and mouths, thus possibly increasing the rate of absorption and the possibility for acute poisonings. Note also that some items may be used in *Kiva* environments where

they may be exposed during ceremonial preparations for up to a week at a time to a certain group of participants.

Third, more handling of the sacred object occurs prior to storage. The contamination of supplementary pieces or objects (feathers, attachments, strings, etc.) which are used in conjunction with the contaminated object could be anticipated.

Lastly, observers of ceremonies may also be at risk for exposure. At times, ceremonial participants have contact with observers at which time exposure may occur. Any residues from a participant or contamination of the local environment, such as in a *Kiva* enclosed setting, may result in exposure of the general public.

THE FATE OF CONTAMINATED HOPI SACRED OBJECTS: REGULATIONS AND HEALTH CONCERNS

Another dilemma of sacred objects and contamination is in the eventual handling, storage, and use of these objects whether their contamination is removed or not. During a workshop held on 20 June 2000, for religious leaders and known object recipients, and at a later meeting with the Cultural Resources Advisory Task Team (CRATT), the recognition of this devastating issue was unacceptable to the Hopi people. Most religious leaders and elders had no knowledge of the risks of exposure to contaminated repatriated objects. The Hopi leaders could not fathom the injustice done by museums and institutions with pesticides applications to sacred objects, now finally returned to their original caretakers. The desire to provide traditional means of ritual retirement of sacred objects can not serve as a feasible alternative due to the hazardous substances involved. In traditional retirement these contaminated objects are placed into the natural environment and this practice may create a means of environmental contamination and chances for accidental exposure.

This introduction of pesticide contaminated objects onto reservation lands also creates another legal issue involving risks to groundwater, subsistence practices, accidental exposure, and other situations not anticipated by museums and federal agencies. There are current environmental regulations on the Hopi reservation which may prohibit the introduction of such contaminants as well as developing health and pesticide regulations that address the presence of pesticides on the reservation. If no funding is specified for research in identifying contaminants, the only alternative may be to house the sacred objects in buildings that are specifically built to house hazardous objects into perpetuity. In this case building and safety monitoring as well as security of these sites would be costly and endless, definitely leaving this issue unresolved for the Hopi communities.

Hopi religious leaders also realize that every ceremony conducted with these sacred objects in the desire for good health and happiness for mankind has been undermined with an element of unknown danger. For the Hopi, losing sacred objects *again* brings more emotional distress for leaders, elders, and participants, but to realize that Hopi children may have been harmed by exercising their beliefs and following our guidance is a great insult upon injury. A consensus of Hopi religious leaders and members of the Hopi CRATT have made the following protocol recommendations to the tribal government:

1. Sacred Objects have been welcomed home and unknowingly pose a health risk to all they may contact.
2. Devastating as it is, we must immediately remove any threat to the Hopi people from these objects.
3. Those who have treated sacred objects in this manner should be responsible for cleaning and testing (Museums, federal agencies, universities, etc.).
4. An appropriate facility to house contaminated repatriated sacred objects should be created near or on the Hopi reservation so they are always under Hopi care.

Actions to follow-up these recommendations are being initiated by the Hopi—EPA Pesticides Cooperative Program and the Cultural Preservation Office in conjunction with the Museum of Northern Arizona and University of Arizona—Arizona State Museum in the form of the NAGPRA Object Retrieval Project, partial on-reservation testing, and a Memorandum of Agreement for a temporary storage facility. As it stands, the presence of these objects in Hopi homes and buildings has not been mitigated and an effort to provide community awareness of this issue has been initiated by conducting workshops, news articles, and radio news stories. The Pesticide Program is also making a conscious effort to educate others about this problem, including local health care staff, tribes, museums, and the general public. Furthermore, the recommendations are pushing the Hopi Tribe to seek only legal repatriation of NAGPRA objects until well-established test results are achieved on sacred object. Only then will there be physical return of objects to the Hopi reservation. The storage and testing of Hopi repatriated items will hopefully be funded by current and future NAGPRA grants appropriated by the National Park Service as few tribes are financially capable of conducting complete and accurate testing of repatriated objects.

DISCUSSION

The fulfillment of Native American rights is continuing to reveal and reassess the injustices brought upon tribal groups by the U.S. government and American institutions. In this particular arena of object repatriation we have just begun the revealing process, and in the haste to re-inter and repatriate, tribes have been dealt another setback in a healing process. For the Hopi, many of the changes and trespasses brought on by American government and society have pushed us into a mode of circumspect conservatism. Yet even with this usual approach the tribal government did not foresee this immediate pesticide concern, and in retrospect we understand that relevant information must be critically reviewed with tribal priorities and concerns clearly identified.

The Hopi understand hardship and challenges well, simply by living in a harsh environment and with a complex religious system, thus they work with patience and diligence in achieving benefits for the overall Hopi community. The commitment of the author to this issue stems from participation in ceremonies and culture wherein family members, friends, society members, and relatives are at risk for exposure. As an anthropologist, the author also understands the role of NAGPRA and its benefit to Native Americans even though pesticide residues and testing may continue to compromise inherent Hopi beliefs and practices. The Hopi will continue working as they have survived by following traditions and teachings

which have lasted over a millennium and now lead them into the future in light of many challenges to come.

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POISONING THE SACRED

G. PETER JEMISON

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Nya weh skannah swah gweh goh (I give thanks that all of you are well). Currently I serve as the Native American Graves Protection and Repatriation Act representative for the Seneca Nation of Indians. In 1998 I chaired the Haudenosaunee Standing Committee on Burial Rules and Regulations, a position I held for ten years. The Standing Committee works on legislation to protect unmarked Native American burial sites in New York State and repatriation. The Haudenosaunee are otherwise known as the Iroquois Confederacy, or the Six Nations.

The Haudenosaunee Standing Committee represents the Tonawanda Band of Seneca, Seneca Nation of Indians, Cayuga Nation, Onondaga Nation, Mohawk Nation Council of Chiefs, the Council of Chiefs from the Six Nations Reserve at Oshweken, Ontario, and we at times have also worked with the Seneca-Cayuga of Oklahoma.

With the passage of NAGPRA in 1990 the Haudenosaunee (Iroquois Confederacy) began receiving inventories from museums and other institutions across the United States. The National Museum of the American Indian was created by a separate legislative act, and repatriation was mandated by that legislation. The Standing Committee chose to initiate repatriation with the National Museum of the American Indian and make it a priority. After repatriating human remains and cultural patrimony (wampum belts and strings) we began the process of bringing home sacred medicine masks (false faces) from NMAI.

To the Haudenosaunee, the sacred medicine masks are our helpers, and in English, we may refer to them as our "grandfathers." On 14 November 1998 four hundred and fifty-five (455) medicine masks were returned to the Onondaga Longhouse at Nedrow, New York. The Onondaga Nation is the Keeper of the Central Fire, the place where the Grand Council of the Haudenosaunee meets. The joy of the return of our sacred objects was overshadowed on that day when we learned that out of fifty-seven (57) "grandfathers," seven percent tested positively for the presence of arsenic. The knowledge that contamination was even an *issue* only came to the Standing Committee approximately three months before the return of the sacred masks.

The Haudenosaunee had been asking that our medicine masks be removed from public display and the "grandfathers" be returned since the 1970s when the museum was known as the Museum of the American Indian (aka the Heye Foundation). Efforts to bring home our "grandfathers" began with NMAI in November of 1993. In July of 1998 a letter from W. Richard West, Director of the Museum, confirmed that repatriation of the medicine masks would proceed. In a letter dated 27 July 1998 Bruce Bernstein, Assistant Director for Cultural Resources confirmed that NMAI was indeed proceeding with the final steps toward repatriation of our medicine masks, and he questioned whether we would allow a representative sample of the masks to be tested for potential fumigants. He further stated that Museum of the American Indian used fumigants, and that possibly some of its collectors had as well. My calendar records that a delegation of the Standing

Committee visited the Research Branch of NMAI in the Bronx on 24 and 25 September 1998. It was at that time that six medicine masks were picked at random for arsenic testing: one proved positive. We then agreed to have 20 percent of the total tested to get a more representative sample.

The National Museum of the American Indian was in the process of moving its storage and research branch from the Bronx, New York, to a newly built state of the art facility in Suitland, Maryland. The Haudenosaunee Standing Committee had to make a decision whether to repatriate potentially pesticide contaminated sacred objects or to have them shipped to Maryland to await further tests, and experience greater delays. We chose to bring home our "grandfathers," study the sample results, and act upon those results.

What we now had, however, was a contamination problem about which we knew next to nothing. 14 November 1998 was a day mixed with a sense of accomplishment on the part of the Standing Committee, and some fear from community members who were alarmed by the information that arsenic was present on some "grandfathers." On that day we didn't know of any precedent for our situation. Each of the representatives that came to the Onondaga Longhouse along with a few hundred other Haudenosaunee sat and listened as I read the information provided by the Conservation Department of NMAI. The letter signed by Marian Kaminitz and Scott Carroll provided only information that indicated a mask tested positively or negatively for arsenic, not the degree of contamination. They did provide a list of precautions they believed we needed to take under the circumstances.

The community representatives from the Six Nations Reserve (Grand River) in Oshweken, Ontario, decided they were not taking home their medicine masks since three of theirs had tested positively. This decision only transferred the problem to the Onondaga Nation even though their caution could be understood. Onondaga was now faced with storing both theirs *and* Grand River's medicine masks until further testing could be carried out on those that were not tested by NMAI.

The position of Chairman for the Haudenosaunee Standing Committee on Burial Rules and Regulations took on a whole new meaning on that day in November. Suddenly I was responsible for a decision we had made collectively, but I signed the paper work and all letters were addressed to me. Some wanted to know why I had brought home this problem to our people. I was in the hot seat—there were more questions than answers. Looking back at my calendar for that year I don't know how I handled the return period. That year at Ganondagan State Historic Site we had finished building a full scale Seneca Bark Longhouse, hosted First Lady Hillary Rodham Clinton, and held a dedication ceremony to open the Bark Longhouse. I had also organized a retrospective of my art at the Iroquois Indian Museum at Howes Cave, New York, that opened in October. These are just the highlights of the year. In addition we had a full season of events and school groups at Ganondagan.

Each of our communities took a different approach to the problem. My Longhouse community at Newtown reacted immediately and began to raise money for the testing. Working with the environmental department of the Seneca Nation of Indians we began taking samples from the surface of the "grandfathers" and identified a company that could provide test results. One difficulty we encountered

was that no one could tell us exactly what the test results *meant*. What *is* a truly safe level of arsenic exposure for humans? The Onondaga Nation reacted quickly as well and began testing, followed by procedures to clean the “grandfathers” and retested them after cleaning to see if lower readings could be obtained. Their cleaning methods did produce lower levels of arsenic or no detectable arsenic. They vacuumed with a HEPA filter, washed with soap and water, vacuumed again, and washed them again, then they tested them. The cleaning method was effective at removing arsenic from the surface.

At this same time it became clear to me that testing would be extremely costly and I needed to locate an independent funding source to pay for all Haudenosaunee tests. Our communities are spread across New York State and southern Ontario. Each community had to identify a laboratory in their area to take surface samples and provide results from the tests.

The discourse on pesticide contamination of museum collections is much more widespread today than it was in 1998. Today curators, chemists, researchers, scientists, doctors, lawyers and Indian Nations are all talking about this issue. Conferences have been organized to share the knowledge that each participant has about the subject. This has brought about some new difficulties; on one level I am intensely interested to learn what is now known about pesticide contamination. On another level I must be cautious about what I can share because the “grandfathers” are alive and sacred to us. Our ceremonial practices are not a subject for this paper. In my community I represent *one voice* and even as much as I have learned from the conferences I’ve participated in, the information is not always greeted with openness or acceptance. Traditional beliefs are very important, and I believe I must show the utmost respect for the views of others within our Haudenosaunee communities.

Only within the last two years has the full extent of organic and inorganic pesticide use on Native American collections in museums become freely discussed. Many Indian Nations don’t yet know what the Haudenosaunee know today. One group that does is the Hopi tribe—it has been helpful to discuss with them the mutual concerns we have. Together we’ve been able to express to the technicians, health professionals and museums our individual recommendations.

One or two Haudenosaunee communities will be undertaking further testing to determine if mercury may have been used on our “grandfathers.” Tests taken upon Mohawk medicine masks after the initial return did not show evidence of contamination, but I’d like to see a larger sample taken. In hindsight did we do the right thing? Sometimes I believe we did the right thing, but sometimes I am left with disturbing unanswered questions. The consolation is that I now know the names of a wider circle of people who understand the problem. Answers to some questions about removing the contamination, or sealing it safely, now have to wait for some future date when more testing has provided new information. My recommendations for museums is that if they undertake testing of their collections prior to repatriation this must be done in consultation with the Federally recognized Nations to understand their concerns. Secondly, disclosure of information must be honest and forthright from museums to Nations and must be in a language that is understandable. If information comes to light after repatriation, museums must assume the responsibility for disclosing these new facts to the Nations that need to know.

ISSUES IN COMMUNICATION AND TRAINING VENUES: MUSEUMS AND TRIBAL COMMUNITIES

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Abstract.—Communicating and building relationships with Native communities by museums is a strong element in the contamination and pesticide issue. Many concerns such as access of knowledge and concept of who is the authority have been challenged with recent work of tribes and museums on their repatriation efforts. This paper will review past NAGPRA related activity to provide examples of training methods and communication venues by museums for tribes.

From the general perspective of Native American populations, museums and the American Indian public have had a long and not so glorious history. This history reflects the fairly common perceptions of Native Americans by the majority of the American public in the late 19th century. With the belief that we were a 'vanishing race' there was an effort to record Native American cultures, but collecting at this time also served to satisfy the curiosity and intrigue about indigenous peoples. Therefore, the collecting of many tangible aspects of our cultures, including human remains, began. This could also include the many intangible aspects, such as songs, stories and religious knowledge. Today they are called collections and can still be found, listed now as ethnographic or anthropological, in today's large natural history museums, both in the United States and abroad. This activity and the collections which were amassed, is the foundation for the contemporary ties Native Americans have with museums.

Changes in the public perception of the American Indian occurred and tribes themselves not only survived, but thrived. This has certainly influenced the tribe-museums relationship. Most recently perhaps, no other aspect has effected change, but that of political action. Peter Whitely (1998) remarks that ethnography in its traditional form will need to be assessed and changed due to the larger Native American pressures for sovereignty—cultural, political, and intellectual. This is also true for museums.

The Native American Graves Protection and Repatriation Act (NAGPRA) passed in 1990. This statute certainly altered museums and tribes on an individual basis, but it also affected how they work together. Timothy McKeown of the National Park Service stated that the NAGPRA statute "heightened public scrutiny of how museums do their jobs regarding Native American collections" (West et al. 2000). This is true. It is also true to state that NAGPRA heightened Native American scrutiny of how museums do their jobs regarding Native American collections. First of all, repatriation work has given increasing authority over museums' Native American collections to the Native American community. This directly affects and perhaps may conflict with the museum field's concept of ownership and authority, which is in turn affecting the museum field's responsibilities of the management and presentation of their collections.

It was at my first job, with the Hopi Tribe's Cultural Preservation Office, that I saw first-hand the impact NAGPRA had on tribes. By the summer of 1994,

when I arrived there, the Hopi Tribe had received hundreds of summaries from various museums. It was at that time that we began to see how much and to some degree what exactly, of the Hopi materials were in museums. The numbers were astounding and the amount of work overwhelming. During this time, we also began to be approached by museums to comment on or review other aspects of museum work, such as exhibitions, educational curricula, and public programming. This was the time that we were all introduced to the pesticide contamination issue.

That summer, our office had arranged evening meetings with the 12 separate Hopi villages to share information about our work. We were just learning that Hopi objects subject to repatriation might be contaminated with various poisons, although we were not sure with what exact poison, when, how much, which objects and why. I remember one evening in particular we met with members of the village of Old Oraibi and told them of this issue. The sadness and disappointment the old people expressed was awful to hear.

The most compelling notion, however, was that that they were not just sad about the fact that this was awful news, but that certain objects themselves, particularly the Hopi Katsina kwatsi (friends), were poisoned, therefore in danger. To us as Hopi people, some objects are just as alive as you and I. What may seem to be an inanimate object is not, and is treated and regarded as alive. Therefore, issues of object contamination elicit strong emotions for Indian people. There was of course, also disappointment, frustration, and perhaps anger felt by tribal members. Last but not least there were many questions. This reaction is the first challenge that all parties will face in working on this issue.

NAGPRA certainly posed new questions and introduced new issues, all of which are still relevant to the subject of object contamination by pesticides. Such questions are posed by tribes to the museum and from the museum to the tribes. In an attempt to present the issues of communication and training venues for museums and tribal communities, I will present some of these questions and state what I have learned from my experiences, but some questions are simply unanswerable at this time.

One such question posed by museums is two-fold: Who has access to knowledge and who has the authority to make decisions and determinations on objects in museum collections? In essence, as a museum, who do we listen to?

I coordinated an AAM panel to explain to the museum community, that decisions on religious information within tribal context are complicated to reach even for Native staff. This panel consisted of tribal staff members of various museums and they spoke of the tasks and issues associated with incorporating tribal protocol and concerns into the museum management tasks of collections. Some comments from that event were:

- 1) As tribal members who are museum professionals, we cannot make decisions for our own people and certainly not for other tribes.
- 2) As museum professionals we are sometimes not trusted, even if we are Native. We too must build trust and understanding with the tribal community.
- 3) It takes leaving the museum walls and traveling to the reservations to meet

face-to-face with people about what you want to do and sometimes it takes your own money.

- 4) Each tribe is different with their own way of doing things. You cannot assume that one aspect or perspective will reflect another tribe's view.

Other facts to understand about tribes are that they all very diverse and complex culturally, religiously and politically. Tribes have rarely written or recorded their own practices. Such knowledge is usually reserved for practitioners only and is usually learned within the context of the cultural and religious setting. If you are not a part of that context, then most likely you will never learn of it either. Therefore not every tribal member will know. And out of any who do carry such knowledge, many do not wish to share this information. This is a fact of Indian life and will remain a constant issue in working with Native American people. So what does this mean to the museum field? Understanding and respecting these general notions is only the beginning in working with Native tribes.

I could also help to better understand the predicaments that tribes find themselves in. From a tribal perspective, the repatriation process has also affected tribal practices and tribal members, by forcing them at times to adapt age-old traditions. For example, only those tribal members associated with a particular ceremony or society may know the details of how a particular object is used and/or any information associated with it. However, another tribal staff member working on the repatriation claim within the tribal government office may believe that this information would be very relevant to help make the claim to return the object. The tribal staff member working on the research may not be religiously associated with this information. Does the staff member ask for this information? Does the tribe risk breaching their cultural protocol, and allow a non-member to know this information outside of the context of their religion? In tribal communities, knowledge comes with responsibilities and sometimes restrictions. Tribal teaching may also instruct that spiritual consequences are associated with this particular decision. This is the belief system in which some tribes operated and these are some of the questions and situations with which tribes are faced. These are perspectives that a museum may not know or understand. No one tribal person will know everything about all the practices of their entire tribal religion. Therefore, the question from a museum to a tribe of who is the authority, may be unreasonable and unanswerable.

This same predicament also affects the issue of access to knowledge and information in museums. Museums feel they exist to teach people about many things, including Indian culture. In this role, museums have often shared information with the general public, in direct conflict with tribal protocol. How much information should a museum share with the general public? If a museum has knowledge of a particular object's religious significance, who within the tribe is or is not allowed access to this knowledge or object? Who outside of the tribe is allowed access to this information, if anyone? The question of access is problematic for museums, in that they view themselves as public institutions; therefore any member of the public is allowed access to objects or information. However, these questions, once again, place tribes in the predicament of having to place a central authority within their own tribal structure. Tribes are all very different groups of people, each with their own cultural and political makeup that has

evolved and developed over time. They are changing and will constantly do so. This certainly presents a challenge for both museums and tribes.

Since the passage of NAGPRA, tribes have become more sophisticated, creating NAGPRA offices or departments within their tribal government structures. Some tribes have been able to create new independent positions such as NAGPRA Specialists, while others simply add this responsibility on to a long list of other responsibilities handled by their staff. It has been a challenge for tribes to be able to include the various perspectives found within their own membership. The same general comment can perhaps be made for museums. Depending on their staff size, financial resources, and collection, independent positions or departments may not be a reality. Many staff find these responsibilities as an added element to their tasks.

Museums have certainly begun to communicate and collaborate with tribes, mainly in an effort to include tribal perspectives in management and use of their collection. Some staff members have taken the next step by providing training forums to share technical knowledge about museum operations and management. There are various ways in which this has been carried out.

Native Staff

Some museums choose to rely heavily on the usually limited Native staff and/or recruit more Native staff. Although a strategy for museums, this can be overwhelming for these staff people. Native staff members, especially if only one or two within a museum begin to see themselves as two-fold: 1) A liaison with tribes for the museum; and 2) an interpreter of museum functions to the tribe. It has usually been such staff persons who have seen the need by tribes for museum training. Curators and collection managers sometimes are the only person within their museum who carry out training work, on top of their other tasks. This is slowly growing to include other staff within the museum.

Advisory Boards

The creation of Native American Advisory boards has been helpful to some museums. Sometimes not associated with the museum field directly, individuals selected for advisory boards usually come from the various tribes that are reflected in the museum's collection. Monthly or bi-monthly meetings are held, with the group serving as a sounding board on issues and used to provide direction to the museum on issues specific to Native Americans.

Face-to-face Consultation

Other museums have taken on the more time-intensive but effective approach of direct one-to-one dialogue with each particular tribe about their specific collection and issues.

Organized Training Venues

Initially, after the passage of NAGPRA, tribes had many questions about the statute. Tribal offices and their staff are very aware of their own cultural protocol and their tribal perspectives on this issue; but they often have questions on the jargon, definitions, perspectives, and process of the law, and even about museums. NMAI realized this need for a better understanding of NAGPRA by tribes, and

organized several regional forums for tribal staff working on this issue. Some of these forums were co-sponsored by the Smithsonian's National Museum of Natural History and other Native organizations, such as the Keepers of the Treasures.

These forums were hosted in various tribal communities throughout the United States. The objectives were: to learn the procedures for repatriation as outlined in NAGPRA; to discuss the practical considerations of repatriation; to provide information on the repatriation policy of NMAI and NMNH; and to create a network of support among Native communities who are attempting to understand NAGPRA. The forums were very successful and very well attended. They were also very timely, occurring at the start of the repatriation process for tribes. The forums also brought together tribal staff from many tribes and other key NAGPRA players to begin the networking process. The agenda provided information on practical application of the NAGPRA issue, and also allowed for presentation and discussion by tribal practitioners and tribal staff on important issues that are relevant to them.

Workshops are other training venues. The NMAI and the Smithsonian's Center for Education and Museum Studies (SCEMS) offer workshops on a variety of cultural issues specifically for tribal staff. This allows for addressing specific needs or issues relevant to tribes. Annual week-long workshops for a 15 to 20-member audience of diverse tribal members provide hands-on training and knowledge in a particular area of museum practice. Past workshop topics include, "Introduction to Archival Research," "Establishing Tribal Archives," and "Exhibition Development." Through my work, I have found that funding for tribal members to attend such training is limited. Therefore NMAI and SCEMS completely fund these workshops and travel costs for participants. Workshop locations are Washington, D.C. and in various tribal communities.

The NMAI also offers a Technical Assistance program. This is a more personal approach to assisting tribes in their training needs. Each program is two to three days and is scheduled with one tribe to focus on one particular issue or need. The number of tribal people in attendance per visit has been two to six people. The training is usually held on their reservation, using their current equipment, and working in their environment and with their staff. These programs are taught either by NMAI staff or other native professionals within the field.

The Visiting Professional program of NMAI is a similarly focused training experience for tribal staff members who are not students and is tailored after an internship. NMAI departments and staff host tribal individuals while providing training on a particular aspect of museum practice. This also helps to foster networking opportunities. Placement is one to six weeks, with NMAI providing financial support to cover transportation and lodging. There are many successful internship programs for students enrolled in a undergraduate or graduate program. NMAI provides a 10-week placement in most NMAI departments. Stipends, housing and transportation costs are available for Native students.

There are certainly other, numerous training and communication vehicles focusing on museum practice and issues. Through national and regional museum associations, panel sessions, one-day pre-conference training workshops are available on a variety of museum issues, specifically for tribal people. Last year, the newly created American Indian Museum Program, which resides at the American Association for State and Local History, sponsored a one-day workshop, titled

"Caring for and Managing Repatriated Collections." This year, the Keepers of the Treasures organization and the American Association of Museums annual conferences will include panel sessions on the pesticide contamination issue, both of which are submitted by Alyce Sadongei of the Arizona State Museum.

Through the university system, several distance learning and/or continuing education courses were created which focused on museum issues. The University of Victoria in British Columbia offers a two-week course titled, "Aboriginal Cultural Stewardship Program," focusing on collections care and collections management, held both on the university campus and at the U'mista Cultural Centre. The University of Nevada, Reno, Continuing Education offered a three-day course on NAGPRA for those individuals affected by the law. The dates and locations vary and are scheduled in conjunction with various conference dates. The University of New Mexico is currently developing a Museum Studies program with a strong Native American component. This will include curriculum on cultural care and treatment of collections, the creation of preservation and conservation labs, and the development of professional long-distance workshops. The program will incorporate indigenous pedagogy and curriculum relevant to tribal museums and cultural centers.

Based on my work at the tribal level and in my position with NMAI, I have noticed that tribal staff office positions seem to have a high turnover rate, partly because of the lack of permanent funding available to tribes and also because of the limited training provided. Many tribal staff are trained on the job. Therefore, duplicate training and information sessions designed for tribes should be a consideration, as well as the costs associated with attendance.

As I have met more museum colleagues and they learn of my job, I am also aware of issues on the other side of the table, by the museum field. This paper has focused mainly on the needs of the tribes, but clearly museums sense the need to better understand tribes. Today, there are various tribal organizations and entities that could be tapped to assist in this effort and to bring this issue to the forefront. The National Congress of American Indians is the oldest, largest and most representative national Indian organization, and works to inform the public and the U.S. congress on the governmental rights of American Indians and Alaska Natives. There are also regional or inter-tribal organizations that bring tribes together to work on a variety of issues, such as the United South and Eastern Tribes organization, which is made up of at least 22 federally recognized tribes from the states of Texas to Maine. There are state based organizations such as the Inter-Tribal Council of Arizona, which was organized to provide a united voice for tribal governments in the state of Arizona to promote Indian self-reliance and public policy development. There are also individual tribal efforts in bringing this and other issues to the attention of the practitioners/users within their own communities.

Museums and tribes have already begun to establish relationships with each other based on the work of NAGPRA. These same relationships will be used and needed when dealing with the pesticide contamination issue. Not only are phone calls, letters, and e-mails necessary, but visits by the museum staff to the tribe and visits from the tribal staff to museums are imperative to ensure understanding. The costs associated with the repatriation of objects have never been adequately documented. This type of relationship-building and maintenance will also be high-

ly time consuming and expensive, but it is vital and worth the results of the outcome.

Tribes themselves have had to learn about museums operations and philosophy. The rise of more tribal museums is helpful in this area as well as the increase of Native museum professionals. It has been 10 years since the initial NAGPRA visits. Both tribes and museums are not close to finishing the NAGPRA process. Although there are issues that may never be resolved, continuous dialogue is imperative to begin addressing them.

For museums, Native concerns regarding their collection provide more insight and curatorial understanding about indigenous life and philosophy. Museums and their staff can only benefit more and enrich their knowledge of collections with the exchange of information that results from a relationship with a tribe. This begins with a spirit of understanding on both sides. It requires tremendous support by museums, their boards, management, staff and by the tribal people. There is no handbook for museum professionals to learn about tribal concerns, so it can only be furthered as it began in the first place—through direct contact and communication.

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RESOURCES

Native American and Museums Collaboration Professional Interest Committee American Association of Museums

2001 Annual Meeting: 6–10 May 2001, St. Louis, MO

Co-Chairs: Polly Nordstrand/Susan Secakuku

Tuesday12@hotmail.com/SecakukuS@nmaicrc.si.edu; <http://www.aam-us.org>

The Native American and Museums Collaboration Network Professional Interest Committee (NAMCPIC) was established in 1994. Its mission is to promote issues and programs relevant to museums and Native Americans within the AAM membership as well as throughout affiliate associations and organizations. The goals of the NAMCPIC are to increase communication and collaboration, and the diffusion of information among museum professionals on issues related to Native Americans and museums. The NAMCPIC also supports Native American professionals working in museums, museums working with Native Americans and Native American students interested in a museum career. To increase the involvement and leadership of museum professionals, the NAMCPIC convenes annually at the AAM conference, assists at the regional museum conferences, sponsors panels and programs at AAM, operates a list-serve and actively participates in the Diversity Coalition of AAM.

Keepers of the Treasures

2001 Annual Meeting: 17–20 April 2001, Tucson, AZ % Inter-Tribal Council of Arizona, 2214 North Central Avenue, Suite 100, Phoenix, AZ 85004
www.keepersofthetreasures.org

The Keepers of the Treasures is a cultural council of American Indians, Alaska Natives, and Native Hawaiians founded in 1990 and is a 501 (c)(3) non-profit organization. The goals of Keepers are to preserve, affirm, and celebrate native cultures through traditions and programs that maintain native languages and lifeways. The Keepers protect and conserve places that are historic and sacred to people who are indigenous to the United States. The Keepers provides technical assistance and seek to identify

funding from private and public sources for these purposes. The Keepers advocate and assist programs that educate and create respect for native lifeways and history.

American Indian Museum Program

2001 Annual Symposium: 12 September 2001, Indianapolis, IN

American Association for State and Local History

Lisa Watt, Project Director, PO Box 1547, Sherwood, OR 97140
(503) 925-9151; (503) 925-9991; watt@aashl.org

The American Indian Museum Program (AIMP) was established in 1996 at the request of several Indian museum professionals who were involved in an earlier effort to establish a tribal museum association. The goals are to foster the development of American Indian heritage institutions and organizations; further the national dialogue of American Indian heritage in all of its traditional and contemporary forms; and assist the continuing professional development of tribal heritage personnel. The AIMP is directed by a 16-member national steering committee, representing 16 different museums and tribal organizations.

National Congress of American Indians

1301 Connecticut Avenue, NW, Suite 200, Washington, DC 20036
(202) 466-7767; www.ncai.org

The National Congress of American Indians (NCAI), founded in 1944, is the oldest, largest, and most representative national Indian organization serving the needs of a broad membership of American Indian and Alaska Native governments. The founding members stressed the need for unity and cooperation among tribal governments and people for the security and protection of treaty and sovereign rights. As the preeminent national Indian organization, NCAI is organized as a representative congress aiming for consensus on national priority issues. NCAI continues to strengthen its foundation and organizational capacity to meet today's challenges.

Conference/Workshop

Contaminated Cultural Material in Museum Collections (16–18 March 2000)
Arizona State Museum, University of Arizona
Contact: Alyce Sadongei, Assistant Curator for Native American Relations; (520) 621-4609

Conference

The Contamination of Museum Materials and the Repatriation Process for Native California (29 September–1 October 2000)
San Francisco State University
Conference Summary: <http://bss.sfsu.edu/calstudies/arttest/sum>

ANALYSIS OF MUSEUM OBJECTS FOR HAZARDOUS PESTICIDE RESIDUES: A GUIDE TO TECHNIQUES

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Abstract.—Many museum objects, particularly natural history specimens and artifacts made of organic materials, have been treated with pesticides to preserve them. This has resulted in residual chemicals being present which may pose a health hazard. Since documentation of the preparation and treatment of museum objects with pesticides was often sporadic, we may not know whether an artifact is contaminated. Earlier treatment records may help determine what compounds should be tested for in a particular collection. A major concern in the analysis of museum objects and sacred objects in particular is sampling. Ideally, methods of analysis that do not require the removal of any samples from the object should be employed. If necessary, microscopic samples can be removed from objects provided they are representative of the object as a whole. The location of the pesticide residues within the object and the type of sample taken both have a critical bearing on the outcome of the analysis. Surveys of collections for the presence of chemical elements with atomic number equal to or greater than 20 (calcium) can be done without sampling using portable x-ray fluorescence spectrometers (XRF). Detection limits, cost and time are important factors to be considered in choosing appropriate techniques for analysis. Quantitative results for arsenic, mercury or lead compounds can be obtained by atomic absorption spectrophotometry (AAS) or inductively coupled plasma-atomic emission spectrometry (ICP-AES). Analysis of organic pesticide residues can be done by gas chromatography/mass spectrometry (GC/MS). Unknown powders and residues present on the surface of an object can be analyzed by Fourier transform infrared spectroscopy (FTIR), polarized light microscopy (PLM), or x-ray diffraction (XRD) for preliminary identification. This paper provides a survey of various methods used in the analysis of pesticide residues on museum artifacts.

INTRODUCTION

Museum objects may contain many hazardous chemicals. These chemicals may have been applied to the artifacts to help preserve them against insect and mold attacks. If an object is to be handled, either by staff or by members of the public, it is important to know whether it is a toxic chemical exposure hazard. It should be noted that not all residues found on artifacts are toxic. Sometimes the residues present are substances such as alum, salt or cornstarch or they may be toxic chemicals such as arsenic trioxide or DDT. A review of artifact dossiers and treatment procedures combined with analysis of the object itself, samples, or suspicious residues on or around the object may assist in determining what handling and storage precautions should be adopted.

The review by Williams and Hawks (1987) on the subject of the materials used in the preparation of taxidermy specimens reveals that the list of different chemicals used and the variety of application methods is long and varied. Arsenical based soaps and corrosive sublimate (HgCl_2) were commonly used in taxidermy along with many other chemicals to prevent infestation of specimens by insects. These chemicals were also used in the treatment of artifacts made of organic materials such as fur, feather, textile and leather. Arsenic, mercury and bromine have frequently been identified in natural history specimens (mammals, birds) and in anthropology collections (Sirois 2001). Other frequently encountered chemical

compounds in museum collections studied to date include: naphthalene, paradi-chlorobenzene, DDT, lindane, methyl bromide and borax (Anderson 1948, Glas-trup 1987, Kelman 1999, Leechman 1931, Lazar 2000, Sirois 2001).

A comprehensive list of toxic chemicals potentially present in museums can be found in the literature (Goldberg 1996, Hawks 2001, Rossol and Jessup 1996, Williams and Hawks 1987). The wide variety of chemicals that may be present in museum collections necessitates their analysis using a variety of analytical techniques. Inorganic chemicals, such as arsenic, mercury and lead-containing compounds, are analyzed using different techniques than are organic pesticides.

Commonly encountered inorganic chemicals in museum collections are:

- arsenic compounds (such as arsenical soaps and arsenic trioxide As_2O_3)
- mercury compounds, primarily corrosive sublimate ($HgCl_2$)
- borax ($Na_2B_4O_7$)
- lead arsenate ($Pb_3[AsO_4]_2$)

The range of potential organic pesticides used in collections is wide. We are interested in synthetic pesticides which are divided into the following groups:

- organohalogen pesticides
 - a) aromatic (e.g., DDT, dichlorobenzene[s] [PDB])
 - b) non-aromatic (e.g., carbon tetrachloride, methyl bromide)
- organophosphorus pesticides (such as dichlorvos, diazinon)
- phenols (e.g., pentachlorophenol, cresol)
- carbamates (e.g., bendiocarb, aldicarb)

Before any analysis is undertaken, it is important to review the conservation literature and any documentation of earlier treatments of the objects. This provides the analyst with a list of the most likely chemicals present on the objects and can assist in selecting the most appropriate methods of analysis. Other factors that affect the type of analysis chosen include:

- the type of pesticide(s) to be detected
- the limit of detection required (parts per billion [ppb], parts per million [ppm], percent)
- the accuracy and reliability of the results required
- determining whether the pesticide residue is present in the object or on its surface
- the number of artifacts to be analyzed
- whether a sample can be taken from the object
- the purpose of the study (determining the penetration of a specific chemical into an object, performing total element analysis or compound identification)
- the type of sample (surface residue, vapor, artifact sample)
- cost
- time constraints
- how the objects will be used and stored

When requesting the analysis of artifacts for pesticide residues, it is important to provide information on the above factors to the analyst so that they can decide how best they can help. Providing all pertinent information in writing before the project is started is advised.

The analysis of museum and sacred objects presents its own problems:

- sampling is not desirable and with some objects all sampling may be prohibited for cultural reasons
- if a sample has to be taken, it must be small—ideally so small it is not noticeable
- low concentrations of chemicals must be detected in these microscopic samples
- the samples could be complex mixtures of many different chemicals

Access to analytical services may be obtained by contacting laboratories in government agencies that may be able to provide services or refer you to a private laboratory. University chemistry, environmental health, occupational health or industrial hygiene facilities could also be contacted. Lists of certified industrial hygiene laboratories can be found on the Internet (see supplier directory at the end of the paper). Larger museums may have access to analytical instrumentation as well.

Due to the limitations on the length of this paper a survey of various methods used in the analysis of pesticide residues on museum artifacts is presented, however it is not a comprehensive review of pesticide analysis. The bibliography contains selected references and is not a complete review of the literature.

The analytical methods outlined below are those methods that are used in some conservation laboratories for the analysis of artifacts. More detail about these techniques can be found in various encyclopedias and texts on analytical techniques (Cahn et al. 1992, Cahn and Lifshin 1993, Skoog et al. 1998). Brief mention will be made of some of the methods used in occupational health (Makos this volume) and environmental chemistry as there are well established techniques for determining arsenic and mercury levels in the workplace as well as for analyzing organic pesticides in the environment.

The analytical techniques section of this article which follows is divided into the following sections: methods that do not require samples and methods that do require samples. The pros and cons of each technique, sample type and size and limits of detection are summarized in Tables 1 and 2. The issue of sampling is discussed with the analytical techniques requiring samples as it is one of the most important steps in the analytical procedure. It is also the step most likely not to be performed by the analyst. Gas chromatography/mass spectrometry (GC/MS) is discussed in the section on analytical techniques requiring samples but can also be used for the analysis of organic pesticide vapors given off by objects.

ANALYTICAL TECHNIQUES NOT REQUIRING SAMPLES

X-ray Fluorescence Spectrometry

X-ray fluorescence spectrometry (XRF) using radioisotope excitation is an on-site, non-destructive technique used to detect chemical elements with atomic number equal to or greater than 20 (calcium) present at the percent level. It is a qualitative or semi-quantitative method of simultaneously detecting several elements. For pesticide analysis on museum artifacts arsenic, mercury, lead and bromine are the most common elements of interest. A typical analysis takes 200 seconds and no sample preparation is required. A surface area of approximately 3 cm² is examined. The x-rays can penetrate beneath feathers and fur allowing

Table 1. Non-destructive (no samples required) methods of analysis for pesticide residues.

Technique	Samples	Detection limits	Pros and cons
X-ray fluorescence (XRF)	Artifact examined, approximately 3 cm ² area analyzed No samples	0.05% As (in an organic matrix)* 0.01% Pb**	<p><i>Pros</i></p> <ul style="list-style-type: none"> ● no samples are needed ● the object is not damaged in any way ● quick ● detects elements at and above calcium (atomic number 20) in the periodic table simultaneously <p><i>Cons</i></p> <ul style="list-style-type: none"> ● semi-quantitative ● cannot determine whether the contaminant is on the surface or in the substrate or inside the artifact ● higher detection limits than other methods (AAS, ICP-AES) ● does not identify the compounds present in the sample—only elements ● reveals areas of higher average atomic number in a specimen or artifact ● useful in conjunction with other techniques which characterize the pesticides more thoroughly (XRD, PLM, AAS, XRF, FTIR, GC/MS) ● x-radiography can show where arsenic or mercury compounds are located in/on the object
X-radiography	Artifact examined, no samples	N/A	

* (Sirois and Taylor 1989).

** (Shefsky 1997).

detection of arsenic, mercury and other elements present in the skin or on the surface of an artifact. The instrumentation used by the authors to analyze museum artifacts on-site consists of a Canberra Packard Inspector portable x-ray fluorescence spectrometer and a cadmium-109 radioisotope source (which emits silver x-rays and γ -rays [Bertin 1975]) and a lithium-drifted silicon x-ray detector. The energy resolution of this detector is 150 eV (Mn K α). Other portable x-ray spectrometry systems are used in museums for similar applications (Nason 2001). XRF is predominantly a surface technique and may not be a totally accurate indication of the arsenic content throughout the object. The presence of a thick layer of fur or feathers between the contaminated area and the detector can lead to a result which suggests smaller amounts of arsenic present in the skin than is actually the case. X-ray spectrometry of an artifact cannot indicate whether the

arsenic detected is in the interior or on the exterior of an artifact. It will only detect whether the element is present or not.

This technique has been used to analyse over 600 natural history specimens and over 300 artifacts from anthropology collections for the presence of arsenic and mercury.

X-radiography

Another non-destructive method that has been used to look for heavy metal residues and arsenic powder in taxidermy specimens is x-radiography. In x-radiography the objects are exposed to x-rays and the image of the x-rays passing through the artifact is captured on a piece of film placed behind the artifact. The more radio-opaque materials (those with higher average atomic number and concentration) show up as lighter areas on the film. Hawks and Williams (1987) used x-radiography to detect residues of radio-opaque materials (such as arsenic or mercury salts, or metal wires) in mammal specimens. Sirois and Taylor (1989) also used this technique to determine the location of arsenic compounds in ornithology specimens previously analyzed by XRF.

ANALYTICAL TECHNIQUES REQUIRING SAMPLES

Sampling

A variety of sample types can be taken if required, many of which are non-destructive to the artifact. Samples must be taken carefully as the sample location greatly affects the analytical results. Samples can be taken of dust on shelves or in storage containers; residues or powders on the artifact; swab or wipe samples from the surface of an artifact; air samples in storage facilities; and pieces of the artifact. The analytical method chosen will depend on the type of sample available or necessary and the species to be analyzed. The types of analysis discussed here will deal only with the analysis of residues relating to the artifacts themselves, and not with the analysis of biological samples (i.e., blood or urine samples from persons handling the artifacts) or air quality samples, both of which lie in the domain of occupational health and industrial hygiene and should be undertaken by a certified industrial hygiene laboratory.

Sampling is one of the most important steps in the analysis of objects for pesticide residues. "The quality of an analysis can be no better than that determined by the sample on which the analysis is performed" (Cahn and Lifshin 1993). The disadvantage of using samples for analysis is that the pesticides applied to the materials being investigated were not usually applied evenly to the object. Consequently, the sample may not be representative of the entire object. Earlier studies have shown that different results can be obtained from the same object depending on the sample locations (Found and Helwig 1995, Sirois and Taylor 1989). Museum samples must be small and generally only one or two samples are removed from an object. Therefore it is important to try to obtain representative samples of the object for analysis.

Various types of samples can be taken for the analysis of pesticide residues on artifacts. Samples of surface residues can be scraped off an object with a scalpel. Powders can be collected from the surface of the objects by dusting the object with a soft cloth to pick up the particles. Powders can be removed from storage boxes and shelving if present. Moistened or dry swab samples can be taken from

Table 2. Methods of analysis for pesticide residues requiring samples.

Technique	Sample type and size	Lower detection limits	Pros and cons
Scanning electron microscopy/X-ray microanalysis (SEM)	Solid samples: powders, skin, feather fur, textile, paper, swab samples Sample size: 0.01–15 cm	X-ray microanalysis: 0.1% As (in an organic matrix)* generally 0.1–1% X-ray lateral Resolution: 0.4–2 μm SEM-Imaging: 5–1 nm resolution depending on the instrument**	<i>Pros</i> <ul style="list-style-type: none"> • specific particles and features of the sample can be studied down to approximately 2.0 μm • all elements in the periodic table from and including boron (at. no. 5) are detected simultaneously • the location of the compound present in the sample can be detected through the preparation of cross-sections and x-ray mapping • quantitative analysis is possible <i>Cons</i> <ul style="list-style-type: none"> • sample must usually be taken • high detection limit compared to XRF, AAS, ICP-AES
Fourier transform infrared spectroscopy (FTIR)	Surface accretion or artifact samples; solid or liquid samples, 0.1 mm minimum sample size	Variable depending on the sample	<i>Pros</i> <ul style="list-style-type: none"> • characterization method for a large range of organic and some inorganic materials • general characterization of pesticide groups • ability to analyze very small samples <i>Cons</i> <ul style="list-style-type: none"> • not quantitative • interferences possible from the presence of multiple compounds
Gas chromatography/mass spectrometry (GC/MS)	Organic vapor monitors; moistened or dry swabs of residues from artifacts; surface residues; artifact samples of approximately 0.01 mg and/or 0.5 mm diameter	Ranges for organic pesticide residues: 0.01–2 $\mu\text{g/l}$	<i>Pros</i> <ul style="list-style-type: none"> • quantitative • precise analysis of organic pesticides • low detection limits <i>Cons</i> <ul style="list-style-type: none"> • may require a sample from the object
X-ray diffraction (XRD)	Crystalline materials: solids, powders, 0.1 mm minimum sample size	Generally 1–2%	<i>Pros</i> <ul style="list-style-type: none"> • small sample size • sample is not destroyed during analysis—can be used for other techniques

Table 2. Continued.

Technique	Sample type and size	Lower detection limits	Pros and cons
Polarized light microscopy (PLM)	Particles and fibers, samples size 0.01–10 cm ²	Traces	<ul style="list-style-type: none"> ● identification of crystalline compounds present <p><i>Cons</i></p> <ul style="list-style-type: none"> ● amorphous or non-crystalline materials are not suitable for this technique <p><i>Pros</i></p> <ul style="list-style-type: none"> ● small sample size ● identification of trace amounts of particles present in samples <p><i>Cons</i></p> <ul style="list-style-type: none"> ● not quantitative ● generally used in combination with other techniques such as SEM/x-ray microanalysis for confirmation of identification
Atomic absorption spectrophotometry (AAS)	Swab and wipe samples; microvacuum samples (5 L of air for air sampling); artifact samples (0.01–0.1 g)	Can obtain detection limits down to: 100 ng/ml As flame 500 ng/ml Hg flame 10 ng/ml Pb flame, Depending on sample size	<p><i>Pros</i></p> <ul style="list-style-type: none"> ● quantitative total element technique ● low detection limits ● cheaper than ICP-AES <p><i>Cons</i></p> <ul style="list-style-type: none"> ● monoelement technique ● sample is consumed through analysis ● larger samples needed than for spot tests, XRF, SEM/XES
Inductively coupled plasma atomic emission spectrometry (ICP-AES)	Microvacuum samples; swab and wipe samples; artifact samples; similar size to AAS samples	40 ng/ml As flame 1 ng/ml Hg flame 2 ng/ml Pb flame	<p><i>Pros</i></p> <ul style="list-style-type: none"> ● quantitative elemental technique ● multielement technique ● lower detection limits than AAS ● determination of nonmetals such as chlorine, bromine, iodine and sulfur ● analysis through a greater concentration range <p><i>Cons</i></p> <ul style="list-style-type: none"> ● more expensive than AAS ● sample is consumed through analysis ● larger samples needed than for spot tests, XRF, SEM/XES

Table 2. Continued.

Technique	Sample type and size	Lower detection limits	Pros and cons
Spot Tests and spot test kits	Sample size approximately 1–2 mm ² ; swabs; surface powders	0.1 mg/L As (label of product vial)	<p><i>Pros</i></p> <ul style="list-style-type: none"> ● kit costs approximately \$100.00 for 100 strips ● good reliability for positive results ● can perform the test in-house if properly trained <p><i>Cons</i></p> <ul style="list-style-type: none"> ● set up time ● disposal of the arsenic containing waste ● arsine gas produced by the reaction is hazardous ● colour matching scale with the test kit is not reliable—use the test only as a qualitative test ● test may require artifact samples

* (Sirois and Taylor 1989).

** (Nissei Sangyo 2001).

specimens that contain high concentrations of arsenic or other toxic elements detected by non-destructive survey techniques such as XRF to determine whether the element of interest is present on the inside or outside. The use of moist towelettes to obtain wipe samples for the analysis of arsenic or mercury by XRF is another sampling method (Makos this volume, Nason 2001). This technique may not be appropriate for the analysis of organic samples however. Vacuum sampling can be used to determine the concentration of arsenic or another element of interest on the exterior of the specimen. The dust is collected from a specific area onto filter paper housed in the vacuum apparatus (Costanzo 1999, Makos this volume). For volatile compounds emitted from objects, vapors can be sampled with passive techniques such as organic vapor monitors or with active techniques which use pumps and sampling tubes.

Lastly, a sample of the object itself can be taken. If sampling of an object is requested it is important to consult with the client who may be a Tribal or First Nations representative, Elder, curator, private collector, custodian or conservator. Both museum and sacred objects require that a minimum sample be taken; therefore, the sample location is important. The sample is best removed from the surface of a skin or wooden object since that is most likely where the pesticides were applied. Some of the preparation methods used in natural history collections have been applied to anthropology collections as well, so similar sampling strategies are appropriate. Fur and feather samples are taken as close to the skin as possible since the inside of the skin on natural history specimens is usually treated with arsenical or mercury compounds. Sampling may not be allowed for certain sacred objects.

TECHNIQUES

Scanning Electron Microscopy/X-ray Microanalysis

Scanning electron microscopy/x-ray microanalysis (SEM) is frequently used for rapid and simultaneous detection of elements present in solid samples. Sample size can range from approximately 0.01 cm to 15 cm in diameter. This technique is often one of the first employed, as it gives an overview of the chemical composition of the sample. It can be used to analyze the bulk sample or specific features present in the sample. Reference databases of the morphology and elemental composition of particles can help in the identification of the samples (McCrone 1993). This technique can also be used to determine the depth of penetration of arsenic and mercury compounds if cross-sections are prepared and analyzed using the technique of x-ray mapping.

A practical sample size for skin, fur, textiles or leather would be a one by one to two by two millimetre sample of skin, a few pieces of hair, the tip or base of a small feather, scrapings of powder samples of an area approximately one mm² or a few fibers of textile. For natural history specimens, the hair or feather samples should be taken from as close to the skin as possible.

Scanning electron microscopy/x-ray microanalysis is used for elemental analysis of volumes down to a few cubic micrometers for elements from boron (B) to uranium (U) in the periodic table to a lower limit of detection of approximately 0.1 to one percent. X-ray microanalysis is performed using an SEM integrated with an energy dispersive or wavelength dispersive x-ray spectrometer. As an example, using a lithium-drifted silicon energy dispersive detector with the SEM, the lower limit of detection for arsenic was determined experimentally to be 0.1 percent for bulk analysis (Sirois 2001a). This technique has been used in the analysis of over 250 natural history specimen samples to detect arsenic and mercury compounds on fur, feathers and skin samples (Found and Helwig 1995, Sirois and Taylor 1989, Sirois 2001).

Fourier Transform Infrared Spectroscopy (FTIR)

Fourier transform infrared spectroscopy (FTIR) has been used extensively in the museum field to identify a wide range of organic and inorganic materials associated with artifacts and works of art. It is often one of the first techniques used, in combination with x-ray microanalysis, because it provides an overview of the constituents of a sample. It has been used frequently to determine whether white powders observed on artifacts contain starch, borax, arsenic trioxide or other substances. Infrared spectroscopy is based on the absorption of infrared radiation by the chemical bonds in a molecule as they undergo various types of vibrations. The frequency and the level of absorption are related to the type of bond and type of vibration. To acquire a spectrum, a sample is placed in the beam of the spectrometer using a sampling accessory appropriate to the nature and size of the sample (Moffatt 1995). Precise identification requires matching the spectrum of a sample with known reference spectra. Various collections of infrared spectra of pesticides have been published (Gore et al. 1971, Visser 1993).

Portable attenuated total reflection (ATR) FTIR spectrometers are available which can be used on-site to analyze liquids, semi-solids and solids (e.g., fibers, particles, powders, polymers and fabrics). Although this technique has not yet

been used on-site to survey samples from museum collections for pesticide residues, it may potentially be useful.

Gas Chromatography/Mass Spectrometry (GC/MS)

Gas chromatography/mass spectrometry is a key technique in the analysis of organic pesticides since it can be used to both identify and quantify the compounds. This technique is also used for the characterization of many other compounds in museum collections, such as oils, natural resins, dyes, paint, adhesives and varnish (Mills and White 1994, Khandekar and Schilling 2001). Gas chromatography/mass spectrometry separates the components of a mixture and identifies them based on their characteristic mass spectra. The sample is injected into the system and is heated until it becomes a gas. A carrier gas then forces the sample through a capillary column where the gas mixture is separated on the basis of the differing affinities of the components for the stationary phase in the column. When they reach the MS detector, the gas molecules are ionized first and then fragmented. The fragments are compiled in a graph of intensity versus mass-to-charge ratio in what is referred to as a mass spectrum. Compound identification is achieved by matching the experimental mass spectrum from the sample against a spectral library or reference mass spectrum of known compounds and by matching the retention time against that of a known standard.

Each compound has its own detection limit which also depends on the amount of sample, and the sample work up procedure. Below, lower limits of detection are given for different synthetic pesticide groups when large soil and water samples are used. There are no specific detection limits quoted in the literature for museum objects (see Table 2).

- group 1 (organochlorinated): 0.01 $\mu\text{g/L}$ (Québec 2000a)
- group 2 (organophosphorus and carbamates): 0.01 $\mu\text{g/L}$ (Québec 2000b)
- group 3 (phenols): 2 $\mu\text{g/L}$ (Québec 1999b)
- group 4 (polycyclic aromatic hydrocarbons): 0.2 $\mu\text{g/L}$ (Québec 1999a)
- volatile organic pesticides: 0.7 $\mu\text{g/L}$

One method of sample preparation is the extraction of pesticide residues from artifact samples with a solvent such as methylene chloride (Palmer 2001) or carbon disulfide (Glastrup 1987). It should be noted that carbon disulfide is a hazardous substance which is heavier than air, explodes easily in air and is highly flammable (Agency for Toxic Substances and Disease Registry 1997). Another method involves collecting organic vapors with passive sampling devices such as organic vapor monitors. The authors have undertaken preliminary sampling and analysis of naphthalene, dichlorovos and paradichlorobenzene vapors by GC/MS. The vapors were collected using 3M Organic Vapor Monitors (see Supplier directory). These monitors are made of charcoal membranes on which the volatile organic pesticides are adsorbed. Preliminary tests were undertaken to determine the recovery coefficient of each pesticide studied using the 3M procedure (3M Technical Data Bulletin). The recovery coefficients were determined to be: 67 percent for dichlorobenzenes, 49 percent for naphthalene and 58 percent for dichlorovos. Following the supplier procedure (3M 1997) the threshold limit value—time weighted average can be calculated and compared with occupational health limits imposed by the Occupational Safety and Health Administration (OSHA).

Gas chromatography/mass spectrometry (GC/MS) has also been used in the analysis of DDT (Glastrup 1987) and naphthalene (Palmer 2001) in museum objects.

X-ray Diffraction

X-ray diffraction (XRD) is a routine technique used in the analysis of museum objects to identify compounds based on their crystal structure. An x-ray beam is directed onto a sample. The x-rays are then diffracted off the atoms that form the various crystal planes and the intensity is measured with an electronic detector as a function of angle. Because the arrangement and spacing of atoms is unique for each compound, the diffraction pattern serves as a fingerprint by which the compound is identified. A database of approximately 85,000 experimental and 46,000 calculated diffraction patterns for standard compounds can be searched to find a match for the unknown phase(s) in the sample diffraction pattern (ICDD 2000). The sample size required for x-ray microdiffractometry or Gandolfi camera x-ray diffraction is similar to the size of a grain of sand. It is generally used in combination with elemental data. "The limit of phase detectability by manual x-ray powder diffraction is usually stated as being in the one to two percent concentration range. . . . For many materials, detectability of 10 ppm is obtainable in an overnight run" (Snyder 1992). This technique has been used to identify arsenic trioxide, mercuric sulphide, borax, calcium sulphate, calcium sulphate hydrate and calcium carbonate which have been present as white surface residues on natural history specimens (Sirois 2001).

Polarized Light Microscopy (PLM)

Polarized light microscopy is a technique routinely used for the identification of particles and fibers. The use of microscopy in the analysis of residues assists in determining the trace particles not always detected by other techniques. It can be applied to any particulate material up to a maximum magnification of approximately 2,000 times (Telle and Petzow 1992). Sample size can range from approximately 0.01 to 10 cm². Slides of the samples are prepared by dispersing the sample in a viscous medium of known refractive index for examination with transmitted polarized light. The practical lower limit of accurate particle size measurement with the light microscope is about 0.5 μm (McCrone 1993). One example of a residue routinely found on natural history specimens which is particularly suited for this technique is cornstarch. It is easily distinguished by the shape, colour, size, a refractive index of 1.53, the presence of air bubbles in the center of each particle, and grey grains with well marked black crosses which are observed between crossed polars (McCrone 1993).

Optical Spectrometry Methods

These techniques are used in the quantitative analysis of environmental samples such as air filter samples and wipe test samples for the presence of arsenic (Costanzo 1999, Feniak 1995) and other elements such as lead and mercury. Both techniques discussed below are types of optical spectrometry routinely used for the analysis of mercury, lead, and arsenic.

Atomic Absorption Spectrophotometry (AAS)

Atomic absorption spectrophotometry (AAS) is routinely used for quantitative elemental analysis. This a total element technique and will distinguish the quantity

Table 3. Detection Limits (ng/ml) (after Skoog et al. 1998).

Element	AAS flame	AAS electrothermal	ICP-AES
Arsenic	100	0.02	40
Mercury	500	0.1	1
Lead	10	0.002	2

of a particular element present but will not identify its particular chemical form, nor distinguish where or how it is incorporated within the sample. This technique has much lower detection limits than XRF. The detection limits for arsenic, mercury and lead for flame and electrothermal atomic absorption and inductively coupled plasma-atomic emission spectrometry (ICP-AES), discussed in the next section, are listed in Table 3.

In this technique, the elements in the sample are converted to gaseous atoms. The sample is introduced into the system through one of two means of atomization. If it is a solid it will be converted to a solution for flame or electrothermal atomization. In flame atomization systems the sample is introduced initially as a solution and is converted to a mist which is carried into the flame where atomization occurs. The absorption of light by the atomic species in the flame is then measured. Electrothermal atomizers (such as a graphite tube) provide enhanced sensitivity for small volumes of sample. This method is more time consuming and has reduced precision (five to ten percent versus one percent for flame methods [Skoog et al. 1998]), but may be better able to cope with smaller samples sizes and is typically applied when flame methods are not sensitive enough. Using either type of atomization, AAS is destructive in that the sample is totally consumed for the analysis. The sample size required for flame AAS analysis is large by museum standards (see Table 2).

Flame AAS has been used to detect the presence of arsenic and mercury in museum objects (Palmer 2001, Purewal 1999). This technique is also specified for the analysis of arsenic in personal air filter samples to comply with the Ontario regulation respecting arsenic made under the Occupational Health and Safety act (Ontario Ministry of Labour 1994).

Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES)

Inductively coupled plasma atomic emission spectrometry is similar to AAS and is used for many of the same applications, such as the determination of arsenic in museum and occupational health samples (Costanzo 1999, Feniak 1995, Ontario Ministry of Labour 1994). The method of atomization however involves the use of an inductively coupled argon plasma. The temperatures obtained using an ICP atomizer are much higher than those for AAS, and temperatures as great as 10,000K are encountered (Skoog et al. 1998). Plasma emission spectrometry offers several advantages over atomic absorption techniques. Among these are lower interelement interferences, and good emission spectra for most elements which are obtained under a single set of excitation conditions, resulting in spectra which enable dozens of elements to be measured simultaneously. This property is of particular importance for the multielement analysis of very small samples. In addition, plasma sources permit the determination of nonmetals such as chlorine,

bromine, iodine and sulfur. Finally, methods based upon plasma sources usually can be applied to samples with much wider concentration ranges in contrast to the AAS methods described previously (Skoog et al. 1998).

Spot Tests and Spot Test Kits

Spot tests for arsenic are a cost effective method which can be done on-site in the museum provided proper and careful sampling and analysis is practiced. Ideally, a sample of skin and a sample of the fur or feather attached to it is taken for the test. If it is not possible to obtain a sample of the skin, samples of fur or feathers taken as close to the skin as possible may have to suffice. One important factor to remember with spot tests is that the result is sample dependant. One of the common spot tests in the conservation literature is a revised Gutzeit method developed by Dr. Steven Weber at the University of Pittsburgh and outlined by Hawks and Williams (1986). A similar test is outlined by Odegaard et al. (2000). Arsenic spot test kits are also available to detect arsenic in solution (Henry 1996) (see supplier directory).

A parallel set of samples was analyzed using two different techniques, an arsenic test kit and inductively coupled plasma—atomic emission spectrometry (ICP-AES). The results from the analyses showed that the test kit results always had lower values than the same samples analyzed by ICP-AES (Costanzo 1999). This indicates that the test kit analyses detect less arsenic in the samples than is actually present. The test kits include a colour calibrated scale provided to assist with quantification of the arsenic levels in the sample. Based on the results from the above study, the arsenic test kit should be used as a qualitative method only to determine whether arsenic is or is not present. Using the test kit, the results of the arsenic analysis was always positive in samples where arsenic had previously been determined to be present using another method (i.e., no false negatives or positives were observed) (Costanzo 1999).

Several negative features of arsenic spot tests are:

- generation of arsine gas (AsH_3) by the reaction. Arsine is a colorless gas with a mild, garlic-like odour. It is heavier than air and flammable. Arsine has an Immediately Dangerous to Life or Health Concentration (IDLH) value of three ppm (National Institute for Occupational Safety and Health [NIOSH] 1995). Its TLV-TWA value is 0.05 ppm (ACGIH 1999).
- proper disposal of the arsenic-containing waste is necessary
- qualitative nature of the test
- inferior reliability as compared to instrumental methods of analysis. Investigations into the reliability of spot tests was undertaken by Found and Helwig (1995). The arsenic spot test was determined to be accurate 87 percent of the time when compared to x-ray microanalysis.

To ensure the tests are working properly, a blank should be run using distilled water and an arsenic standard should also be run before performing the tests on any samples. Atomic absorption standards for arsenic can be used as the arsenic standard (see supplier directory). *The test must be done in a fume hood with proper safety apparel (safety glasses, lab coat, gloves).*

A diphenylcarbazone spot test (Feigl and Anger 1972) modified and developed by Stephen Weber for the Carnegie Museum has been used for the detection of

mercury with powder or crystalline samples only. This test is less reliable than the arsenic spot test (Found and Helwig 1995).

The use of palladium chloride test strips for the detection of mercury vapor in storage cabinets is outlined by Waller et al. (2000). A positive reaction with this technique appears to be difficult to interpret.

RESULTS AND DISCUSSION

Anthropology Collections

From our analysis of over 300 objects in various anthropology collections using x-ray fluorescence spectrometry (XRF), several trends are becoming apparent. The incidence of arsenic and mercury in the First Nations and anthropology artifacts analyzed to date was 23 percent. In general the XRF data from different museums show very different results. In one museum, nine percent of the collection contained levels of arsenic less than 0.1 percent (trace) and bromine was detected in 19 percent of the artifacts, usually in the hair portion of the masks. In another museum 86 percent of the artifacts showed the presence of bromine, 42 percent contained arsenic at a level of 0.1 percent, and 18 percent contained traces of mercury. One interesting feature was that in many of the false face masks the hair attached to the wooden masks contained both arsenic and mercury while no arsenic or mercury was detected in the wooden portion of the masks. The results obtained to date from the analyses of artifacts from anthropology collections suggest that each museum (or collector) had its own "pesticide program" and that different results would most likely be obtained for different institutions (Sirois 2001). Some collections or groups of artifacts appear to have been treated en masse (such as a methyl bromide fumigation), others are more likely to have been treated individually. Within groups of objects acquired at one time, there may be a higher incidence of a particular pesticide applied to the object. One example of this was noted in a site survey where many objects in a specific collection obtained through one individual contained high concentrations of lead and arsenic, most likely from lead arsenate. The lead and arsenic detected were not due to lead or arsenic based paints such as red lead (minium), lead white, realgar, orpiment or emerald green (copper aceto-arsenite) in this instance. In another group of artifacts from the same museum, no arsenic, mercury or lead was detected. Within the museum setting, this information is helpful in guiding curators and conservators in adopting appropriate safety and handling procedures.

Natural History Specimens

Analysis by XRF of over 600 natural history specimens has shown that 81 percent (530/656) of the specimens in natural history collections tested positive for arsenic and five percent (39/656) tested positive for mercury (Sirois 2001). Ornithology specimens had the highest occurrence (86 percent) of arsenic. Comparing the results of natural history collections to anthropology collections, the concentrations of arsenic detected in natural history specimens is much higher (32 percent of the natural history specimens examined contained arsenic concentrations of one percent and higher) than the concentrations detected in the artifacts from anthropology collections. None of the objects tested from anthropology collections to date had arsenic present at a level of one percent or higher.

A parallel x-ray microanalytical (SEM) study of arsenic present in swab or dust

samples taken from natural history specimens, where high concentrations of arsenic had been detected by XRF, showed that approximately 35% of the samples contained arsenic in varying concentrations. Characterization of the powders by Fourier transform infrared spectroscopy (FTIR) and x-ray diffraction (XRD) identified arsenic trioxide in some of the samples. The remaining samples were composed of materials such as borax, cornstarch, calcium carbonate, calcium sulphate hydrate or Epsom salts, and were identified using a combination of FTIR, XRD and polarized light microscopy (PLM) (Sirois 2001).

SUMMARY

The first step in dealing with potentially contaminated collections and objects is to find out if they are indeed contaminated. It is important for investigators to check the museum records to find any written evidence of earlier treatments applied to the objects and consult the conservation literature to obtain information on what compounds may have been applied to objects. Various methods of analysis should be investigated, depending on the scope of the project. Cost, time and the end goal of the project must be considered. If contamination is suspected, non-destructive analysis of a selection of artifacts in the collection may be a good first step to determining the presence of some of the possible pesticides. Depending on the results obtained from the survey, further analysis may be required by a general survey technique such as FTIR to broadly categorize the residues present. If organic pesticides are suspected, a more thorough GC/MS study may be necessary. Analysis of wipe tests of the artifacts to determine whether available arsenic was present on the surface may be necessary if arsenic was detected in the non-destructive analysis.

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SUPPLIER DIRECTORY

AIHA Industrial Hygiene Accredited Laboratories, 26 January 2001 Internet address at: (<http://www.aiha.org/labstate.html>)

EM Quant® Arsenic (As^{+3/+5}) Spot test kit—available from: Thomas Scientific, 99 High Hill Road at I-295, PO Box 99, Swedesboro, NJ, 08085-0099 U.S.A., Phone: Main number: 856-467-2000, Customer Service: 800-345-2100. Also available in Canada through Canadawide Scientific.

3M Organic Vapor Monitors for a variety of compounds including p-dichlorobenzene and naphtha-

lene—available from Fisher Scientific Safety Catalogue, catalogue number 17-985-363A for monitors with backup membranes and without analysis, case of 5 for \$142.54, catalogue number 10-030-91 for monitor with prepaid analysis, case of 5 for \$560.25. Internet address at: (<http://www.fishersci.com>), Phone: Safety number: 1-800-772-6733. In Canada internet address at: (<http://www.fishersci.ca>), Phone: Safety number 1-800-234-7437.

Arsenic reference standard solution, 1,000 ppm \pm 1%, 100 ml. The standard is arsenic trioxide in dilute nitric acid packaged in a poly bottle. Available through Fisher Scientific Chemical Catalogue, catalogue number SA449-100, price \$17.78 (Mar. 2001), Internet address at: (<http://www.fishersci.com>), Phone: 1-800-766-7000. In Canada: (<http://www.fishersci.ca>)

POISONED HERITAGE: CURATORIAL ASSESSMENT AND IMPLICATIONS OF PESTICIDE RESIDUES IN ANTHROPOLOGICAL COLLECTIONS

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Abstract.—The need to find efficient and non-destructive analytical means to detect contamination of collections from prior use of pesticides is vital for the safety of museum staff and for Native American communities receiving objects through repatriation. Yet many museums lack both records on previous treatments and the expertise to interpret the data that does exist in terms of actual health risks. This paper outlines the results of preliminary detection research using a handheld multi-element x-ray fluorescence spectrometer. These results indicate the presence of arsenic and mercury residues in a significant proportion of objects in the test group. Moreover, accession and catalog data show that a considerable number of contaminated objects were treated by private collectors prior to museum acquisition. Air sampling tests further demonstrate that object residues are not entering the work environment, although they can be transferred by direct handling of objects. New guidelines for handling are outlined along with recommendations for further research and other actions.

INTRODUCTION

We are all well aware of the explosion in the use of pesticides since World War II, and of the health concerns about their use. We are also generally aware of both the potential health hazards for staff and the damage to objects associated with pesticides used in museum collections from the late 1800s. Historically, pesticide use on collections in order to prevent insect damage has been a standard component of collections management practices, ethically and legally mandated as a part of a museum's public trust fiduciary responsibilities. Because of NAGPRA these historic applications of pesticides are increasingly in the spotlight, and the consequences of this practice are the focus of this paper. The primary question that museum professionals and tribal representatives must consider is whether these past practices of pesticide treatment now represent a serious health hazard for museum staff and tribal personnel who use or handle cultural objects.

The approach used here is from a curatorial perspective, one influenced by work with about thirty tribes on museum and heritage concerns over the past thirty years. Based on this experience and the past six years of intensive and extensive NAGPRA consultations with tribal representatives, four key questions have emerged that require close examination:

- 1) Which pesticides were routinely used by museums or collectors from the 1890s on, and, more particularly, which specific pesticides were used on objects in our collections (with the more specific issues of specific formulations, concentrations, methods of application, and frequency of application for those pesticides)?
- 2) What is the probability that these pesticides have left persistent residues on collection objects, and how can these residues be detected on particular objects?

- 3) What is the toxicity hazard represented by pesticide residues through handling or use of objects?
- 4) What are the possibilities for the removal or mitigation of pesticide residues, especially on those objects being repatriated to tribal communities?

Discussions with tribal colleagues also made it clear that there were two other significant considerations. First, any analytical testing carried out to determine the presence or absence of pesticide residues should not result in further damage to the physical or non-physical (i.e., living or sacred) integrity of objects; and second, any attempts to remove or mitigate pesticide residues should also not result in fundamental changes to the integrity of an object, and should be done only with prior consultation with appropriate tribal representatives. Finally, from a curatorial point of view, are there tests available that can be easily and effectively used by museum staff or by tribal personnel? These questions and concerns, then, formed the main parameters for the ensuing research.

Since we were actively engaged in the repatriation of human remains and cultural objects to tribes, the need for prompt action has from the outset seemed clear. Some objects or remains being repatriated might be burned or reburied, while others would potentially be put back into use. If pesticide residues were present, and if they did present a continuing toxic hazard, this would mean that objects which would be worn, or played, or otherwise come into very close skin, respiratory, or mucous membrane contact with tribal members could result in health problems, while objects or remains being burned or reburied might represent an environmental contamination threat. Beyond this there might also be for some tribes the even more perplexing problem of how to purify contaminated burial objects or human remains prior to reinterment. Finding the answers to past pesticide use and resulting current object toxicity is also mandated by Federal law for potentially repatriatable materials:

The museum official or Federal agency official must inform the recipients of repatriations of any presently known treatment of the human remains, funerary objects, sacred objects, or objects of cultural patrimony with pesticides, preservatives, or other substances that represent a potential hazard to the objects or to persons handling the objects. (Native American Graves Protection and Repatriation Regulations, 43 CFR Part 10, Sub Part B §10.10 [e])

Thus, even if our own ethical standards would not require it, and they do, and even if we were to ignore the obvious liability issue that had been discussed by Malaro (1981), it is clearly imperative to discover what pesticide treatments had been employed in our collections, and with what results.

THE HISTORICAL DETERMINATION OF PESTICIDE USE

My research began with a review of museum records, but this produced no records regarding pesticide applications prior to the 1970s. In fact, there were no treatment records or condition reports at all until after 1970 in our museum, and in many smaller area museums such records are still not kept. How widespread this situation might be is unknown, but the reasons for it almost certainly include one simple explanation that I was given by a retired colleague. Everyone working in a museum knew, at any one moment in time, what these customary practices were and as a result no one bothered to record them. In this connection it appears from a review of the literature that it may not have been until after the production

of the Murray Pease Report of 1963 that even those institutions with conservators began keeping consistent records of collection treatments. It would be interesting to learn whether this was, in fact, the case or if any significant number of institutions were maintaining treatment records involving the application of pesticides.

In the absence of written records, contacts with former curatorial staff established a brief oral history record of what had been used. As later testing would show, this data on pesticide use prior to 1960 was definitely incomplete, but did indicate that arsenic in some form was apparently used fairly commonly prior to World War II, especially on leather and fur objects. Chloropictrin had been used in exhibit and storage cases in the 1920s or 1930s. Paradichlorobenzene was used from some unknown date prior to the 1970s, especially for textiles, fur, feather, and leather objects which were usually placed in either sealed storage containers or in very small storage rooms with containers of crystals. Naphthalene may also have been used before paradichlorobenzene. There was no indication that DDT, chlordane, lindane, or later organochlorine or organophosphate pesticides had ever been used.

More recent curatorial records showed that paradichlorobenzene use was terminated in the early 1970s and that hydrogen cyanide had been commercially applied twice in large storage rooms, also in the 1970s. Methyl bromide had been used by museum staff in the late 1970s for two years in a sealed in-house fumigation chamber. Dichlorvos (Vapona strips) had been used in some exhibit and sealed storage cases from the mid-1970s to the early 1980s; and two floor spot applications of Cyfluthin one percent had been made in the early 1990s in two small storage areas. By the late 1980s, freezing had replaced virtually all on-premise chemical treatments, with pheromone and other non-toxic traps used sporadically in the 1990s. Off-site commercial treatments had been limited from the 1970s to a few applications of cyanide and ethylene oxide for large objects or large collections of infested materials arriving from overseas. These data, combined with a general search of the literature, yielded a general listing of primary pesticide agents of varying levels of persistence and toxicity that could have been applied in the past to our collections (see Table 1).

This history reflects what we see in the literature as commonplace practice in museums during this period, and for the pre-1940 period certainly follows Otis T. Mason's advice for American Indian basketry collectors: "Above all they should be poisoned with a weak solution of corrosive sublimate or arsenic dissolved in alcohol." (Mason 1902). At the same time, smaller institutions in our area used more over-the-counter commercial products intended for garden and household use, including pesticides such as chlordane, lindane, and dieldrin. In general, we could be fairly certain that arsenic and a limited number of other agents had been periodically used prior to 1940 and perhaps after that date. This suspicion was reinforced by such statements as the comment made in the National Park Service's *Museum Handbook*: "... arsenic and mercuric chloride have a long history of topical application to ethnographic objects . . . and their residuals remain extremely active for long periods of time. All specimens collected prior to 1970 should be examined for evidences of these pesticides before being handled." (NPS 1990, 11:11). In summary, the literature search and limited oral history had shown that our collections were likely to have had pesticides applied to them; that many of these could be present as persistent and toxic residues; and

Table 1. Possible Museum Pesticides by toxicity and Persistence.

EPA Category I pesticides (highly toxic)	Type	Persistence
Lead arsenate	Inorganic	High
Mercuric chloride	Inorganic	High
Ethylene oxide	Fumigant	High/Moderate
Methyl bromide	Fumigant	Low
Hydrogen cyanide	Fumigant	Low/Moderate
DDVP (Dichlorvos)	Organophosphate	Low
Chloropictrin	Fumigant	Low
EPA Category II pesticides (moderately toxic)		Persistence
Aldrin/Dieldrin	Organochlorine	High
Chlordane/Lindane	Organochlorine	High
Cyfluthrin	Pyrethroid	Low
DDT	Organochlorine	High
Paradichlorobenzene	Inorganic	Moderate
Carbon disulfide	Fumigant	Low
Chlopyrifos	Organophosphate	Low?
Diazinon	Organophosphate	Low
Sulfuryl fluoride	Fumigant	Low
EPA Category III pesticides (slightly toxic)		Persistence
Naphthalene	Inorganic	Moderate
Pyrethrin	Botanical	Low
EPA Category IV pesticides (relatively non-toxic)		Persistence
Methoxychlor	Organochlorine	Low

See ATSDR 1998, Edwards et al. 1981, EPA 1998, Extoxnet 1998, ILO-CIS 2001, Rossol and Jessup 1996, and Zycherman and Schrock 1988.

that we could in all probability only determine their presence through analytical testing. This analytical determination had to be carried out for ethical and legal reasons, and had to be done expeditiously due to the imminent repatriation of potentially contaminated objects. Finally, tribal community consultations made it clear that any testing should be non-destructive and should not affect the total integrity of objects. In short, our critical need was for a rapid, non-destructive, and effective test that was both cost and time efficient. At this juncture, in 1998, an advisory notice regarding the possibility of pesticide residues in repatriated materials was prepared and distributed to tribal NAGPRA representatives (see Appendix A).

PESTICIDE RESIDUE TESTING

The possibility of pesticide testing was discussed with staff in the Hazardous Materials Office and Environmental Health and Biosafety Office of the Department of Environmental Health and Safety at the University of Washington. While they could carry out tests for us, the costs would be prohibitive, e.g., \$15 per arsenic test and \$50 to \$60 for organic pesticide analyses, and would require considerable time. Subsequent discussions with Dr. Rolf Hahne, Director of the Environmental Health Laboratory in the University's Department of Environmental Health, led to the suggestion that we experiment with a portable multi-element

x-ray fluorescence (XRF) scanner. While this would primarily provide us with data on possible arsenic or mercury contamination, we suspected that these would be the most, or certainly among the most, serious pesticide residue problems for this collection. A Niton XL700 unit was acquired and initial experiments on its suitability carried out by adding known quantities of lead arsenate and mercuric chloride to surrogate artifacts of different material types (i.e., basketry, leather, and wood) from the museum's conservation test collection of historic materials. Wipe samples using deionized water on one square inch prepared cotton patches were then taken and analyzed, following digestion, using flame atomic absorption analysis for lead and atomic fluorescence spectrometric analysis for arsenic and mercury. These tests suggested that the XRF unit was an efficient detector of arsenic, lead, and mercury residues in a wide range of objects.

This was followed by carrying out XRF tests on a sample of museum collection objects. These tests targeted a variety of objects that were likely or known priorities for repatriation as well as other objects of various material types representing acquisitions from every period of the museum's history and from a variety of sources, including professional collectors, avocational collectors, museum staff research collections, and purchases. The age range of acquisitions for test objects was from 1893 to 1999. Test objects for this survey included such diverse materials as Navajo wool rugs, Asian silk garments, Arctic fur and bird skin clothing, other fur objects, Plateau and Plains leather clothing of deer and elk skin, mountain goat wool Chilkat blankets, seal body whaling floats, Plateau and Plains pipe bags and miscellaneous leather and horsehair objects, basketry of all types, Pacific Island tapa and mats of various kinds, wood and leather drums from the Western United States, wood masks and ceremonial regalia, beaded leather objects, feather headdresses, cedar bark articles, Northwest Coast ivory and whalebone objects, a variety of ethnographic and archaeological stone objects, and human remains. As a continuing check on the XRF data additional wipe tests were also done on objects which were tested with significantly high readings for either arsenic or mercury from the XRF scan. Additional tests were also done at a later time using a Merckoquant arsenic test kit, also primarily on objects that had tested highly positive in an XRF scan. These wipe tests also provided us with insights into the potential removability of residues from some object types. Because of time constraints, we have not attempted to extrapolate XRF data for total or surface-removal concentrations, which will be a component of the next phase of testing. Because of variations in object permeability, the irregular shapes and masses of objects, and the depths for which XRF readings can be made below an object's surface, the quantification of total contaminate level for an object will be complex and may ultimately depend upon the utilization of models based on further experimentation with surrogates.

This initial testing confirmed the presence of both arsenic and mercury residues on a highly varied sample of objects in the collection, and also confirmed that some of these residues were being removed by direct contact with objects through handling. Because of this it was decided that additional tests should be conducted immediately to determine if any arsenic or mercury residues were present in laboratory and storage air environments or on work surfaces. Dr. Stuart Cordts, Industrial Hygiene Supervisor in the Department of Environmental Health and Safety, carried out aggressive air sampling tests in storage rooms and laboratory

spaces in the Museum's Ethnology, Archaeology, Geology, and Zoology areas, and collected wipe test samples from storage and work surfaces in these locations, which are spread over three floors of our facility. The Environmental Health Laboratory, which is accredited by the American Industrial Hygiene Association for analysis of airborne metals, carried out the analyses on the samples taken by Dr. Cordts. Air samples were made using a large oscillating fan to disturb any settled particulates, with samples taken using a medium flow sampling pump operating at a known air flow of 2.5 liters per minute, drawing air through 0.8 micron mixed cellulose ester fiber filters. The work and storage area wipe tests were collected in 10 cm² areas, bounded by tape, using deionized water dampened filter paper which was wiped over the area in one direction and 90 degrees from the first direction. Filters were dissolved by acid digestion. Lead was analyzed using flame atomic absorption with a limit of detection of 2.0 µg per filter. Arsenic was tested using flow injection analysis with hydride generation and atomic fluorescence spectrometry with a limit of detection of 0.025 µg per filter. Mercury was analyzed using flow injection cold vapor generation and atomic fluorescence spectrometry with a detection limit of 0.0075 µg per filter. Dr. Cordts converted the results to µg/m³ by multiplying the detection limit by 1,000 liters per cubic meter and dividing this quantity by the air volume of the sample. These were then compared to PELs.

TEST RESULTS

The goal of finding a testing method that is non-destructive, time and cost efficient, easily done by curatorial or tribal staff, and that provides good data seems to have been met by the XRF scanner, at least for two of the most persistent toxic pesticides, arsenic and mercury. The XRF test seems promising. It provided results in about one minute per object; its use is relatively simple and does not require extensive training or other equipment; and the results provide us with data about the presence or absence of arsenic and mercury residues, and do so at least in a relative scale of the levels of residues present. The limited number of initial wipe tests carried out on objects that tested positive for arsenic and mercury all confirmed XRF results. While the cost of a portable XRF unit is high, the per object cost for XRF testing remains significantly lower than wipe tests for collections of 25,000 to 30,000 objects or more. But, since per object costs begin to become comparatively and absolutely prohibitive with collections of less than 5,000 to 6,000, the use of an XRF for smaller collections, such as tribal museums, will be best approached from a consortium or regional approach.

The XRF tests did bring a surprising result. While 50 percent of the total number of objects tested proved to have residual arsenic and/or mercury, 73 percent of this group were mercury residues, while only 16 percent were arsenic, with 11 percent having both arsenic and mercury residues. The surprise was that there had been no indication from the oral history data that mercury had ever been used by staff in the museum, only arsenic. This suggests considerable caution must be exercised when using oral history data of this kind. All objects but one that tested positive for arsenic also tested positive for lead, indicating that the pesticide used was probably lead arsenate. Arsenic residues ranged from a low of 700 ppm to a high of 15,000 ppm, with most readings between 3,000 and 10,000 ppm. Mercury residues ranged from a low of 55 ppm to a high of 57,500

ppm, with most between 600 to 3,000 ppm. Lead residues tested from a low of 60 ppm to a high of 31,000, with most between 200 and 1,000 ppm. Thus, a significant number of objects tested positive for arsenic, mercury, and lead residues at levels apparently well above current regulatory limits, bearing in mind that further experimentation is required to assess actual health risks. Since 11 percent of objects tested contained both arsenic and mercury, it is possible that private collectors who ultimately donated materials to us might have been responsible for some of the treatments with one or both of these pesticides. The source of these pesticides becomes clearer if we examine more closely these data by object material type and collection history.

Of the leather, fur, and feather objects from the Northwest Coast, Arctic, Plains and Plateau, and Eastern Woodlands as well as from the Pacific, Mexico, and Egypt, 60 percent had arsenic and/or mercury residues, with 74 percent of those testing positive for mercury, nine percent for arsenic, and 17 percent for both arsenic and mercury. Virtually all of these objects were originally collected before 1950, including a number not acquired by the museum from donors until after 1970, which implies that collectors had applied the pesticides for at least those objects. All of the objects in some single source collections appear to have been treated, probably at the same time, including a 1910 Blackfoot collection and 1893 collections made by the same collector from the Makah and Quinault tribes—collections that went to the world's fair that year in Chicago. This tends to confirm the suspicion that collectors were responsible for pesticide treatments.

Of the Northwest Coast, Arctic, and Plateau objects made of marine mammal ivory, bone, whalebone, and mammal claw, 29 percent had residues, 75 percent of these with arsenic and 25 percent with mercury. All of the contaminated objects were collected around 1900 and acquired, with few exceptions, by the museum prior to 1960, thus leaving open the question of who had applied the treatments.

Some 31 percent of basketry items representing some 30 tribes tested positive for residues, with 14 percent having arsenic, 77 percent mercury, and 9 percent both arsenic and mercury. Not all baskets from the same source had been treated with pesticides, and no basketry items collected in the field by museum staff in the pre-1950 period had either arsenic or mercury residues, suggesting that museum staff did not routinely apply pesticides to collected objects. All of the objects in some private collections assembled before 1940 but not acquired by the museum until the 1990s were contaminated, implying that their private collectors were entirely responsible for much or all of the pesticide treatments for these materials.

Of the sampled wooden objects from the Northwest Coast, Arctic, Plateau, Plains and the Pacific Islands (Samoa, Fiji, Palau, Solomon Islands, Philippine Islands) 67 percent tested positive for residues, 65 percent with mercury, 23 percent with arsenic, and 12 percent with both arsenic and mercury. All of these objects had been collected prior to 1950 and some objects with residues had been acquired by the museum from private collectors after 1970, again implying collector treatment at least in some cases. But since not all objects from the same source tested positive for residues, museum staff could have been responsible for some pesticide applications after acquisition.

Similarly, 67 percent of textile and plant fiber materials from the Northwest Coast, Southwest, Eastern Woodlands, Mexico, the Pacific Islands, and China

tested positive, with 63 percent of these having mercury residues, 26 percent arsenic, and 11 percent both arsenic and mercury. All of those with residues were collected before 1940 and two had been acquired by the museum after 1960, again implying collector treatment. Comparably, 67 percent of all feather and hair objects tested from the Native American collections were positive, with 75 percent having mercury residues and 25 percent having arsenic residues. Finally, a small number of archaeological objects were also tested. One unpainted stone object, a small mortar made of vesicular lava, tested positive for arsenic, leading to speculations that this might be a case of collateral damage when pesticides were applied in a former building general storage area. It is also important to note that none of the small number of human remains tested with the XRF had any residual lead, arsenic, or mercury. We have relatively few human remains, nearly all of which were archaeologically recovered from the Northwest region, and we did not anticipate that any of these would have been treated with pesticides in the past.

These data show that in many cases and for many different types of materials, private collectors had treated objects with pesticides prior to the museum's acquisition of those collections. It also seems clear that in some cases museum staff did use pesticides to treat objects. These data imply that both arsenic and mercury pesticides were in common use among both collectors and museum staff prior to the 1940s and 1950s.

The aggressive air sampling tests indicated that airborne particulate levels for arsenic, lead, or mercury were well below the eight-hour TWA permissible exposure limits, ranging from less than 0.1 to less than 0.2 $\mu\text{g}/\text{m}^3$ for arsenic (PEL = 10); less than eight to less than 15 $\mu\text{g}/\text{m}^3$ for lead (PEL = 50); and, from less than 0.03 $\mu\text{g}/\text{m}^3$ to less than 0.06 $\mu\text{g}/\text{m}^3$ for mercury (PEL = 10). Wipe samples analyzed from laboratory and storage area work surfaces, floors, and shelving were all, with two exceptions, also well below the one $\mu\text{g}/100\text{ cm}^2$ permissible exposure limits recommended by the Department of Environmental Health and Safety for arsenic and mercury and the 11 $\mu\text{g}/100\text{ cm}^2$ for lead. All tested lead levels were below two $\mu\text{g}/100\text{ cm}^2$; from 0.1575 to 0.0075 $\mu\text{g}/100\text{ cm}^2$ for mercury; and, with two exceptions, from 0.3550 to less than 0.025 $\mu\text{g}/100\text{ cm}^2$ for arsenic. The two exceptions were in storage areas where the Zoology Division had stored mounted bird specimens, and these tested at between 2.098 and 4.283 $\mu\text{g}/100\text{ cm}^2$ for arsenic, or between two to four times the permissible exposure level. Additional personal air sampling tests carried out with ethnology staff during the relocation of specimens in storage, including objects with known contamination, were negative, indicating that there is no entry of residues into the air environment during routine handling.

The consideration of all of this data has led us to develop new policies for handling and general collection operations, including new guidelines that are now required for all staff, volunteers, and researchers, and a set of operations guidelines for collection managers (see Appendices B and C). Finally, it is important to note that while the XRF data does provide us with good data on historic arsenic and mercury pesticide use, the equally important potential for fumigant and organic pesticide residues remains an open question at this time for this collection and, presumably, other collections. This is an area where new research is also urgently needed.

CONCLUSIONS

I began this report with four key questions: (1) what can we find out about pesticide use in our collections?; (2) are there non-destructive tests to discover which pesticides have left residues on objects in our collections?; (3) do these residues represent a toxicity hazard through handling or use?; and, (4) can these residues be removed or mitigated? While pesticide use data for the last several decades is complete, museum records do not exist for earlier periods and oral history data has been shown to be unreliable. The use of XRF equipment has proven successful as a non-destructive way of establishing the absolute presence or absence of arsenic, lead and mercury residues. Wipe tests have shown that residues can be removed through handling, but air sampling tests also show that these residues are not entering the air environment in our museum. To what degree these residues represent a health hazard remains unknown, as does the question of the degree to which they can be removed or reduced on objects. Our research in collaboration with the Environmental Health Laboratory on both of these points is continuing, with further tests scheduled for the next several months that may shed additional light on both issues.

We have thus far spent approximately 42,000 staff hours and more than \$1.2 million dollars in operations costs at our museum on NAGPRA related work since the passage of the law in November, 1990. We know now beyond question that we need to fully examine our anthropological research and teaching collections for pesticide residues which may pose health hazards for staff and other users, especially Native American recipients of repatriated materials. The XRF testing reported here, while far more time efficient than wipe tests, will nonetheless require a minimum of at least two years of dedicated staff time for two staff, or about 6,000 hours, to completely assess arsenic and mercury residues in just our ethnological collections. How much more time will have to be devoted to the testing of relevant materials in our 1.5 million archaeological objects is not clear, but it is certainly substantially more.

We began our research by testing a sample of our collections, ensuring that objects of differing material types, provenience, and ages of acquisition were a part of the sample. This approach has the advantage of quickly establishing a sketch of what might be present. This has been followed by testing all objects slated for repatriation, or in a clearly repatriatable category as well as all education materials. This must be a priority given our need to provide advance notification to tribal community representatives, and to work out possible options for mitigation and future use, as well as to ensure that materials being made available for hands-on use are not contaminated. Our next priority has been the testing of all newly acquired historic materials, since we now know that these were often treated by collectors or others in the past; all objects intended for exhibition or other public use; and, all objects being used in research projects. Beyond this we will be systematically testing particular types of objects that are likely, on the basis of our test results, to have been treated, notably leather, fur, textile and basketry materials. These kinds of prioritizing decisions on testing will have to be made by institutions given the scope of collections and limitations of resources. It is also worth noting that while collections numbering in the hundreds of thousands could be tested by using random sampling formulas, the results would be

of limited value since our tests have shown that there is a high degree of variation in prior treatment even within a single source collection.

An important related issue is our need for appropriate training and equipment access that will permit our tribal museum colleagues to conduct their own tests, either independently or with our institution on a consortium basis. It is not only essential for all of this testing to be done, but for the testing to be done in the closest possible collaboration between our institution and concerned Native American institutions and communities. This basic policy perspective should be the foundation of all museum work on this problem, and should obviously extend to the even more important area of residue removal or mitigation. The tribal representatives we are working with do want to know about pesticide contamination, do want to know what options exist for contaminated materials, and certainly do want to be involved in collaborating with us on further testing and mitigation work. Among the options tribes might explore are (1) limited ceremonial use with relevant precautions; (2) exhibition use only in a tribal museum or cultural center; (3) sealed containerization and retention for future research, reproduction, and other uses; (4) containment and reburial; or (5) maintaining objects as in-trust collections in non-tribal museums under special curation agreements.

The results of the assessment work reported here indicate that there are significant numbers of objects with arsenic and mercury residue contamination in this collection. This research also demonstrates that the prior treatments span a long period of collecting, were carried out by private collectors as well as museum staff, and were systematically applied in some unit collections but not in others. The latter suggests that applications were event driven, as we might expect. Some of our tests also indicate that there is the possibility of collateral contamination for objects not intended for treatment, a result easy to imagine under older crowded storage conditions. Tests further indicate that standard cleaning techniques routinely employed for ethnological objects, including vacuuming, have not in the past removed all of the significant residues of either arsenic or mercury, although such cleaning may have reduced levels by some unknown degree in the past for some equally unknown number of objects. Finally, it is clear that residues are transferred by handling, but apparently not entered into the air system and are not being deposited on work or office surfaces or equipment. This in turn suggests the need for new collections management guidelines for handling and for work in general in storage and research areas where the gloved handling of objects will occur along with contact with compactor handles, light switches, and other work surfaces and paraphernalia.

Because of obvious legal and ethical obligations it is clear that the continuing assessment of pesticide contamination of these collections is required. Furthermore, this assessment work must be done in a manner consistent with the significant perspectives of our colleagues in Native American communities. That is, testing should be carried out in consultation with tribal representatives and should be done in as non-destructive a manner as possible, while also attempting to yield the best data for hazard assessment, especially for those objects which are sought by communities in order to be put back into active use for religious or other purposes. We must also make comparable efforts to determine if it is possible to either mitigate or eliminate toxic pesticide residues on these objects, and to do so by means which will not change object integrity in any sense (i.e., physical or

non-physical). The latter point relates directly to the spiritual nature of many objects and is an essential conservation concern for many if not all Native American communities.

My preliminary research in 1998, prior to the initiation of the testing reported here, ended with six recommendations:

- 1) Our museums should review all available institutional records about pesticide applications in order to establish what has been used, how often it has been used, and how it has been used.
- 2) We should begin as soon as feasible the testing of the most relevant ethnographic objects to determine whether or not there are residue levels that represent a health concern.
- 3) We should prepare written information for tribal representatives that outlines our concerns and whatever firm data we have about toxic residues that are present, along with our recommendations regarding removal or mitigation options and ultimate tribal use or disposal options.
- 4) We should, based on available test data, undertake a program of appropriate and systematic cleaning of any contaminated objects, beginning with those most likely to be repatriated and continuing through all of our holdings, including in this the appropriate disposal of all potentially contaminated plastic bags, acid free tissue, or other storage materials.
- 5) We should report our findings to our colleagues in other institutions, especially in those cases where we have exchanged collections with other museums.
- 6) And, finally, that we add to our inquiry list for new donors questions about whether they ever used pesticides in the storage or treatment of the objects they are now transferring to us.

To these I would now add several other matters for consideration. First, we should also concern ourselves with the status of objects now being used in hands-on education kits. These often contain materials that have either been transferred from our research collections, acquired from collectors, or purchased from auctions or dealers—all of which could be sources of contaminated specimens. Second, we need to reinforce existing standards for personal protection and hygiene in the handling of museum collections, and continue to promote those practices in smaller local institutions where they are more commonly breached than obeyed. Third, we need to conduct workshop sessions that fully explore these issues for the benefit of our tribal colleagues as well as others, workshops like the one recently organized by Nancy Odegaard and sponsored by the Arizona State Museum in March, 2000. Fourth, we need to adopt changes in professional codes of ethics that clarify the obligation of our institutions to more fully assess the contamination status of their collections. And last, we need to explore with medical and environmental health experts the desirability of instituting routine monitoring of our work environments and perhaps of staff health.

The repatriation of Native American cultural objects and human remains has highlighted pesticide residue concerns for many of us, and has prompted new investigations into this problem. While the immediate focus of our attention has and should be on Native American collections, and especially on those collections subject to repatriation, we should not lose sight of the fact that the repatriation

of cultural materials to indigenous communities is a growing phenomenon in the world. We should be prepared to embark on testing on a far wider cultural scale, and this will almost certainly require that we respond to increasing demands for answers to the removal and mitigation problem. This is not, in other words, an issue that is going to go away, and it does require further work on our part to protect the public trust for and in our institutions.

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APPENDIX A

THOMAS BURKE MEMORIAL WASHINGTON STATE MUSEUM UNIVERSITY OF WASHINGTON, BOX 353010, SEATTLE, WASHINGTON 98195

ADVISORY NOTICE REGARDING MATERIALS BEING REPATRIATED

The Burke Museum supports the repatriation of Native American human remains and cultural objects under the guidelines contained in the Native American Graves Protection and Repatriation Act (25 USC 3001 et seq.). As a result, many tribal communities will receive repatriated human remains and cultural objects from our institution. The purpose of this notice is to provide advice on a potential hazard that may be present in some of these materials.

Over the past 100 years American and foreign museums have attempted to protect their collections from the ravages of insect and fungal damage through application of pesticidal and antifungal chemicals to collections. While many museums ceased this activity in recent decades, some of these chemicals can leave residues on collection materials. It was also not until very recently that museums kept detailed records on which chemicals were used on which portions of a collection. Since many of these materials will be handled after repatriation, and some cultural objects may also be considered for reuse (e.g., to be worn, played, or otherwise used ceremonially), it is important that recipients of repatriated materials use appropriate caution.

The protective chemicals used in the past by the Burke Museum include arsenic, paradichloroben-

zene, dichlorvos, methyl bromide, cyanide, and ethylene oxide. It is possible that other chemicals were also used. With tribal representative permission, we will whenever possible clean materials prior to their repatriation. However, this may not eliminate all traces of chemical residues. We recommend that disposable gloves be used when handling these materials and that appropriate precautions be taken prior to any use of materials to limit direct contact. While individual reactions may vary, those who may be particularly sensitive include the elderly, individuals with asthma or other chronic respiratory, heart, or circulation problems, anyone who has allergies or who smokes or who drinks heavily, and individuals with low body weight.

We will be happy to discuss this matter further with you, and will continue to share any additional information that we are able to develop about this matter. Please contact:

Dr. James D. Nason, Chairman
Repatriation Committee
Burke Museum
Telephone: (206) 543-9680
FAX: (206) 685-3039
email: jnason@u.washington.edu

APPENDIX B

THOMAS BURKE MEMORIAL WASHINGTON STATE MUSEUM
ANTHROPOLOGY DIVISION: ETHNOLOGY DEPARTMENT,
UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON 98195

VISITOR AND STAFF GUIDELINES FOR SAFE HANDLING OF COLLECTION OBJECTS

Some objects in the collection were historically treated with pesticides that remain as residues potentially harmful to human health. It is necessary that you assume that these residues are present on all objects, unless you know otherwise, i.e., through notations made in object documentation records. While you will be given access to objects considered appropriate for handling. It may not be possible to provide access to all objects due to their condition. An initial review of your handling requirements as a visitor or researcher by the collection manager or by a curator may lead to the assessment of a laboratory materials fee for expendable supplies. This will be established and due prior to the beginning of any work. It is also essential for your own safety and that of staff that you observe the following guidelines at all times. Any failure to do so may result in the immediate revocation of access privileges.

1. You must wash your hands with soap and water before and after handling artifacts.
2. You must use nitrile or other approved impermeable gloves for handling all artifacts except for works of art on paper; cotton gloves will be used for works of art on paper. If using thick reusable nitrile or other impermeable gloves please wash the gloves with soap and water before removing. Always remove gloves in a way so that your hands do not touch the outside of the gloves. Thin disposable nitrile gloves are used for detail work. Due to the expense, please try to reuse these gloves if possible. Discard by turning inside out and toss in regular trash receptacle. Always remove gloves in way so that your hands do not touch the outside of the gloves.
3. It is all right to use gloved hands when touching compactor handles, ladders, cart handles, brushes, cleaning tools, marked pencils and clipboards. These surfaces are to be considered 'contaminated' and the handles will be wiped clean periodically in order to keep contamination to a minimum.
4. DO NOT use gloved hands when touching the door handles, phones, computer keyboard, vacuum, camera equipment, or cataloging equipment (tape measure, scissors, knives, tools, balance, microscope, etc.).
5. Use only specially marked pencils and clipboards when working with gloves.
6. Vacuum contaminated objects with HEPA filter vacuum. Do not handle the vacuum hoses with gloved hands. We want to minimize contamination of the vacuum exterior and attachments.
7. Resist the temptation to play or manipulate artifacts, as this can cause damage to the artifacts and could be dangerous for you and other staff.
8. A lab coat must be worn when handling objects. Be sure to completely button lab coat. Remove lab coat before leaving lab area and store in the designated location.

9. Do not chew on pencils or glasses. Keep hands (gloved or not) away from face (eyes, mouth, nose).
10. Do not consume food or drink in lab area. Wash hands with soap and water before eating or drinking.
11. If you discover any white powdery or crystalline material on any object stop your work immediately and report this to the collection manager or to a curator.
12. It may be necessary for some objects to be handled in a special air ventilated environment, e.g., a fume hood. You will be advised when this necessary.
13. Keep work areas clean at all times.
14. Certain restrictions on where objects can be placed may be necessary. In general, objects may NOT be left in open or non-enclosed exhibit cases, taken by carts outside of secure areas unless otherwise approved by the collection manager or curator, or similarly removed from the building.

By signing this I recognize that I have read the above guidelines and have agreed to follow them in order to provide a safe working environment for my colleagues and myself. I understand that my access privileges may be permanently revoked if I fail to follow these guidelines.

Signature _____ Date _____
 Print Name _____
 Reviewed by _____ Date Reviewed _____

APPENDIX C

THOMAS BURKE MEMORIAL WASHINGTON STATE MUSEUM
 ANTHROPOLOGY DIVISION: ETHNOLOGY DEPARTMENT,
 UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON 98195

COLLECTIONS MANAGER GUIDELINES AND PROCEDURES FOR
 SAFELY WORKING WITH COLLECTIONS

Place hot pink warning tape on cart handles, ladder handles, compactor handles, and other appropriate surfaces to indicate areas where gloves must be worn.

Wash vacuum hose and nozzle monthly or more frequently as appropriate.

Store lab coats and cotton gloves in polyethylene containers after use pending washing.

Wash table coverings, lab coats, cotton gloves, compactor handles, ladder parts, and cart parts monthly or more frequently as appropriate.

Clean lab floors with wet mop, or vacuum with HEPA filter vacuum monthly or more frequently as appropriate.

Test all new accessions for pesticide residues. Identify and tag contaminated objects and enter pesticide test data into the collection database.

Maintain separate specially marked pencil jar and clipboards in work areas for use with contaminated objects.

Implement periodic air sampling and other testing of work spaces as required.

Do not permit access to objects unless testing is completed or appropriate handling precautions are taken.

Ensure that objects with significant levels of contamination are identified for restricted access.

Provide separate storage enclosures for objects with significant levels of contamination.

Disseminate safe handling procedures to all staff and researchers; thoroughly discuss procedures with staff and researchers and maintain signed guideline forms.

Ensure that non-vacuum object cleaning employs special hazardous waste procedures.

Dispose of shelf liners, acid-free tissue wrappings, and plastic object bags as hazardous waste.

Review, monitor or restrict as required the use of contaminated objects outside of secure storage areas.

Post "Staff Guidelines for Safe Handling of Contaminated Objects" in lab area.

TRIBAL REPATRIATION OF SACRED OBJECTS: PUBLIC HEALTH ISSUES

ANA MARIA OSORIO

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The conclusions and opinions expressed herein are those of the author and do not necessarily represent the views and policies of the US Environmental Protection Agency.

Abstract.—A review of the scientific literature, key concepts and health effects associated with the tribal repatriation of sacred objects is provided. The discussion includes a description of current medical training efforts for tribal communities, biological and environmental monitoring, and pesticide illness surveillance programs. A review of potential pesticide exposures during the entire tribal repatriation process will be explored: field and private collecting, museum preservation work, and, ultimately, the transport and return to the tribal community. Prevention in the form of an integrated pest management approach will be presented. In addition, recommendations for exposure prevention programs are described (e.g., training, engineering controls, personal hygiene practices, personal protective equipment, environmental monitoring, and biological monitoring). Finally, a list of informational resources (WEB, text, and a telephone hotline) will allow access to more in-depth information on pesticide intoxication.

INTRODUCTION

In 1998, the US Environmental Protection Agency (EPA) began an initiative to identify strategies for educating health care providers on how to recognize, diagnose, treat and prevent pesticide-related health effects (EPA 1998). Another term for this type of pesticide associated ill health is pesticide intoxication or poisoning. This effort was led by EPA and involved other federal partners (US Department of Agriculture, US Department of Health and Human Services, and US Department of Labor), as well as numerous non-governmental organizations (including clinical, academic, toxicological and other stakeholder groups). After a series of workshops and meetings, a draft implementation plan for "Pesticides and National Strategies for Health Care Providers" was completed (EPA 2000). Recently, an EPA-funded Tribal Medicine Project has begun under the direction of George Washington University staff to conduct training on pesticide intoxications for health care providers, and health and safety personnel serving tribal communities. During the course of this project, the following issues regarding pesticide exposures were cited by the numerous tribes consulted: (1) Bystander exposure to pesticides which included subsistence, drift and other lifestyle activities, (2) Agricultural activities in the form of tribal farming and/or leasing of tribal land to non-tribal entities, (3) Residential exposures, and (4) Repatriation of sacred objects. The concern about pesticide-contaminated repatriation objects varies by tribe and often is not reported to be the primary pesticide exposure of interest. Lack of concern could be attributed, in part, to the fact that many tribes are not aware of any potential problems associated with contaminated repatriation objects.

In looking at the overall issue of possible health effects from tribal repatriation of sacred objects, it helps to evaluate all the possible scenarios which may lead

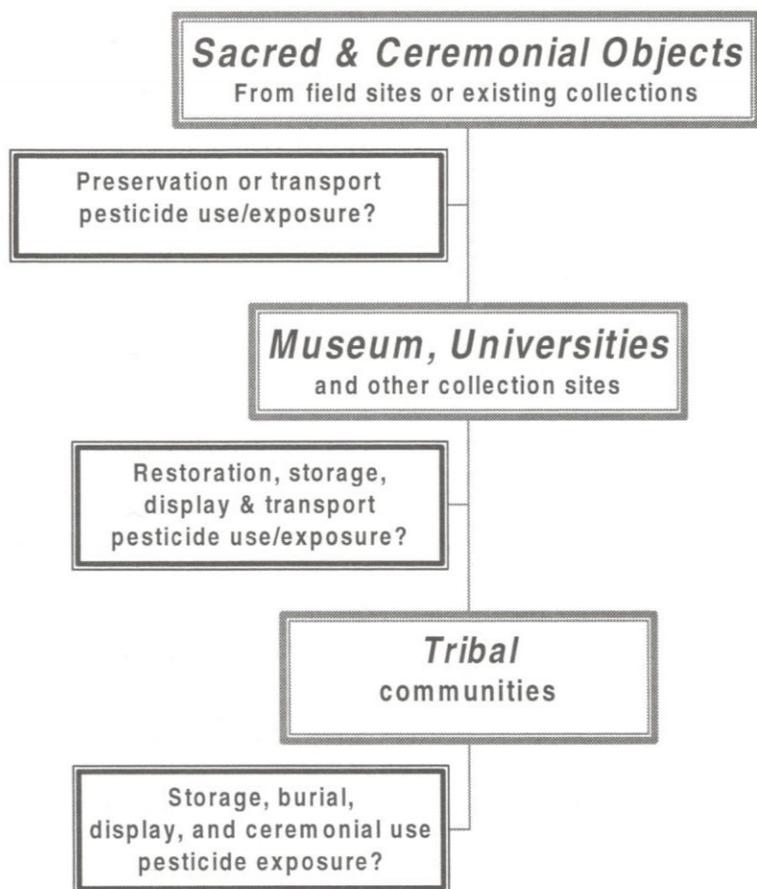


Figure 1. Possible human exposure scenarios with contaminated collection objects.

to human exposure (Fig. 1). Following this sequence of events, the primary groups that may be exposed to contaminated sacred, ceremonial or burial objects include museum workers in the field and museum setting (preservation, transportation, restoration, storage and display activities) and the tribal recipients of the sacred objects (storage, burial, display, and ceremonial use activities). In some situations, there is an overlap of exposures for tribal members and museum workers. For example, tribal representatives may need to visit museums to inspect collections for requested items, and both museum personnel and tribal representatives may accompany sacred objects in transport from the museum to the ultimate tribal site. Much of the interest in potential health effects from repatriation began with the enactment of the 1990 Native American Graves Protection and Repatriation Act (NAGPRA) (US Congress 1990). NAGPRA requires that an inventory and return occur of any human remains, funerary objects, sacred objects and objects of cultural patrimony belonging to Native Americans. In 1996, a requirement was added for notification of known pesticide or other chemical contamination associated with these objects. Thus, there is no requirement that contaminant testing of the objects be conducted during the inventory or return phase of the repatriation. The museums are required only to report those contaminants that they know about.

DEFINITION OF KEY CONCEPTS

Understanding the following environmental and occupational evaluation concepts will help in discussing the possible health effects associated with repatriation and the methods for prevention of exposure to hazardous substances.

Biological monitoring refers to the measurement of a chemical or its metabolite, or a biochemical effect in a biological specimen for the purpose of assessing exposure. In an exposure to certain pesticides, it may be possible to measure the parent compound in the blood, or its metabolite in the urine. In the case of certain pesticides (e.g., organophosphate insecticides), one can measure the activity of a neuroactive enzyme that may be suppressed by the parent compound: acetyl cholinesterase in the red blood cell or in plasma. Biological monitoring either of a single patient or a group of potentially exposed individuals is conducted and interpreted by a health care provider.

Environmental monitoring refers to the measurement of ambient exposure of a chemical in a workplace or environmental setting. For example, one can measure the surface content or the ambient air concentration of a possible chemical agent associated with an object. This type of evaluation may be conducted in a workplace setting or any other environment thought to be hazardous and is usually performed by industrial hygienists or related health and safety professionals.

A *disease surveillance program* is the ongoing systematic collection, analysis and interpretation of health data used for planning, implementing and evaluating public health interventions and programs (Klaucke et al. 1988). An example of a pesticide-related program is that of the Pesticide Illness Surveillance Program for the state of California. Data on pesticide intoxications cases are collected from health care providers and other medical data sources for analysis of disease trends and identification of high-risk subpopulations within the state. This information is then distributed to key stakeholder groups (medical community, local and county governments, worker groups, industry, and community groups). Finally, this surveillance information and involvement of affected groups will hopefully lead to intervention actions that will eliminate or control any future exposure and minimize the risk for subsequent disease. In the case of a group or cluster of pesticide intoxications, the surveillance team may go to the site where the cluster occurred to investigate how the exposure occurred, interview the individuals affected and obtain medical information, as needed. The earlier mentioned techniques of environmental and medical monitoring may be employed to assess the full extent of the disease cluster. Once all this information is obtained and analyzed, specific measures will be taken to control or eliminate further exposure and, hopefully, prevent future intoxications.

DIAGNOSIS OF AN ENVIRONMENTAL OR OCCUPATIONAL DISEASE

Determining whether an illness in a museum worker or a tribal community member is due to exposure to a contaminated sacred object is not always straightforward and may necessitate consultation with a health care provider who is experienced in the assessment of environmental and occupational toxicants. In establishing that a disease is due to a pesticide in the environment or workplace, a clinician needs to ask the following questions:

- Are the symptoms and physical signs of the individual consistent with those associated with the pesticide in question?
- Are there co-workers or other individuals in a shared environment who are similarly ill?
- Are the timing of the exposure and the subsequent health effects consistent with the toxicology of the pesticide?
- Is there confirmation of the individual's physical exposure to the pesticide? For example, sampling has detected a pesticide contaminant on the object handled by or workplace of the individual in question.
- Are there positive test results from environmental monitoring?
- Are there positive test results from biological monitoring?
- Keeping in mind the toxicology of the pesticide and the circumstances of the exposure, is it biologically plausible that the exposure led to the subsequent health effects?
- Can one rule out non-pesticide exposures or pre-existing illnesses?

The latter item is deceptive in that a pesticide exposure can cause all or part of the health problems. Thus, if there are concurrent exposures, one cannot rule out that the pesticide had no effect only that a partial effect occurred. Likewise, one cannot rule out that a disease occurred from a pesticide exposure because an individual already had an underlying similar condition. What can be said is that the pesticide exposure could have exacerbated or worsened the existing underlying health condition. After taking all this information into account, a clinician should be able to make a diagnosis as to whether or not the presenting symptoms and physical signs are caused or exacerbated by a pesticide or a combination of a pesticide and other exposures.

SCIENTIFIC LITERATURE

The literature on human exposures to contaminants on museum collections, including sacred objects, is sparse. There is no medical literature that links a human pesticide intoxication with handling or contact with a repatriated sacred object. However, we know that this topic is relatively new and, to our knowledge, there have been no formal medical studies looking specifically at the health effects among museum workers or tribal recipients of sacred objects. One can look at some of the literature regarding museum collection exposures.

In 1981, a National Institute for Occupational Safety and Health (NIOSH) study was conducted at the Denver Museum of Natural History (Pryor 1983). The survey evaluated the potential exposure to DDT among collection staff. The investigators tested dust, dirt and surface scrapings from animal skeletons handled during museum preservation work. The results showed the presence of DDT ranging from low to very high levels (minimum level of four $\mu\text{g}/\text{gm}$ and maximum of 5500 $\mu\text{g}/\text{gm}$). Thus there appeared to be the potential for dermal contact with DDT associated with some of the specimens tested.

A 1998 study at the Denver Museum tested objects contained in their Hopi collection (Southward et al. 2000). The arsenic test kit uses two reagents (zinc and hydrochloric acid), which react in the presence of arsenic to produce a color change on an indicator strip. The limit of detection for the testing procedure was 0.1 parts per million for arsenic ions. The results showed that 473 objects (92.4

percent) had non-detectable arsenic ions, one object (0.2 percent) tested positive at 3.0 parts per million, and 38 objects (7.4 percent) had levels of arsenic ions less than 0.5 parts per million. The extremely high level was found in a Kachina mask that is used in ceremonial activities that allow prolonged skin contact which in turn could lead to unintentional hand to mouth or eye transmission of arsenic.

In 1999, a study was conducted of a university-based botany collection (Rader and Ison 1999). Mercuric chloride had been used as a pesticide on the vascular plant specimens from the beginning of the century until 1978. A survey was undertaken to determine the concentration of mercury vapor derived from the herbarium items. The principle findings included air concentrations of up to 400 mg/m³ of mercury vapor upon opening the botany cases. This extremely high concentration can be compared to the Occupational Safety and Health Administration (OSHA) standard of 0.05 mg/m³ (as an eight-hour average value).

In May 2000, the University of Arizona conducted testing of three ceremonial objects in their tribal collection (Seifert et al. 2000). These objects were composed of leather, grasses, corn husks, feathers, yarn and paint. Arsenic content was measured by energy-dispersive x-ray analysis. Total object arsenic levels were derived from a weighted sample average for the total surface area. Organic pesticide residue was evaluated by gas chromatography-mass spectroscopy (GC-MS). Two tribal objects had moderate to high levels of arsenic: 1.3 gram total object arsenic for one and 60 milligrams for the other. In addition, there were trace amounts of naphthalene detected on the interior surfaces of a third object. It is important to note that two of these objects lacked any catalog records indicating past pesticide treatment.

A NIOSH survey is underway that will evaluate exposure risks among museum workers involved in field excavation, fossil preparation, herbarium collection management, painting conservation, textile conservation and other general museum activities (Burroughs and Makos 2000). This study is being conducted in collaboration with the Smithsonian Institution and the American Institute for Conservation of Artistic and Historic Works. The evaluation will include testing for the following agents: silica, inorganic arsenic, mercury vapor and salts, lead pigments and solvents. Of special interest is the testing that will involve tribal sacred objects within the National Museum of the American Indian collection.

One investigator attempted to summarize all the pesticides used to prevent damage from insects and rodents among the collections of the Smithsonian Museum of Natural History (Goldberg 1996). This historical reconstruction demonstrates the changing agents and methods employed by the museum:

- *Early 1800s*: Compounds containing inorganic arsenic, and compounds containing inorganic mercury
- *Mid-1800s*: Continued use of arsenic and mercuric compounds, tobacco, sulfur, camphor and heat
- *Late 1800s and early 1900s*: Continued use of arsenic and mercuric compounds, strychnine, carbolic acid, naphthalene, wax/solvents, and carbon disulfide
- *Mid-1900s*: Dichlorobenzene, hydrocyanide gas, aluminum silicate, DDT, ethylene dichloride, carbon tetrachloride, ethylene dibromide, dichlorvos, sulfuryl fluoride, and freezing

Table 1. Evaluation of Carcinogenicity to Humans (based on: International Agency for Research on Cancer)

IARC Category	Agent
1—Human carcinogen	Arsenic (skin and lung cancer) Silica (lung cancer)
2A—Probable human carcinogen	Ethylene dibromide
2B—Possible human carcinogen	Carbon tetrachloride DDT Dichlorobenzene Dichlorvos Mercury (methyl mercury)*

* As noted in text, mercuric chloride, not methyl mercury, has been used in museum collections.

It is important to note that many of these substances are now banned or severely restricted for use as pesticides by EPA due to their toxicity: arsenic compounds, mercuric compounds, strychnine, carbon disulfide, hydrocyanide gas, DDT, ethylene dichloride, carbon tetrachloride and ethylene dibromide (EPA 1999). Furthermore, the current practices in museums rely much less on chemical methods of preservation and employ the principles of integrated pest management (described later).

POTENTIAL HEALTH EFFECTS

In reviewing the potential health effects of the exposures noted in the museum collections, one aspect to consider is whether the pesticide is considered a carcinogen. The International Agency for Research on Cancer (IARC) is an independent agency which reviews the world animal and human literature on chemical and physical agents in order to categorize their carcinogenicity (IARC 2001). Among the compounds used as preservatives by museums, certain agents have been designated as definite, probable or possible human carcinogens (Table 1). Arsenic has been associated with dermal and pulmonary cancers. Silica (used in combination with active ingredients in certain pesticides) has been shown to cause pulmonary cancer. Ethylene dibromide is a known genotoxic agent and has been associated with reproductive effects. Dichlorvos (also known by commercial name of DDVP or Vapona) is an organophosphate insecticide which has potential neurological effects.

For the purpose of this brief health effects review, we will focus on the four pesticides that have been found on museum collection objects: arsenic, mercury, naphthalene and DDT. The following list identifies the key symptoms and laboratory tests that could be used for biological monitoring (EPA 1999).

Arsenic (As): Various inorganic arsenic compounds have been used as pesticides

Symptoms: gastrointestinal disturbances, skin lesions, peripheral neuropathy, anemia, cardiovascular effects and skin/lung cancer

Chronic effects: skin pigmentation, hyperkeratosis (excessive thickening of the skin), peripheral neuropathy, renal effects and anemia

Laboratory: urinary levels for recent exposure (need to rule-out dietary sources such as seafood)

Mercury (Hg): To date, only the mercuric chloride form of mercury has been used (not the more toxic organic forms such as methyl mercury)

Symptoms: irritant to skin, eyes, nose, throat and lungs (possible shortness of breath and coughing), skin allergy

Very high exposures: gingivitis, tremor, proteinuria (protein loss in the urine indicating renal damage), neuropsychiatric manifestations (changes in personality, sensations and motor coordination)

Laboratory: Urinary levels of low-molecular weight proteins. Urinary and blood mercury levels (need to rule-out dietary sources such as seafood)

Naphthalene: Commonly used in the form of moth balls.

Symptoms: dermatitis (can be an irritant or result in skin sensitivity)

High level exposures in children: unintentional ingestion by young children have resulted in hemolysis and renal damage

Laboratory: Urinary biomarker and blood hydrocarbon DNA-adduct (need to rule-out dietary sources such as char-broiled food and tobacco smoking). These laboratory tests are for research purposes and the diagnosis is usually made by history and clinical presentation

DDT (Dichlorodiphenyltrichloroethane):

Symptoms: Irritant, gastrointestinal disturbances, central nervous system effects of hyperexcitability, suspect fetotoxicity, possible liver and kidney damage, suspect carcinogen and under study for endocrine receptor interaction (e.g., estrogen and androgen receptors)

Environmental: biopersistent in the environment and deposition in fatty tissues of humans

Laboratory: serum, urinary, adipose tissue and breast milk DDT levels and metabolites (e.g., DDE). These tests usually done in research surveys

MUSEUM WORKER PROTECTION PROGRAM

Once we know what sort of health effects can occur with the pesticides used on the sacred objects, it would be inappropriate to just wait for individuals to report symptoms or show physical signs of disease. It is important to institute a prevention-oriented program that protects the individuals from exposure to the pesticides. The following is a description of possible components that can be incorporated into a museum worker protection program.

- *Training*—fact sheets, signs, posters on safe handling procedures, possible health effects and emergency measures for an acute exposure event, and medical assistance information.
- *Engineering controls*—Enclosure to handle contaminated objects, and local exhaust ventilation with HEPA vacuum.
- *Appropriate personal hygiene*—Shower at end of work day, wash hands and face prior to meals and smoking, and wash work clothes separately.
- *Personal protective equipment (PPE)*—Impervious overalls, boots, gloves and goggles, and NIOSH-approved respirators.
- *Environmental monitoring*
- *Biological monitoring*
- *Disease surveillance program*

The latter two items need to be tailored following environmental testing and any other information that indicates which potential exposures are associated with the museum collection. Furthermore, there may be non-pesticide chemical and physical hazards that co-exist in the workplace and these need to be reviewed in developing a complete worker protection program. A formal disease surveillance program is better suited for larger groups of individuals where the number of cases allows for further analysis of trends and intervention. The groups that might benefit from a surveillance program include the following: professional organizations of conservators, museum employees at multiple collection facilities, and tribal community members potentially handling or exposed to contaminated repatriation objects.

All of the listed items may be considered for any individual that comes into contact with a potentially contaminated collection. For example, when a tribal representative goes to the museum to review the sacred objects that pertain to his or her tribe, what sort of training or PPE should be offered? Likewise, when a sacred object is returned to the tribal community, should they now institute some elements of this protocol until they can be assured that their objects are not contaminated? Some of the basic precautions required for pesticide handlers by EPA may be of use in developing these protocols (EPA 1993). For further information regarding pesticides and health effects, the following resources may be of interest:

National Pesticide Telecommunications Network

Based at the Oregon State University and funded by EPA, this group will answer questions regarding pesticide intoxications, safety information, environmental effects, pesticide emergencies, emergency treatment for humans and animals and cleanup/disposal procedures. The web site contains links to other sites with information on pesticide-related health data.

Hotline: 800-858-7378

Hours of operation: 9:30 AM to 7:30 PM EST daily except holidays

Web site: <http://ace.orst.edu/info/nptn>

E-mail: nptn@ace.orst.edu

EPA—Office of Pesticide Programs

Can obtain information regarding all aspects of pesticide regulation.

Tel: 703-305-7090

Web site: www.epa.gov/pesticides

Can order copy of *Recognition and Management of Pesticide Poisonings*, 5th ed. (in Spanish or English)

Tel: 703-305-7666

Web site: www.epa.gov/pesticides/safety/healthcare (online version of text available)

California Pesticide Data Bases

Contains information on pesticide chemical ingredients, link to EPA chemical dictionary, product and label database information, and other related material.

Web site: www.cdpr.ca.gov/dprdatabase.htm

Association of Occupational and Environmental Clinics

This association is a network of 63 clinics representing more than 250 specialists in both the US and Canada. The web site has many links to sites containing pesticide-related health information.

Tel: 202-347-4976

Web site: <http://152.3.65.120/eom/aoec/htm>

MUSEUM INTEGRATED PEST MANAGEMENT PROGRAM

Sometimes a non-chemical method of control is as effective and convenient as a chemical alternative. The most effective strategy for controlling pests is to combine methods of pest prevention, non-chemical pest controls and chemical pesticides in an approach known as integrated pest management or IPM, (EPA 1995). With the IPM approach, information about pests and available pest control methods is used to manage pest damage with the least possible hazard to people, pets, property and the environment, and in an economical manner.

Low-risk techniques used in IPM programs that have been used in museum settings include the following:

- Pheromone insect traps
- Monitor for pests and do not use pesticides until an infestation has been verified
- Anoxic (low-oxygen) atmospheres using, for example, nitrogen or carbon dioxide
- Freezing
- Good housekeeping practices
- Closed storage areas
- Isolation of new items until evaluation of the objects is complete
- Inventory of past and present treatments

Whether the sacred object collection resides in the museum or within the tribal community, the IPM approach should be considered in any preservation effort.

REPATRIATION AND PUBLIC HEALTH ISSUES

After the review of the scientific literature, the general health effects associated with sacred object contamination, protective measures for exposed workers and individuals, and IPM approaches to preservation, we are still left with many unanswered questions with respect to tribal repatriation of sacred objects and public health:

- How to prioritize the inventory activities and evaluation process?
- Should each object be tested prior to return to the tribes?
- Are there safe decontamination procedures?
- What are the museum worker health risks?
- What are the tribal recipient health risks?
- What is an appropriate handling protocol for the objects in the field and museum setting?

- What is an appropriate handling protocol for the objects by the tribal recipients?
- Should a formal survey be conducted on the extent of health effects among exposed groups (both museum workers and tribal community members)?
- How best to network among interested and potentially affected parties?

While the scope of this public health review does not deal with the spiritual nature of the sacred objects, it is important to emphasize that "safe" decontamination or handling will include the concept of causing no harm to both the physical and spiritual aspect of these objects. Additionally, the health effects of any individual that may be exposed will need to be evaluated whether that person is a museum worker or a tribal member, an adult or a child, or a designated handler or an unintentional bystander. Finally, the issues identified during this review will be successfully resolved only if information sharing and decision making involves all concerned parties in an atmosphere of mutual respect and trust, when adequate attention is given to cultural and spiritual issues.

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HAZARD IDENTIFICATION AND EXPOSURE ASSESSMENT RELATED TO HANDLING AND USE OF CONTAMINATED COLLECTION MATERIALS AND SACRED OBJECTS

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Abstract.—Occupational and environmental risk assessment is the systematic evaluation of exposure and toxicity data for the purpose of estimating health risk to members of a population. The process includes: hazard identification, dose-response assessment, exposure assessment, and risk characterization. These processes can be applied to the determination of potential health risk to museum workers and tribal community members who handle contaminated collections materials and sacred objects. Many acquired hazards are unknown to the user, as documentation of preservative treatments is often poor. Rigorous occupational health studies are needed to fully characterize workplace exposures within this non-traditional "industry." Tribal community members, as well as the toxicologists and public health officials with whom tribes will be consulting, need to compare source contaminant data in order to make rational statements as to potential risks. Critical to this process is the need for standardized, and in some cases revalidated, assessment protocols that take into consideration the restrictions placed on traditional industrial hygiene sampling methods on sacred objects and reflect an appreciation of the cultural issues surrounding the object's intended use.

INTRODUCTION

Risk assessment is the systematic and scientific evaluation of both exposure and toxicity data for the purpose of estimating health risk to members of a population. The four basic elements of this process are:

- *hazard identification* (is there a causal link between the chemical found and human health effects?);
- *dose-response assessment* (what is the probability of adverse health effects from the chemical, ascertained through animal study extrapolations and human epidemiological studies?);
- *exposure assessment* (what is the dose to the exposed population, under the conditions of use?); and
- *risk characterization itself*, which incorporates the first three elements into a summary of the potential for cancer incidence or other health effects under the conditions of exposure (Nelson 1997, Tardiff 1994).

When applied to an occupational and environmental health scenario, such as the handling of contaminated objects, risk assessment enables the stakeholders in the process to more fully understand the relative risks involved, and compare those with the impact of control alternatives. The risk evaluation process also puts the major and minor risks into perspective for an employer or community, and thus helps to prioritize resources for future actions.

This paper briefly summarizes the more traditional toxicological methods used in the occupational and environmental health risk assessment process and the practical applications in the field of industrial hygiene exposure assessments.

Table 1. Glossary of selected abbreviations.

ACGIH	American Conference of Governmental Industrial Hygienists
ATSDR	Agency for Toxic Substances and Disease Registry (part of the Centers for Disease Control)
BEI	Biological Exposure Indices
HEPA	High Efficiency Particulate Air (filter)
LOAEL	Lowest-Observed-Adverse-Effect-Level, as derived from animal or human data
MCEF	Mixed-Cellulose Ester Filter
MRL	Minimum Risk Level, risk estimate term used by the ATSDR
MSDS	Material Safety Data Sheet (chemical manufacturers are required to produce and provide to users)
NIOSH	National Institute for Occupational Safety and Health (part of the Centers for Disease Control)
NOAEL	No-Observed-Adverse-Effects-Level, typically extrapolated from LOAEL data
OEL	Occupational Exposure Level
OSHA	Occupational Safety and Health Administration (part of the U.S. Department of Labor)
PEL	Permissible Exposure Limit
RfC	Reference Concentration, risk estimate term used by the USEPA
SEG	Similar Exposure Group, used as basis for inclusion of certain staff in a workplace exposure study
TVL	Threshold Limit Value
UF	Uncertainty Factor, used in risk estimate conversion from animal to human data
USEPA	United States Environmental Protection Agency

Within each discussion section, emphasis is placed on those aspects pertinent to situations involving contaminated collections and repatriated objects, along with aspects that require further research. A glossary of selected abbreviations is provided in Table 1.

HAZARD IDENTIFICATION

With respect to contaminated collections/repatriated objects, the first step is the identification of the inherent or acquired hazard itself, as well as documentation of its ability to elicit acute or chronic human health effects. A compilation of probable pesticides used by museums, although not necessarily on objects identified for repatriation, is found in Table 2.

Literature and Records Review

All records of purchase or donations, chemical inventories past and present, collector's field notes, preparation or processing methods, conservation treatments, literature review of similar practices, and interviews with past and present staff will be useful in identifying potential sources of chemical exposures. The museum and conservation literature incorporates some discussions of collections-based hazards (Duckworth et al. 1993, Goldberg 1996, Hawks 2001, Hawks and Makos 2000, Hawks and Von Endt 1986, Hawks and Williams 1986, Howie 1987, Johnson 1999, Kondratis 1991, Lambert 1994, Makos 1998, Makos and Dietrich 1995, Miller 1991, Odegaard 2000, Purewal 1999, Seifert et al. 2000, NPS 1993+, Waller et al. 2000, Williams and Hawks 1987).

Obvious and useful sources of hazard information on pesticide or treatment chemicals are the container labels themselves, and the Material Safety Data Sheet

Table 2. Chemicals that may have been used on natural science and ethnographic objects specifically for pest or mold control (Adapted from Hawks 2001).

Alcohols	Endosulfan II
Aldrin	Ethylene dibromide
Argon (anoxic)	Ethylene oxide
Arsenic compounds (trioxide, sulfide)	Formaldehyde
Bendiocarb (Ficam)	Heptachlor
Benzene hexachlorides (Lindane)	Hydrogen cyanide gas
Borax/Boric acid	Hydrogen phosphide
Carbaryl	Lauryl pentachlorophenate
Carbolic acid (phenol)	Malathion
Carbon dioxide (anoxic)	Mercuric chloride (corrosive sublimate)
Carbon disulfide	Methyl bromide
Carbon tetrachloride/ethylene dichloride (Dowfume)	Methoxychlor
Chlordane	Naphthalene
Chloropicrin	o-Dichlorobenzene
Chlorpyrifos (Dursban)	p-Dichlorobenzene
Diatomaceous earth	Pentachlorophenol
Diazinon	Propoxur (Baygon)
Dichlorodiphenyltrichloroethane (DDT)	Pyrethrins (natural & synthetic)
Dichlorvos (Vapona)	Silica gel
Dieldrin	Sodium aluminum fluorosilicate
Edolan U	Sodium fluorosilicate
Endrin aldehyde	Sulfuryl fluoride (Vikane)
	1,2,4-trichlorobenzene

(MSDS) which is manufacturer-specific for each product and required by the U.S. Occupational Safety and Health Administration (OSHA). Useful sources for generic MSDSs (not as beneficial as those for the specific trade name product) and current health hazard status reports can be found through a number of agencies, listed in the "Resources" section of this paper.

Sampling for Chemical Identification: a Brief Summary of Pertinent Methods

This section offers a selection of sampling methods which might best pertain to the testing of contaminated objects which have handling restrictions due to cultural and conservation concerns. Analytical methods for materials analyses have been discussed in detail by Sirois and Sancoucy (this volume). Comprehensive discussions of sampling methods and instrumentation are found in standard industrial hygiene texts (ACGIH 1995, DiNardi 1997, Ness 1994).

The following methods have practical application to collections objects, in that all are available to both the environmental and conservation scientist, and none involve the type of destructive sampling that is generally unacceptable to both the tribal and conservation communities. This should be viewed as testing for disclosure, not necessarily sampling for risk, since the surface concentration of a hazardous substance cannot be extrapolated to a defined airborne concentration, or even a quantifiable ingestion or absorption hazard, unless these specific bio-transfer rates are known. Other confounding factors in linking a surface concentration with relative risk are that most pesticides a) were not applied externally in a uniform manner, b) were applied evenly on the interior of the specimen but

have now migrated unevenly to the surface, or c) were applied only to parts of the object most vulnerable to insects or mold.

Unless a rigid, quality controlled pattern of multiple random samples is applied to each object, it may be misleading to compare objects in terms of relative hazard based on a surface sample alone. Energies might be better utilized in 1) standardizing surface sampling methods that have maximum sensitivity for positive/negative disclosure determinations, and are affordable so that multiple samples can be made on each object, and 2) educating the health and safety professionals involved as to the most probable locations of applied pesticides, given what museum staff know about the object.

Wipe samples for particulate residues.—The most common surface sampling method involves a wipe, in a consistent pattern (Z or S stroke) over a set area template (100 cm² or 1 ft²), using collection media that are selected for best adhesion on the surface in question. Media can include Whatman filter paper or gauze, typically moistened with deionized water, an alcohol, or other solvent (e.g., hexane on gauze for DDT and its isomers); mixed-cellulose ester filters (MCEF); pre-moistened commercially-available towelettes (e.g., "Wash-n-Dri"); or cotton-tipped swabs. As basic as these techniques may seem, careful consideration must go into the selection of the media and any wetting agent. Each method has its own demonstrated limits of detection and accuracy, and results from one method cannot always be directly compared to another (Found and Helwig 1995).

For instance, MCEFs are useful on smooth surfaces, like tabletops, but would be ripped to shreds on a rough surface such as a wooden mask. Commercially-available moistened towelettes have been validated for many metals, such as lead, arsenic, and mercury, but if the media has dried in parts, or the alcohol has concentrated through settling, the collection efficiency will be less. A suitable alternative to commercial products, available in any conservation laboratory, might be Whatman or other filter paper. However, it must be determined that the filter paper porosity is the same as the media specified in the validated sampling method, or else collection efficiency data must be established for the alternative filter media. Certain compounds may require a dry wipe because moisture may prevent adequate analytical recovery from the collection media.

Conversely, some standard surface sampling methods may adversely affect the object, and may need to be altered due to conservation restrictions. For instance, either isopropyl alcohol or deionized water is commonly used to moisten the sample filter. However, alcohol may not be allowed on many surfaces due to its drying affect, and water may be of greater harm to wood objects. Some commercially-available wipes contain unwanted and harmful (to the object) surfactants. Persons conducting the test must be careful to prevent unwanted loss of dyes, pigments, significant markings, or residual organic matter of cultural significance. These considerations alone may preclude a strategy of random sampling.

For objects that cannot be touched directly due to cultural restrictions, a useful measure of contamination would be to request to test the hands or gloves of those authorized to handle and examine the object. This type of sample has additional value in that in the repatriation examination process, the anticipated handling of these objects in ceremonial or tribal collections care use could be simulated if this release of information is granted by the tribal representatives. A variation on

a standard method for surface wipe samples (NIOSH 1996) involves a vigorous 30-second wipe of the hand (or glove) with a pre-moistened filter that has been validated for low metal background and adequate ashing characteristics.

Microvacuum wipes with pump and filter cassette.—A standard sampling pump, with tubing and filter cassette attached, can be used to literally vacuum across the surface of an object. This method is less damaging from pressure, although the air flow pressure of the pump may take up other surface features (pigment, etc.) much as will a wipe sample. Air flow can be decreased, but only to a point that is still effective for collecting residues. The advantage of this method for metals analysis is that the fragile MCEF filter (preferred for analysis) can be used.

Portable x-ray fluorescence.—The portable (hand-held) X-ray fluorescence (XRF) analyzer, commonly used to sample lead-based paint, is ideally suited for analysis of metals (e.g., arsenic, lead) on or within objects, and of wipe samples taken from such surfaces. The application of XRF to conservation work has been explored in the literature (Sirois 1988, Sirois and Taylor 1989). While the purchase of the instrument, with multiple sources for broad-spectrum metals analysis and wipe analysis platform, can cost over \$20,000, the rental of a unit is relatively affordable (e.g., \$1,000/week) if a museum can arrange to survey as many items as possible. Some considerations include the need for training to comply with regulatory licensing for an instrument with a radioactive source, understanding that the device requires a relatively smooth and flat surface for reliable readings, and accommodation for the fact that pressure will be applied to the surface by the instrument (which can be avoided through the use of a wipe).

Bag enclosure sampling.—Not every pesticide can easily be sampled by surface wipes, particularly those that have sublimed and ingrained themselves into the object, like naphthalene or p-dichlorobenzene. Sulfur-based pesticides, or the natural organic degradation of organic substances, can release a variety of irritating sulfur gases. The use of analytical bag enclosures, and the withdrawal of accumulated gases or vapor from an ambient sample around the object is practical and useful. Individual tribal groups might object to the idea of an enclosure, so prior consultation with the tribe is essential. Heating a sample of the object matrix in a head-space bottle, or heating of the bagged object itself, would be ideal but possibly of limited acceptance to tribal groups or conservators.

Direct-reading instrumentation.—Of the other varieties of sophisticated “portable” versions of major analytical instrumentation, the most practical may be the mercury vapor analyzer (Jerome 431-X model by Arizona Instruments is a reliable version). With its wand attachment, the unit easily measures vapor concentrations within cabinets, which is of great value in screening collections and can be used with individually-bagged objects. Portable infrared analyzers, and portable GC-MS instrumentation are available, although expensive and high-maintenance. “Grab” samplers (bellows-pumps with sorbent media tube attachments) are of limited value for museum collections applications due to their general lack of sensitivity and specificity.

Passive dosimetry.—Constructed to take advantage of Fick’s basic law of diffusion, these small clip-on devices contain either an appropriate sorbent media (requiring laboratory analysis) or a reactive material that produces a colorimetric or length-of-stain change that can be directly read against a standard reference chart. The sensitivity of most major brands has increased over the years, making

this a reliable and validated method for many vapors and gases (not particulates). However, it does rely heavily on a certain constant air flow across the diffusion membrane and therefore passive monitors are of dubious value inside storage cases or enclosure bags.

Classifying the Chemical as Hazardous

Once the identity of the chemical is demonstrated, references are consulted to determine whether the chemical has been deemed as hazardous. For chemicals suspected of causing cancer, various weight of evidence methods are used by the International Agency for Research on Cancer (IARC 1987) and the U.S. Environmental Protection Agency (USEPA 1996). Industrial hygienists are familiar with the data analyses conducted by the American Conference of Governmental Industrial Hygienists (ACGIH) in classifying carcinogens and other chemical hazards. The National Toxicology Program of the U.S. Department of Health and Human Services is the premier source of such study data. The hazardous properties of a chemical are assessed by a review of the human epidemiological and toxicological data derived from scientific studies (Tardiff 1994). These are based on evidence demonstrating cause-and-effect and suggesting that toxic effects observed in one setting (e.g., animal studies) can occur in other settings (e.g., humans). The next step (dose-response assessments) refines the classification of hazard by studying the degree of observed adverse health effect at varying exposure doses of the chemical.

DOSE-RESPONSE ASSESSMENTS

Dose-response assessments are a determination of toxic potency, which is the dose of a substance needed to cause a specific incidence of injury or severity (e.g., X milligrams of substance Y, per kilogram body weight of the rats studied caused respiratory irritation in 50 percent of rats studied). Many dose-response relationships may exist for a substance depending on the conditions of exposure (short-term, acute; long-term, chronic) and the response being considered (cancer, mutagenicity). Data for toxic potency (dose-response) evaluations can be derived from epidemiological studies of exposed human populations and/or from experimental animal studies. The obvious advantage of human studies, particularly to determine causation in acute or rare chronic disorders, is that toxicity is assessed directly on human health. Human studies are preferable; however, disadvantages still exist. Actual dose may be difficult to ascertain in the absence of good exposure monitoring data, confounding factors must be accounted for (cigarette smoking, exposure to chemical mixtures which may have synergistic effects), and results may need to be extrapolated before estimating risk in a different population or exposure scenario. Animal toxicological studies can better control exposure variables and offer precision as to the duration, frequency, amount, and route of dose administered, provided that a species is selected which can best predict human target organ response. After the study is complete, pathological changes can be observed in a controlled manner in all study subjects. However, the caveat is that there is often a poor correlation between animal and human data. One of the greatest challenges and potential disadvantages of animal studies over human studies involves the use of the correct mathematical models for extrapolating high-to-low dose, and for converting animal data to predicted human effect.

If a substance causes cancer, in which case the presumption is that no biological threshold exists, then quantitative risk estimates can be presented in several ways. The slope of the cancer dose-response curve can be used to describe potency, as risk per mg/kg-day. The unit risk is an estimate in terms of, say, risk per $\mu\text{g/L}$ drinking water or risk per $\mu\text{g/m}^3$ air breathed. Risk may also be presented as a drinking water or air concentration providing cancer risks of, e.g., one in 10,000 or one in 1,000,000 (USEPA 1998).

If the substance causes any form of toxicity other than cancer, risk estimates may be given as "reference dose" (RfD) or "reference concentrations" (RfC), as used by the USEPA, "minimal risk levels" (MRLs), as used by the Agency for Toxic Substances and Disease Registry, or "acceptable daily intake" (ADI), a term often used by the World Health Organization. These terms are based on mathematical extrapolation from the substance's No-Observed-Adverse-Effects-Level (NOAEL), which is the highest dose level at which no harmful effects were seen in the organ system studied, and the Lowest-Observed-Adverse-Effects-Level (LOAEL), which would be the defining animal study.

INDUSTRIAL HYGIENE EXPOSURE ASSESSMENT

If exposure is defined as the opportunity for the body to receive a dose substantial enough to result in an adverse health effect, then the job of the industrial hygienist is to control that exposure and reduce that dose. The industrial hygienist measures exposure in a variety of ways depending on the possible routes of entry into the body and an understanding of how the contaminant in question will be contacted in the specific activity. Inhalation dose can be measured via an air sample in the person's "breathing zone," which is considered a radius of one to two feet around the subject's head. If absorption through the skin is a significant route of exposure for the chemical in question, then dermal wipes or patch tests can estimate exposure dose. Finally, biological samples of excretia, such as urine, feces, blood, or exhaled breath, can be used to back-calculate the total exposure dose from all significant routes of exposure, and give the occupational physician a reasonable estimate of body burden.

Before a sampling strategy can be set, the objective of the exposure survey must be clearly defined. Surveys are conducted for many reasons. They can be *initial identification* surveys of hazardous substances, the processes that involve their use, as well as the task duration and frequency. *Screening* surveys identify higher-than-acceptable exposure levels within a target population. This type of approach does not describe the entire population but provides reasonable assurance of protection for the most likely at-risk employees. *Compliance* surveys may be mandated by federal or state regulations; this survey is basically another screening tool for highest-risk tasks. Surveys may be conducted for evaluation of the *effectiveness of implemented controls*. Control evaluation can be assessed through a simple before and after sample approach, a strategy that would be appropriate for evaluating the effectiveness of object cleaning and decontamination methods. Finally, the most *comprehensive* exposure survey serves to generate a sizeable database that will be of use to medical or epidemiological personnel in that it can statistically characterize the true distribution of exposure levels within a target population (Leidel and Bush 1994, Conrad and Soule 1997).

In recent years, the approach has shifted from compliance-based sampling of

maximum-risk employees to comprehensive exposure assessments that emphasize the characterization of all exposures for all workers on all days (Mulhausen and Damiano 1997). This is particularly true of exposure surveys of the intermittent and highly variable work tasks of collections care. These must be of sufficient sample size to be analyzed properly, and consist of an integration of surface and dermal sampling in conjunction with air and biological monitoring to properly characterize expected dose from those tasks.

Sampling Strategy

As Mulhausen and Damiano (1998:11) observe, "One of the biggest weaknesses in current epidemiological practice is the lack of useful exposure data." Before epidemiology studies can be conducted on museum staff, or true health risks ascertained, it is critical that acceptable exposure profiles be generated. Very little quantitative data has been published on occupational exposure risks within the museum workforce (Briggs et al. 1983, Jiggins et al. 1998, Pryor 1982, Purwal 1999, Rader and Ison 1999, Waller et al. 2000). This severely limits the possibilities for retrospective or mortality studies within this group, and opens the door to broad and possibly incorrect assumptions about disease causation factors. In generating acceptable exposure profiles for museum workers in any of their myriad of tasks, the industrial hygienist will need to resolve several issues.

Sample size and the nontraditional workforce.—Museums or other collection institutions that have a safety and health office should request repetitive monitoring sessions (not just a single, compliance-oriented survey) to truly understand the task exposure profile. In practice, a museum or university's risk management personnel might have the opportunity or resources to collect only a few well-chosen air samples, and would be looking for a worst-case scenario. Industrial hygienists often recommend control measures conservatively, to compensate for the high uncertainty from small sample sets. Professional judgment is necessary in evaluating how representative these few samples are. To increase the confidence of the hygienist's judgment (particularly to confirm low exposure risk), a larger database is needed with which to apply statistical analysis. Likewise, while a dangerously high sample result for an individual will trigger prompt control actions on the part of an industrial hygienist or an occupational physician, the assumptions about exposures to the rest of the representative workforce *will* require additional sampling to prove if this high result is indicative of the task or an unusual event.

A sufficient number of randomly collected samples must be taken to adequately estimate the day-to-day variability of exposures (the exposure profile), and allow for formal statistical characterizations (Mulhausen and Damiano 1998). If sample concentrations are detectable, then a minimum of 6–10 samples might suffice to render a statement about the operational risk. If these samples are below the detection limit, many more samples (perhaps 40+) will be needed before statistics can be applied (Mulhausen and Damiano 1998). The latter level of magnitude requires a collaborative effort between institutions, working from the same protocols, in order to pool data effectively. The National Institute for Occupational Safety and Health (NIOSH) is currently completing a screening survey of various museum tasks that should serve as a springboard for further studies (see Resources section, this article).

Agreement on what constitutes a similar exposure group.—Similar exposure

groups (SEGs) are groups of workers having the same general exposure profile because of the similarity and frequency of the tasks they perform, the materials and processes with which they work, and the similarity of the way they perform the tasks (Mulhausen and Damiano 1998). The potential for exposure to residual pesticides applies to several job classifications in the museum: curatorial, conservation, collections management, exhibit preparation, educator. Many task descriptions between these occupations overlap, or are done in the same work area, such as: curation, accessioning, identification and cataloguing, comparative study, research, preparation, preservation/conservation, pest management which may involve limited application of registered pesticides and housekeeping in storage areas that have residual pesticides, and shipping and handling of loans.

Grouping these functions and tasks into just a few SEGs may be justified for the study of pesticide exposure, particularly because of the variability of work and the overlap of staff functions. A possible exception is the task of moving collections from one storage location to another. This task typically involves inventorying and handling every item, usually some cleaning, more vigorous contact with object surfaces than in previously described tasks, and a more consistent daily and weekly shift. However, the objects themselves vary widely in type and in potential for contamination; therefore, random multiple samples benefit the assessment of this task group as well.

MONITORING METHODS

Airborne (Inhalation) Monitoring

If inhalation is the only significant route of entry to the body, then the results of ambient air samples taken within the person's "breathing zone" reflect the dose of that chemical to the body. The collection media (sorber tube, filter cassette, liquid media in an impinger/bubbler device) is placed close to the person's breathing zone, typically on the worker's lapel and within a one foot radius around the head. The device may be connected to a battery-operated, calibrated sampling pump, which is worn through the work/exposure period, often an eight hour shift or 15 minute short-term exposure period. An alternative method that now has wide acceptance is the use of passive diffusion dosimetry (discussed earlier, under "Sampling for Chemical Identification"). Passive dosimeter collection devices offer a great advantage for occupational exposure studies because they do not require coordination of monitoring schedules ahead of time (difficult for sampling tasks of great intermittency), nor calibrated and charged sampling pumps. Passive dosimeters are not available for particulate sampling.

Sampling and measurement accuracy.—Apart from the considerations for selection of sample size, location, frequency, and duration, there are other factors that will affect the accuracy of the sample itself. The sampler or media must be carefully chosen to achieve the degree of specificity needed (e.g., separation of gas-phase species from particulate interferences), have sufficient capacity (dependent on temperature, humidity, flow rate, and interferences), and adequate collection volume and rate (i.e., volumes or rates greater than the validated range may cause loss of sample from the media due to saturation or limited residence time of the chemical on the media; air volumes less than the validated range may result in a sample below the limit of detection).

Sampling errors can be controlled through precise pre-and-post calibration of instrumentation, collection of field and laboratory blanks, use of fresh media, and submission of bulk samples to identify interfering compounds collected (Eller 1994). The measurement technique itself must be sensitive enough to quantify the likely contaminant and selective enough to detect it in the presence of other substances. Sample results below the analytical limit of detection should never be reported as "zero" but as "not detected," with the limit noted. Sample results between the limit of detection and limit of sample quantitation (lowest mass that can be reported with acceptable precision) should be reported as a numerical value, again with the limit declared.

Dermal Exposure Monitoring

The USEPA and the World Health Organization have issued standardized methods for assessing dermal exposures primarily for organic pesticides (Ness 1994). However, unless the chemical is known to have a significant and tested rate of skin absorption, other techniques for estimating the potential for environmental exposures are occasionally used, such as wipe samples to estimate the concentration of a toxic chemical on work surfaces or even on the worker's skin. There are, however, only a few validated techniques for collecting and analyzing these types of samples, or standards against which to judge results, so these procedures are generally of qualitative not quantitative value to the investigator. Dermal, or glove, wipes do serve a valuable purpose in confirming the presence of a chemical (most notably arsenic or mercury salts) on the objects handled. If the correlated air sample does not detect the compound in the breathing zone, then a positive wipe determination serves as a reminder to the worker that an ingestion hazard still exists.

Biological Monitoring

Biological monitoring is often described as the relationship between chemical parameters measured in the biological media of humans (typically: blood, urine, or exhaled breath) and past exposures to chemical factors (Que Hee 1993, 1997). These are markers of *exposure*, to be differentiated from "medical monitoring" which is the collection and analysis of markers reflecting actual adverse *health effects*. Biological monitoring results can support a physician's medical monitoring analysis. If significant exposure can occur through any routes of entry other than inhalation (which can be evaluated through a breathing zone air sample), then biological monitoring may also be warranted (AIC 1999), because the results can be used to back-extrapolate total exposure estimates from all routes of entry. One reference commonly used in occupational exposure studies is the Biological Exposure Indices (BEIs), published by the ACGIH. The BEIs do not represent a sharp distinction between hazardous and non-hazardous exposures, but are indicators of the uptake of the substance and are meant to represent *workplace* exposures based on eight hour exposures, five days per week. (ACGIH 2001). They are not substitutes for inhalation exposure standards such as the ACGIH Threshold Limits Values (TLVs) or OSHA Permissible Exposure Limits (PELs). The compounds for which BEIs have been established to date, some of which may not be relevant to collections management, are listed in Table 3, along with the biological matrix used for their evaluation.

Biological monitoring can assist the physician to assess total body burden, detect

Table 3. Chemicals with established BEIs (ACGIH, 2001).

Chemical	Biological specimen
Acetone	Urine
Acetylcholinesterase-inhibitors (pesticides)	Blood
Aniline	Urine or blood
Arsenic, elemental & sol. inorganic	Urine
Benzene	Urine
Cadmium	Urine or blood
Carbon disulfide	Urine
Carbon monoxide	Blood or exhaled air
Chlorobenzene	Urine
Chromium (VI)	Urine
Cobalt	Urine or blood
Dimethylacetamide	Urine
Dimethylformamide	Urine
Ethoxyethanol	Urine
Ethoxyethyl acetate	Urine
Ethyl benzene	Urine or exhaled air
Fluorides	Urine
Furfural	Urine
Hexane, n-	Urine or exhaled air
Lead	Blood
Mercury	Urine or blood
Methanol	Urine
Methemoglobin inducers	Blood
Methoxyethanol	Urine
Methoxyethyl acetate	Urine
Methyl chloroform	Exhaled air, urine or blood
Methylene bis(2-chloroaniline)	Urine
Methyl ethyl ketone	Urine
Methyl isobutyl ketone	Urine
Nitrobenzene	Urine or blood
Parathion	Urine or blood
Pentachlorophenol	Urine or blood
Perchloroethylene	Exhaled air, urine or blood
Phenol	Urine
Styrene	Urine or blood
Tetrahydrofuran	Urine
Toluene	Urine or blood
Trichloroethylene	Urine, blood or exhaled air
Vanadium pentoxide	Urine
Xylenes	Urine

non-occupational exposure among workers, and monitor work practices by offering information beyond that provided by air sampling alone (ACGIH 2001). Occupational physicians use a wider range of biological monitoring techniques (and more complex interpretations of the results) than do industrial hygienists, for the purpose of estimating total exposures and body burden, particularly for the individual patient. This topic is addressed in more detail by Osorio (this volume).

Validated Methods and Laboratory Accreditation

Protocols for the development of methods for industrial hygiene must contain experiments designed to estimate bias and precision of the analysis of realistic

samples (Eller 1994). The process validated through the OSHA Standards Completion Project forms the basis for most of the analytical methods published by OSHA and NIOSH. Adhering to specified media, and recommended sample duration and pump flow rate (calibrated pre-and post-sampling) for a particular chemical ensures the optimal collection and desorption efficiencies. The critical laboratory accreditation in the field of industrial hygiene is that of the American Industrial Hygiene Association (AIHA). Estimates of interlaboratory variability can be made through proficiency testing schemes such as the Proficiency Analytical Testing program administered by the AIHA and NIOSH.

Interpretation of Results and Comparison of Data

If the evaluation was conducted for compliance purposes, the results must be compared with established regulatory standards, such as the OSHA PELs, or consensus guidelines, such as the annually-revised ACGIH TLVs, or the NIOSH Recommended Exposure Limits (RELs). None of these concentrations should be construed as absolute lines between safe and unsafe exposures, but should be evaluated in the overall exposure assessment. General exposure evaluations must first place the sample result in the proper context as to the conditions it represents: a full-shift, time-weighted average or a short-term exposure to peak concentrations within a task with highly variable exposures. The conditions surrounding the monitoring period, the parameters of the sampling methodology, the limitations of the analysis, and the professional judgments involved with interpreting results must be carefully documented and justified in accompanying reports. Otherwise, historical data cannot be compared to more recent data collected with more advanced techniques, nor can public health professionals compare or apply the results from various sources.

The practicing industrial hygienist must also examine the basis for the standard and the adverse health effect the standard was designed to prevent. The standard may be based on data or on workplace situations that do not have direct bearing to the task being evaluated. Professional judgment must then be applied to the development of a more relevant occupational exposure limit specific to the work situation.

Example: Application of toxicological data to the development of a lower occupational exposure limit to naphthalene in entomology collections areas.—In 2000, the author examined naphthalene exposure standards in the workplace, with respect to their applicability as ambient standards in occupied office work areas that also contained treated collections. Examination of the then prevailing community-based toxicological reviews (USEPA 1998, ATSDR 1995) indicated that the health hazards of most serious concern included hemolytic anemia and cataracts (primarily identified in acute exposure studies) and respiratory toxicity (nasal and pulmonary irritation and lesions), primarily from chronic irritation. Symptoms of exposure could include skin and eye irritation, headaches, and nausea. The LOAEL referenced by both the USEPA and ATSDR was 10 ppm, based on respiratory effects on mice. Their risk assessment methods led the agencies to establish a community Minimal Risk Level (ATSDR) of 0.002 ppm (24 hr/day, 365 days or more), and a Reference Concentration (USEPA) of 0.0006 ppm (24 hr/day, 365 days or more). The difference reflects the use by USEPA of a more conservative “uncertainty factor” (UF) in its conversions from animal to human

data. Uncertainty, or safety, factors include extrapolations from LOAEL to NOAEL and from animal to human, a factor to account for human variability, and a factor to account for database deficiencies.

Upon examining the documentation for prevailing occupational health standards, it was discovered that the OSHA Permissible Exposure Limit of 10 ppm (eight hour TWA) was established to protect workers from cataracts and ocular effects rather than respiratory effects (OSHA 1989). The ACGIH Threshold Limit Value of 10 ppm (eight hour TWA) was likewise recommended to prevent ocular toxicity. The documentation of this TLV stated that the ACGIH does not presume this TLV to be protective against respiratory irritation nor blood dyscrasias (ACGIH 1999). NIOSH had adopted the same recommended exposure limit of 10 ppm PEL by concurrence with OSHA (ACGIH 1999).

Industrial "fitness for duty" standards are not necessarily applicable to the working population in museums. These populations may have wide variation in age, health status, and individual susceptibilities, factors that have minimal impact on their ability to carry out many museum tasks (as opposed to the rigors of work in a manufacturing plant environment). Therefore, the MRL and RfC data had to be reconverted to a new "occupational exposure level" (OEL), using an eight hour day and 40 hour workweek. A factor of two was applied to convert the long-term mean exposure level (MRL/RfC) to an OEL, a finite limit not to be exceeded, with an upper 95 percent confidence limit estimated as twice the arithmetic mean.

OEL Calculation, Using the ASTDR MRL

$$\frac{10 \text{ ppm LOAEL} \times 6 \text{ hr study/8 hr workday}}{1,000 \text{ UF}} \times 2 = 0.015 \text{ ppm OEL}$$

OEL Calculation, Using the EPA RfC:

$$\frac{10 \text{ ppm LOAEL} \times 6 \text{ hr study/8 hr workday}}{3,000 \text{ UF}} \times 2 = 0.005 \text{ ppm OEL}$$

At the time, the most sensitive and reliable sampling and analytical method for naphthalene appeared to be the OSHA 35 Method (OSHA 1982) which declared a minimum quantitation limit of 0.08 ppm. More recent analytical trials (Kase 2000) indicated that a quantitation limit of 0.0098 ppm was attainable. Therefore, as a practical matter, an OEL goal for ambient work areas could be set at 0.015 ppm, reflecting ASTDR toxicity evaluations rather than the OSHA or ACGIH levels. (Note: This evaluation preceded the January 2001 National Toxicology Program report indicating clear evidence of carcinogenic activity in rats from naphthalene exposure).

DISCLOSURE REPORTS, CONTROL RECOMMENDATIONS, AND RISK COMMUNICATION

Critical to the subsequent utilization of this information are the development of exposure controls and an effective program of risk communication. For an occupational workforce, the mechanisms for selection and implementation of these programs are well established. Appropriate glove and skin barrier materials are chosen to prevent contact with residual pesticides. Local exhaust ventilation

is utilized for cleaning activities or other tasks that may result in disturbance of settled particulate. All collections activities are performed in well-ventilated areas. Respirators may need to be considered as an interim control based on exposure assessment data. Hazard awareness training for staff and fact sheets to alert visitors and incidental users of collections should be standard practice.

To provide such hazard awareness information to the outside community, specifically Native American communities repatriating objects, the transfer of hazard data must be detailed carefully. In many cases, the museum or university will not have the opportunity to clarify safety issues once the objects leave their domain. Units of measurement and analytical methods must be described, with references, so any future sampling can utilize the same parameters. The topic of hazard mitigation of contaminated surfaces is discussed in more detail in Kaminitz (this volume) and Odegaard (this volume). Consideration of all feasible decontamination and control measures includes the preferences and religious practices of the individual tribe. This concept is discussed by Sadongei (this volume). In considering the following suggested outline for disclosure information, all parties involved must respect the possibility that tribal members may have religious or cultural constraints on disclosing certain information and describing ceremonial procedures.

Suggested Outline for a Disclosure Statement

- Identification of cultural affiliation of the objects, and pertinent dates of object examination and testing for presence of hazardous materials.
- Summary statement acknowledging that objects in the repatriation agreement may have been treated with pesticide chemicals since leaving the tribe, and any and all supporting evidence as to the types of chemicals used and/or remaining.
 - Historical records and MSDSs.
 - Visual indications of residues or treatments.
 - Analytical test results statement.
- Statement as to whether any efforts to date have been taken to clean the object or stabilize any residues (include pre-and post-surface tests if available).
- Hazard warning containing a succinct statement of possible health effects, associated with the chemical(s) identified. Museums are cautioned against postulating relative risk unless the conditions of future use have been well discussed between tribal representatives and appropriate public health professionals familiar with the particular conditions of use.
- General precautions and/or remediation recommendations related to the intended future use could be developed if requested by the tribe. Consideration must be given to the culturally sensitive nature of the inquiries, which may preclude a complete discussion in some cases. Recommendations must also be carefully worded to apply only to the future use as described. Otherwise, precautions may be inadvertently applied to other use situations for which they might be inappropriate and unprotective. Questions to guide both parties might include:
 - *How will each object be handled?*
 - Will objects be reinterred? Is there an issue of groundwater, crop, live-

stock contamination and will the tribe need to contact local pollution control authorities? Can this be done by the tribal Pesticide Manager or will the tribe need other assistance?

- Will the objects be housed in tribal cultural resource center collections? Does the center have a safety and health program to manage this risk?
- Will the objects be used, or stored, in ceremonies or in family settings? In these instances, direct skin contact may be inappropriate, as well as storage next to eating utensils, food supplies, or in certain parts of the home. Tribal groups should describe the intended use in as much detail as possible given cultural constraints on sensitive information.
- Are there some scenarios (bare skin contact for hours, heavy exertion, hot unventilated rooms) for which controls may be especially difficult?
- The types of information that would be useful are:
 - Can a traditional use practice be altered for protective reasons?
 - How intimate is the skin contact? (Eyeholes, mouthpiece, garment on bare skin?)
 - What will the age of the users be?
 - What is the duration of use in a single event?
 - What is the frequency of events in a given year?
- *What possible remediation actions might be feasible for both the museum and the tribal group?*
 - Does the tribal group have or prefer its own methods to purify objects? If so, these should be respected and discussed with the tribal group.
 - May objects be HEPA-vacuumed now (and post-tested)?
 - Can the surface be sealed or painted?
 - Can a liner be used (for mask or body)? What material?
 - Are there some objects for which all currently available remediation methods are unacceptable?
- References and resources in museums and public health agencies, in the tribe's locality, should be given where possible.
- Attached data tables should include, as a minimum: sample number, object description, chemical tested (analyte), area sampled, sampling method, analytical method, concentration detected, limits of detection and quantitation, name and professional credentials (accreditations, certifications) of investigator and analyst or analytical laboratory.

RECOMMENDATIONS FOR FURTHER STUDY

The application of risk assessment principles and industrial hygiene methods to the characterization of health hazards associated with handling contaminated collections objects and repatriated sacred objects will require adaptations and revalidations of standard procedures. Issues for further research and resolution include the following.

1. Surface sampling methods and terminology need to be standardized for this body of research. Sharing of data among tribes, museums, and universities is possible, perhaps through the establishment of a nationally shared database, but only if data can be compared. Research is also needed to ascertain if results from one method can be compared to that of another (for example, can swab tests be related to filter wipes?). Surface sampling methods must be validated that have

maximum sensitivity for positive/negative disclosure determinations, and are affordable so that multiple samples can be made on each object. The wording of reports and disclosure statements must be both ethically and legally acceptable, and developed in concert with the recipient tribe and their local public health professional tasked with community risk assessment.

2. What is known about environmental background levels of naturally-occurring elements such as arsenic and mercury? These can vary depending on the geographical area from which the raw materials were gathered. For example, arsenic is frequently found in plants, including tobacco, often as a result of agricultural pesticide treatment. A literature review conducted by the Agency for Toxic Substances and Disease Registry (ATSDR 1998) notes that concentrations in plants may vary from zero to five parts per million, reflecting a wide variety of soil histories. How does this factor in the interpretation of sampling data from pipe interiors that had been smoked with tobacco or sweet grass prior to being part of the museum collection? This may be important in discussing what is known about exposures to low-level natural sources with the Native American community.

3. What is known about the chemical changes a treated material may go through over time and are any byproducts of a different or altogether new hazard potential? (For example, are DDT isomer breakdown products of toxicological importance?) Related concerns have been raised regarding the creation of microclimates in sealed storage cases which may contain accumulated chemical vapors and gases resulting from natural organic product degradation and/or treatment chemical releases. While this may not be applicable to the majority of tribal use exposure scenarios, it may be of health significance to collections-care staff in both museums and tribal cultural resource centers.

4. Is it possible to establish any meaningful basis of comparison between objects tested, particularly if the amount of surface available for testing is limited, and the original method of application was not uniform? Although surface concentrations cannot be directly related to inhalation hazard, they can be associated, in some cases, with harmful dermal absorption and ingestion rates. Therefore, can risk assessment methodologies be applied to the establishment of consensus standards for acceptable levels of pesticide residues?

Consider the following scenario: A Native American tribe has repatriated 100 objects, which spot-tested positive for arsenic and mercury. The objects include a mixture of clay pots, reed baskets, feathered headdresses, pipes with skins and feathers, and wooden masks. Skin absorption is not a major route of exposure for either metal, although facial perspiration inside a mask may enhance this effect. These are serious hazards, but what is the possible dose in terms of the reality of their end use? If the entire surface of each object could be sampled, would it be reasonable to assume a worst case ingestion or inhalation of that amount? Would it be statistically valid to collect a random sampling from similar object types and draw broad assumptions about the handling risk of this collection? Can a surface concentration limit be established prior to testing, based on the likelihood of acute exposure should someone ingest or inhale that amount within a certain time frame of handling or wear? (This theoretical process cannot in all practicality

be applied to chronic low-level exposures over time.) Or should the public health community redirect its resources to perfecting decontamination and remediation methods, as well as risk communication sessions to discuss personal protection while using objects suspected of contamination? Tribal communities may be interested in participating in a prospective study of the long-term effects of exposure. However, it could be argued that we have a moral imperative to offer these types of studies after ensuring that remediation measures (developed between the returning museum and the tribe) have been applied to the objects in question. The value of any prospective studies then becomes a measure of the effectiveness of controls, for use within both the museum and tribal communities in future repatriation efforts.

5. Collaborative studies, between museum or university risk health and safety departments, are necessary to pool resources and infrequent monitoring opportunities, and create a database suitable for generating a statistical valid exposure profile for collections-care tasks. Museums or other collection institutions that have a safety and health office should request repetitive monitoring sessions (not just a single, compliance-oriented survey) to truly understand the task exposure profile. Occupational exposure limits are not intended as community-based standards for the general population, and it is doubtful that correlations can be drawn between museum workers and tribal community members. However, when interpreted by a public health professional, exposure studies of collections handling by museum workforces might be useful as a first approximation of risks from comparable ceremonial handling.

6. Current occupational limits are not always appropriate to the population at risk in the museum/university/cultural resource setting. There appears to be justification for creating occupational exposure limits for this "industry." The chemicals in question will need to be identified after consideration of the toxicological basis for the existing limits.

7. Recommendations for collections-care health hazard control policies must also be developed, to include not only collections handling, but public programs, shipment declarations and incoming loan restrictions, labeling and general hazard awareness for visiting users of the collections. In the case of repatriated sacred objects, these policies are to respect the cultural and religious practices of the recipient tribe.

CONCLUSIONS

The collections-care workforce in museums, universities, and cultural institutions is potentially exposed to a myriad of health hazards, both in present applications and from residuals of past practices. Many acquired hazards are unknown to the user, as documentation of preservative treatments is often poor. Concern over health risks to museum workers, and to recipients of treated objects, such as those repatriated to Native American communities, has resulted in more recent literature detailing past chemical usage. However, rigorous occupational health studies are needed to fully characterize workplace exposures within this "industry." Institutions with in-house industrial hygiene resources should seek out these opportunities, such as in university academic collections and federal and state museums and park service sites, to add to the exposure database. Peer-review

collaboration is critical for the development of a useful database. The most immediate assistance that can be offered from the medical, toxicological, and epidemiological professions is consensus on how to interpret the results of objects testing in light of their intended use, and how best to communicate this data to the tribal communities. Tribes receiving many objects from different sources need to have results that can be compared. Most importantly, the toxicologists and public health officials with whom tribes will be consulting need to compare data in order to make rational statements as to potential risks. Critical to this process is the need for standardized assessment protocols that take into consideration the restrictions placed on traditional industrial hygiene sampling methods on sacred objects and reflect an appreciation of the cultural issues surrounding the object's intended use.

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RESOURCES

- Agency for Toxic Substances and Disease Registry; 888-42-ATSDR; (www.atsdr.cdc.gov)
American Conference of Governmental Industrial Hygienists. 1330 Kemper Meadow Drive, Cincinnati, OH 45240; 513-742-2020; (www.acgih.org)
Association of Occupational and Environmental Clinics; 1010 Vermont Ave., NW #513, Washington, DC 20005; 202-347-4976
National Institute for Occupational Safety and Health (NIOSH); 800-356-4647; (www.cdc.gov/niosh);
Contact for museum studies: Dr. G. Edward Burroughs.
Occupational Safety and Health Administration (OSHA); 200 Constitution Ave NW, Washington, DC 20210; 202-219-8148; (www.osha.gov)

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AMERICAN INDIAN CONCEPTS OF OBJECT USE

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Abstract.—Tribal communities, the museum field, and conservation professionals are faced with an urgent situation: sacred objects and objects of cultural patrimony eligible for return under the 1990 NAGPRA law have been found to be contaminated with pesticide residues. Standards for testing and possible removal of residues must be developed to reduce the physical harm these objects pose to tribal religious leaders and cultural practitioners. The manner in which tribes use repatriated objects can indicate how residues may come into contact with the human body or the environment. Equally important is understanding how tribes define use since this can assist in developing protocols for testing that are culturally relevant and mutually beneficial to the tribes and the museum and scientific community. A general description of use as understood by tribes encompasses three categories: Physical, Symbolic and Life Ending Use. These three categories of tribal use suggest parameters for handling that can inform the preservation communities and enable them to assess mitigation and handling guidelines for objects returning to tribal communities.

INTRODUCTION

The concept of use is critical to the discussion of pesticide residues on museum objects. Recent interactions between tribes and museums indicate that concepts of use must be re-examined in light of the potential health risks such objects pose to tribal communities seeking repatriation. This paper describes the different concepts of use that tribal cultural practitioners employ when interacting with a sacred or culturally significant object. American Indian concepts of use are based in cultural religious practice and are therefore not usually understood by museum professionals, conservators or scientists. A cursory understanding of how tribes conceptualize object use will enable the preservation community to assess mitigation and handling guidelines for objects returning to tribal communities.

BACKGROUND

It is necessary to review how objects in a museum are valued and cared for because it provides a significant contrast as to how a tribal community cares for and handles its sacred objects. Museums in general attribute greater value and significance to objects where specific use can be documented. For example, objects that have an association to historic events such as the Cherokee Trail of Tears or the Lewis and Clark Expedition may be deemed significant because their use documents and confirms an essential part of American history. Therefore, it is essential that museums preserve the object, in order to maintain its integrity. Object use then, in a museum, is restricted to preservation activity that allows for limited handling and viewing. Preservation and stabilization techniques are applied to reduce the risk of damage to the object due to exposure to heat, light, moisture or pests. The historic use of routine application of pesticides and other deterrents to museum collections served to emphasize the museum value of object preservation. While current museum practice seeks to limit any use of pesticides as a preservation tool, the legacy of chemical residue poses a risk to museum workers and tribal cultural practitioners reclaiming sacred objects and objects of cultural patrimony.

NAGPRA LEGISLATION

The passage of the Native American Graves Protection and Repatriation Act (NAGPRA) in 1990 challenged the museum definition of object use as tribes asserted claim to ancestral remains and cultural patrimony. NAGPRA required all museums that receive federal funding to repatriate human remains, sacred objects, and objects of cultural patrimony to tribes with whom they are culturally affiliated. For many Native American communities, the NAGPRA legislation is viewed as a mechanism to reclaim and strengthen tribal religious and cultural practices by allowing the return of culturally significant objects. Cultural use of a repatriated object is implied in the legislation. The law offers the following definition: *Sacred objects which shall mean specific ceremonial objects which are needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present day adherents.* The traditional religious practices referred to in the law vary from tribe to tribe and instances of use are diverse and complex. However, general patterns of object use are observable and can be loosely categorized into three different types.

TRIBAL CONCEPTS OF OBJECT USE

The simplified definitions proposed here—Physical Use, Symbolic Use, and Life Ending Use—are not conclusive; rather they serve to educate and inform those who are not familiar with tribal cultural practices. The definitions are informed by abstract constructs of religious worldview as experienced by American Indian tribal communities. For many American Indian people who are knowledgeable about their tribes' culture and religion, these definitions are intuitive, based on experiential and observed ceremonial practices. In this discussion, the word "use" is employed to indicate applied activity and may or may not imply that an object is connected to the activity. Also, it is implied that the object refers to objects that are sacred or culturally significant.

PHYSICAL, SYMBOLIC AND LIFE ENDING CATEGORIES OF USE

Physical Use occurs when practitioners physically come into contact with, or physically use the object. It must be emphasized that for many tribes, the actual use of a sacred or ceremonial object is not arbitrary. Generally, only traditional religious leaders or individuals with special knowledge are allowed to handle, touch or activate the object. This includes gender specific restrictions. The category of Physical Use suggests that the object comes into physical contact with an individual or group of people. The object may be worn as ceremonial apparel, either as a mask or head gear. It may be applied to the skin as a pigment or used to aid in ritual smudging or smoking. The object may be used as a container for other objects or for people. Physical Use occurs usually in tribal community settings but there have been instances of this type of use in museums, usually as part of a repatriation.

Symbolic Use occurs when a tribe enters into a partnership with a museum to have access to an object for the purpose of confirming artistic traditions or to use as a model for replication. This type of use is similar to those employed by researchers. The difference lies in the range of symbolic use and its ultimate application to the larger tribal community. No physical contact is assumed or required for Symbolic Use. This type of use does not usually involve those objects

subject to repatriation, but the physical presence of the object symbolically represents a connection to tribal ancestors and cultural legacies.

Life Ending Use occurs when practitioners engage in the act of ritually disposing of an object thereby nullifying and ending its sanctified attributes. Such use is based on the assumption that traditional religious leaders and cultural practitioners regard these objects as having been imbued with some kind of life energy, force or power. In order to complete the purpose for which they were created, these objects may be burned, or they may succumb to natural decay. In the museum field, the best known example of this kind of use applies to the Zuni War Gods. The Zuni sought to have these objects of cultural patrimony returned to the community to complete their purpose, which involved exposure to the elements (Roth 1991). For the Zuni, natural decay was the acceptable practice of care for these objects (Merrill et al. 1993).

CULTURAL RISK

Tribal religious leaders and cultural practitioners are not only subject to health risk when interacting with repatriated objects, but they are at cultural risk as well. Cultural risk occurs when individuals with special knowledge, acting on behalf of the larger tribal community, arbitrarily encounter the life forces or sources of power that reside in culturally sensitive objects and/or ancestral human remains, and funerary objects. Cultural risk is inherent when tribes interact with sacred objects in any of the three categories previously described. To reduce the risk of spiritual or cultural harm, tribal religious leaders and cultural practitioners may activate protective methods to ensure their safety. It should be noted that for some tribes these safety measures, steeped in tradition and religious practice, will be considered as a method of mitigation in addition to prescribed scientific methods.

CROSS CULTURAL COMMUNICATION AND COLLABORATION

It is advantageous for preservation specialists and scientists to understand how tribes regard and interact with a sacred object. Tribal concepts of use and their observed patterns may inform the processes of mitigation currently being evaluated. While scientific testing is based on empirical standards, and conclusive evidence of object contamination may direct tribal practitioners to continue or restrict a cultural practice, for many tribes the decision to restrict ceremonial use or ritually retire objects is not reached simply by ruling out the health hazards. For some tribes the objects themselves are considered living, breathing relatives and their relationship to the tribal community so profound that any decision regarding their fate must be carefully considered (Secakuku 2001). An increased awareness of tribal perspective may seem gratuitous, but it can inform the testing and analysis process especially when tribal practitioners are directly involved. For example, at the University of Arizona, in the case of the Hopi tribe's request to test and analyze contaminated sacred objects, it was necessary for religious leaders to confer on where the sample should be taken from the object. At a workshop on Contaminated Cultural Materials in Museum Collections held at the Arizona State Museum, University of Arizona, 16–18 March 2000, Kuwanwiswima and other tribal cultural practitioners described the conditions of object use without divulging any privileged information. Knowing the cultural context of object use provided clues as to how toxic residues might enter the body. As more tribes seek

testing of their objects, consultation as required under the NAGPRA legislation, will only enhance deliberations and may lead to cultural understanding. (Odegaard and Sadongei 2000).

SUMMARY

Pesticide residues on objects returning to tribes raise concern from a variety of communities due to the potential of human health risks. On the surface, this issue may be viewed as a strict scientific exercise to lessen the effects of pesticide residue on museum objects until the tribal perspective is considered. Under federal mandated law, entire communities of American Indian people are seeking to strengthen and reclaim their cultural and religious worldview by using sacred objects and objects of cultural patrimony that had previously been denied them. Consider the emotional distress of tribal religious leaders and cultural practitioners when they learn that their sacred objects may contain pesticide residue that may cause physical, spiritual and environmental harm to their communities as well as placing the continuance of their religious practice in jeopardy. As standards for testing and analysis are developed, it is important that the object's cultural context be considered, by direct consultation with tribal religious leaders and cultural practitioners. Due to the diversity among tribes it is unreasonable to suggest that testing procedures may be adapted and well suited to all tribes. Herein lies the greatest challenge to tribes, museums, and the preservation community. On a case-by-case basis, tribes acting within their own protocols must deliberate over the consequences of mitigation and how it might affect their traditional, religious and social structures. Museums and the preservation community must begin to be aware of tribal concepts of use. Communication with all affected parties is essential to accommodate the cultural concerns that these objects represent to tribes.

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METHODS TO MITIGATE RISKS FROM USE OF CONTAMINATED OBJECTS, INCLUDING METHODS TO DECONTAMINATE AFFECTED OBJECTS

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Abstract.—The contamination of museum objects by residual pesticide treatments presents legal and moral issues to individuals of museum professions and tribal communities. After a discussion of general remediation, this paper considers some of the risk mitigation techniques that may be applicable to cultural objects. These include the use of HEPA filtered vacuums, compressed air, washing, ultraviolet light, chemical alteration, freeze-drying, laser, and microbial detoxification.

INTRODUCTION

Since the discovery of pesticide contamination within the environment a great deal of knowledge and prediction has been applied to better understand the risks of exposure to humans and the ecosystem (Carson 1962). Today, scientific efforts and an expanded regulatory system attempt to balance the risks of pesticides with their benefits. Museum policies and procedures regarding the use of pesticides also have evolved over the last 20 years. However, within the large volume of literature devoted to museum pest management and pesticide treatment techniques for objects, there is little information regarding the reversal or detoxification of residues from these treatments. The concept of "returning objects to cultural use" has stimulated the need to consider risk mitigation techniques that are applicable to cultural objects in museum collections.

Efforts to remove or counteract pesticides are referred to as *remediation*, and efforts to diminish pesticides are referred to as *mitigation*. Because toxicity is based on the form of the toxin and the exposure, detoxification does not necessarily require complete removal of all pesticide residues present.

DISCUSSION

General remediation approaches for contaminated objects include the following examples:

- Replacement—removal of the entire object and replacing it with a duplicate, reproduction, or alternate object.
- Containment—application of covers or coatings that isolate the hazardous material on the object in question from human exposure.
- Washing—removal of contaminants by water, laundering, or solvent wiping.
- Physical removal—removal by the application of manual scraping, vacuum suction, or laser blast.
- Chemical removal—removal by the application of chemical processes or exposure to high heat or ultraviolet light.
- Biological removal—removal by the application of specialized microorganisms.

Several actions must precede any remediation effort involving pesticides on contaminated cultural objects. These include:

- Determination of probable pesticide presence through documentation or screening tests.
- Identification of chemicals through qualitative and quantitative analytical techniques.
- Assessment of the potential human health risk through toxicological studies.
- Coordination of a team of diverse specialists to consider/evaluate potential methods of decontamination as they relate to a range of issues including:
 - the category of cultural use (physical, symbolic, life ending);
 - risks of cultural object use (considering the potential for absorption, inhalation, ingestion or environmental contamination);
 - hazardous waste disposal regulations (procedures for handling, personal protective equipment, containers, transport, disposal);
 - any necessary equipment or supplies;
 - particular professional knowledge and skills required for the process; and
 - specialized cultural knowledge and skills required for the process.

Published information about pesticide mitigation is commonly associated with the environmental conditions in water and soil where treatments with temperature, ultraviolet light, and the use of complexation additives have been previously explored (Water Resources Abstracts Database 1967 to present). The clean-up procedures related to the manufacture, transport, application, and storage associated with pesticide products also are available (material safety data sheets or MSDS for specific pesticide products). Toxicity concerns for humans and animals have been identified as they relate to specific chemical quantities, types or forms, and modes of entry.

Unfortunately, studies involving the mitigation of pesticides from museum objects are rare and the actual detoxification (that is the removal of enough pesticide to render the quantity remaining as safe) of an American Indian cultural object has yet to be published. An examination of available literature revealed the following methods as possible approaches that are currently being considered.

HEPA Filtered Vacuum

The use of specialized high-efficiency particulate air (HEPA) or ultra-low penetration air (ULPA) filter vacuums for the removal of hazardous contaminants have been recommended for asbestos or lead abatement, liquid and granular mercury spills, and the collection of other hazardous residues. After DDT residue was confirmed (GC-mass spectrometry) in a storage room at the Australian Archives, a cleaning procedure involving Nilfisk GS80 HEPA-filtered vacuum was recommended by the Occupational Health Safety Unit of the Australian National University (Altree-Williams et al. 1993). The researchers conducted area monitoring after the vacuuming, found no DDT, and concluded that the vacuum cleaner filtration system was effective. In a separate instance at the Australian Archives, a white pesticide powder (sodium hexa-fluorosilicate) was tested and specialists from the Australian Government Analytical Laboratories suggested vacuuming to remove it from archived files as it was not considered a serious health risk (Caldwell 1995). Although HEPA-filtered vacuums do not redistribute toxic materials

into the air during cleaning, the National Park Service recommends the use of a respirator with HEPA-filter cartridge (Suits 1998). Lundbaek (1995) illustrates the use of respirators, special safety suits, and gloves during a vacuum removal of DDT. The measured effectiveness of HEPA filter vacuuming techniques in the detoxification of cultural objects by pesticides (so that they may be safe to return to cultural use) has not been reported.

Compressed Air

The cleaning efficiency of compressed air to remove pesticide crystals (PDB, naphthalene, DDT, and methoxychlor) was studied on 20 ethnographic objects at the Danish National Museum (Glastrup 2001). While identifying the method as practically usable, the results indicated that most of the pesticides tested remained in the objects. While the use of a fume cupboard is mentioned, Glastrup does not discuss in depth the capture and retention of pesticides by filters or the inherent safety of blowing pesticide dusts and crystals.

Washing

Tests to remove pesticides from contaminated clothing using laundering techniques have indicated that the use of pre-rinsing, hot water (preferably 60°C or 140°F), heavy-duty detergent, and line drying were partially effective on removal of some pesticide residues (Laughlin and Gold 1996). They also suggest that storage in moving air may maximize evaporative dissipation if the pesticide contaminants are known to be volatile, but they warn that no tests have been done on leather or rubber-based clothing.

Aqueous cleaning products that are designed to remove persistent pesticide residues from fruits and vegetables have reported an overall reduction of the pesticide Endosulfan by 94 percent (Mom's Veggiewash 2000). The use of these liquids requires thorough rinsing. Their use on cultural objects has not been reported.

Wiping with solvents has also been recommended (Caldwell 1995). Following a thorough vacuuming, acetone in a lightly soaked cloth was used to dissolve and capture or disperse trace quantities of residual DDT that may have remained on the surfaces of the volumes and the room at the Australian Archives (Altree-Williams 2001).

Ultraviolet Light

Many organic compounds found in pesticides are sensitive to ultraviolet light resulting in a diminished toxic persistence on objects. Findings reported by O'Rourke (2000) indicate that organophosphates and carbamate-based pesticide residues (on the clothing of agricultural workers) underwent degradation and detoxification with outdoor exposure to the sun. Asmus (2001) discusses the experimental use of pulsed UV light to remove Malathion from surfaces. The application of UV light exposure to cultural objects from museum collections has not been reported.

Chemical Alteration

References to chemical hydrolysis, complexation, and physical interactions that work on degradation of pesticide compounds are common in the literature related

to mitigation of pesticides in the environment. Hawks and Bell (1999) have studied the use of a water-based oxidizing agent to remove mercuric chloride stains on herbarium sheets. They indicate that while the process successfully removed the stains, it is unlikely that all pesticide residues were actually removed or permanently altered.

Freeze-drying

Researchers (Zabik and Dugan 1971) tested the potential of freeze-drying to remove pesticide residues from hen eggs. Several organo-chlorine pesticides (Lindane, Dieldrin, DDT and DDT-DDD) were tested. Factors such as vapor pressure of the pesticide and the amount of pesticide contamination affected the success of the technique. Though freeze-drying has long been used in conservation, there are no reports of its use to decontaminate cultural objects. The complex stresses that the technique imposes on a sample, the variability of materials found in cultural objects of multiple components, and the range of pesticide possibilities, make it a difficult solution.

Laser

Scientists at Los Alamos National Laboratory have used lasers to detect pesticides in air and other contaminants in soils and on materials (Multari and Cremer 2000). Adapting laser divestment/cleaning techniques to remove pesticide residues on cultural objects is under consideration by investigators at the Institute of Pure and Applied Physical Sciences at University of California, San Diego (Asmus 2001). However, conservators (Abraham 1999) caution that there is little evidence regarding the long-term effects of laser treatments, or the secondary effects caused by localized heating and light irradiation.

Microbial Detoxification

Metal-resistant bacteria are a group of microorganisms that are resistant to the toxic effects of a variety of metals. They have been successfully used to detoxify and remove metals from contaminated soils and water in the environment (Roane and Pepper 2000). Roane (2000, 2001) is currently studying the potential use of non-pathogenic metal resistant bacteria to remove persistent metal-based pesticides (mercury and arsenic) that have contaminated cultural objects. Using volatilization as a mechanism, objects undergoing treatment are contained and the appropriate microorganisms are introduced and later removed. The study also is pursuing the use of biological indicators to identify the presence of metal (toxins) on artifacts.

SUMMARY

The mitigation of pesticide contamination on cultural objects in museum collections presents a difficult problem. While it is clear that there are possibilities for physically detoxifying artifacts, this brief discussion merely indicates the types of techniques that have been considered. Knowledge based on successfully testing mitigation techniques on American Indian cultural objects has not been reported. Many of the assumptions regarding applicability of these techniques to cultural objects that are undergoing repatriation for the purpose of "returning to use" in traditional religious practice are questionable. Some of these suggested techniques

deserve further consideration and testing by museum professionals and tribal communities. However, there remains a great need to continue to formulate and adapt new techniques that will improve the situation.

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A REVIEW OF METHODS TO MITIGATE THE RISKS FROM USE OF CONTAMINATED OBJECTS

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Abstract.—To assure the preservation of cultural materials, past museum collecting and storage practices included the use of pesticides as a deterrent and eradication agent. Pesticide residues present on museum collections are a possible health risk. Within the museum setting, guidelines for the safe handling and record keeping of pesticide contaminated collections have been incorporated into standard collections management practices. Many museums, including some tribal museums, address the issue of pesticide contamination of collections with similar care practices. The bigger question of how standard collections management practices can collide with cultural guidelines and preferences is addressed as a basis for understanding the impact of museum methodologies on Native sensibilities in a summary statement by NMAI Collections Management Museum Specialist, Terry Snowball.

INTRODUCTION

Pesticide residues on museum collections pose a health risk to those who handle or work around them. Current removal methodology cannot guarantee 100% detoxification of pesticide contaminated cultural materials. However, museums and tribal communities will continue to access and use collections that are in their care, and therefore recommendations for handling, storing, and record keeping for these items are needed. This section summarizes suggested handling guidelines and records specific information from several museums, both native and non-native, for current handling, storage, and record keeping procedures of contaminated artifacts. These procedures are standard collections management processes in a museum setting and are presented as such.

Native cultural sensitivities and traditional community care practices can easily collide with these standards (Sadongei this volume). Many Native communities view objects as living entities. Therefore, freezing, plastic bags, anoxic treatments, and pesticide applications may be seen as endangering these living entities. Furthermore, isolation of contaminated collection objects may conflict with the need to have culturally associated objects together. Undoubtedly, the impact of pesticide contamination of museum collections is best dealt with by forming partnerships between museum staff and Native representatives to find appropriate and mutually acceptable solutions. The following is a summarized list.

DISCUSSION

Handling

Guidelines for safe handling of collections considered to be contaminated have been outlined by numerous authors (Davis et al. 2001, Hawks and Williams 1986, Johnson 1999, Lazar 2000, National Park Service 2000, Sirois and Taylor 1989, Spencer et al. 2000).

- Unless confirmed as safe, assume all collections have been treated with pesticides sometime in their past. This approach is not meant to cause alarm,

but rather to be considered precautionary for safeguarding all those who handle or use collections.

- Any collection materials known to be contaminated should not be used for hands-on interpretation in the museum, especially by children, persons with weakened immune systems, pregnant women, or the elderly, because they are considered to be more susceptible to arsenic, mercury, lead and other toxins. Individuals with diseases of the skin, blood, hair, liver, kidney or central nervous system should avoid any risk of exposure to arsenic.
- Enclose exhibited specimens inside display cases to keep particulate residues from dispersal into the air.
- Do not eat, drink, or smoke in the storerooms or around collections.
- Do not handle contaminated collections with bare hands. Handle specimens by their mounts, trays or other supports as much as possible.
- Use nitrile rubber gloves and discard them appropriately after use. Do not use cotton gloves as they absorb the contaminants that you are trying to provide a barrier against.
- Keep hands away from face where inhalation, ingestion, or absorption of particulate residues are possible.
- Wash hands and exposed skin after handling specimens, before eating, smoking, or applying cosmetics.
- Wear protective clothing such as a lab coat and launder it separately from other fabrics.
- Wear a fit-tested respirator equipped with a high efficiency particulate air (HEPA) filter. As an alternative, a dust particle mask will work as a barrier against airborne particles, but not fumes. Before wearing any respirator (defined as any close fitting face mask), it is important to have a medical evaluation and a fit-test.
- Work in a well ventilated area; clean work surfaces after use with a HEPA vacuum.
- Give a clear, written set of instructions for handling contaminated materials to all staff and researchers to read.

Storage and Record Keeping

- Clearly label museum storage cabinets housing collections known to be contaminated.
- Keep written records of individual collection objects that are tested for contaminants with accession and collection information, such as repatriation and conservation treatment reports. Data should include the date of the test and its results, what procedure was followed, who conducted the test, and conclusions drawn from the sampling method and results.
- Use identifying labels and sealed plastic bags to isolate contaminated objects and prevent dispersal of residues and fumes. Ideally, store contaminated materials in separate areas to lessen the risk of contaminating other items in the collection. Actions taken should be relative to the level of contamination. For instance, if the materials are highly contaminated or if levels of contamination are lower than short-term exposure limits (STEL), different decisions might be made.

- Consult with a professional conservator, chemist, industrial hygienist, and toxicologist to implement a holistic plan for your collections.

Specific Museum Approaches

Several museums shared information regarding their current approaches and decision processes when dealing with contaminated collections.

At the Field Museum of Natural History in Chicago, a pesticide identification program has been instigated. Arsenic testing was performed on randomly selected organic materials in the anthropology collections storerooms. Whenever test results were positive, every object made from organic materials in that specific locale was tested. A database was established so that all test records were available in electronic form. This database was linked with the main anthropology database so that anyone with access to it could find out if a specific object had been tested. Hard copy files were maintained by the conservation office. Objects found to contain arsenic were sealed in plastic bags and clearly labeled. A copy of the label was put inside the bag with the object. Bagged objects were left with their culturally affiliated material as requested by the curatorial staff. Testing still needed to be done to ascertain whether arsenic dust migrated to adjacent surfaces. It was hoped that in the future, bagged objects would be HEPA vacuumed to reduce arsenic dust on the objects (Sease 2001).

Harvard University's Peabody Museum in Cambridge, Massachusetts, also has made use of a database to track 'poisoned' objects. Any object found in storage during routine work with a 'poison tag' physically attached to it is recorded in the database. Objects from early accessions, a group highly likely to have been treated with pesticides, are being containerized with archival corrugated paperboard trays and interleaving tissue. There has been no use of polyethylene containers in response to tribal groups that do not want their objects in plastic. For example, "the three Hopi friends that were analyzed with the Hopi tribal approval are each held in a shallow paperboard tray with a tissue paper covering, and stored on a shelf with other Hopi cultural material" (Holdcraft 2001).

Staff and researchers at the Science Museum of Minnesota in St. Paul, are instructed to wear gloves and wash their hands after handling collection objects. Everything in the collection is assumed to have had pesticides used on it at some time. Visitors for repatriation research are requested to use protective gloves and are told about the pesticide history of the collections. The Museum's education programming involves handling of natural science collections; however, taxidermy, study skins, and entomology specimens are not handled by youth program participants due to the amount of pesticide residues on these collections (Anderson 2001).

Smithsonian's National Museum of Natural History (NMNH) Anthropology Department, Washington, DC, conducted and published research on its pesticide history in 1996 (Goldberg 1996). This historical account of pest eradication techniques serves as a model for other institutions. Handling recommendations are in line with those previously listed. Currently, pesticide contaminated collection objects are not isolated (Hansen 2001).

Arizona State Museum (ASM), University of Arizona, Tucson, has conducted a thorough study of its pesticide history. Results of this study were made available at the NAGPRA funded workshop, "Contaminated Cultural Materials in Museum

Collections,” that took place in March 2000. A handout of “Guidelines for Handling Contaminated Museum Collections” was produced by ASM for the workshop.

Any potential problem object is bagged and labeled to reflect that it is poisoned. Four examples of isolated objects that illustrate the breadth of the issue are:

- 1) taxidermy buffalo, treated with arsenic, was moved away from a barricade in 1984 so that children could not touch it. The buffalo will be placed on extended loan and will be enclosed in a sealed case;
- 2) some South American feathered items are bagged and sit in trays with labels that identify them as poisoned;
- 3) some poisoned arrows are bagged and labeled;
- 4) two cans (old, tinned, sheet-metal cans), one contained food, and the second contained sheep dip; both when emptied blew up from biological or chemical activity of the material in the cans. Full canned containers kept in collections have the potential to leak and harbor toxic, biologically active substances. Canned containers are best stored empty (Odegaard 2001).

Smithsonian’s National Museum of the American Indian is in the process of moving its collections from an old storage facility in the Bronx, New York to a new collections storage site in Suitland, Maryland. During this process, wipe tests and air monitoring for concentrations of arsenic, mercury, and lead are performed on shelving surfaces, windowsills, and floors. The results indicate that all of the tests conducted “failed to reveal concentrations that exceeded current occupational exposure limits.” Currently, the only collection objects tested are those being repatriated. Therefore, storage for any contaminated collection objects has yet to be addressed. Staff follows safety precautions by wearing gloves and lab coats. Collection objects in the Bronx are routinely vacuumed with a HEPA filter fitted vacuum prior to moving them (Kaplan 2001).

Staff at the Hoopa Tribal Museum in Northern California have had to address what to do with contaminated repatriated materials. They take safety precautions by using gloves and protective clothing. Contaminated materials are stored in black plastic garbage bags, placed in a cardboard box located in a storage area inside the museum. When examining these items, the bags are opened in a hallway outside the museum to protect staff, visitors, and other collection materials from possible exposure. The example of a tribal museum is interesting because it brings into consideration the museum setting in contrast with tribal sensitivities. In this specific situation at Hoopa, they use standard collections management practices regarding isolation of contaminated materials.

From his presentation at the San Francisco State University, Contamination of Museum Materials Conference, October 2000, Mr. David Hostler, Director of the Hoopa Tribal Museum, said that, “he now has mixed feelings about repatriations. He said two years ago he contacted the Peabody Museum at Harvard for a copy of their inventory. He said when he got there he was unaware of contamination and was told to wear gloves and a mask. He said he didn’t know how to react. Mr. Hostler found each room secured with locks and when the doors were opened he could smell odors. He said he also found some artifacts were not being stored according to Hoopa religious practices, and he did re-store them properly for the

Peabody staff. . . Mr. Hostler said the Peabody museum was unfamiliar with the tribe's beliefs" (Spencer et al. 2000).

SUMMARY

The successful blending of tribal sensitivities in a non-tribal museum setting involves collaboration with tribal representatives (Sadongei this volume). The repatriation process and tribal visits to the museum allow for this. If physical isolation of contaminated objects is required, storage and handling solutions are best done in partnership with the tribal representatives. What, if any, are the types of cultural considerations that should be incorporated into collections care by non-tribal museums? What is the cultural risk involved for tribal communities? How much adaptation is possible to bridge the needs of the tribal communities within a non-tribal museum setting? Are current practices by non-tribal museums sufficient? Terry Snowball (Ho-Chunk Tribe of Wisconsin), NMAI Collections Management Museum Specialist, explains it this way:

"The tribal perspective offers that there be a domain for the acknowledgement of all things in this world, and it is with this sentiment that all things be respected. The institutional perspective gives respectful acknowledgement to what is either intellectually or scientifically derived, which in turn establishes the bounds of what contexts can be applied. The challenge for both is to understand and respect the other's perspective.

"In light of this reality, discourse should be given with respect to both the physical and metaphysical states of an object, which may provide some alignment in understanding the pertinent sensitivities that are present with an object's being as well as its importance to a community or people. The possession of these objects by a museum has established what state these objects are currently in because of institutional considerations, and those considerations are the issue of what is currently within the ethical bounds of a museum's responsibility.

"The repatriation of contaminated objects has in effect either severed those responsibilities and/or placed tribes in the uncomfortable position of finding resolution to the problem for themselves. Evaluating the treatment history of a collection can possibly affect some resolve as to the profiling, testing, and possible eradication of an object. Understanding the different tribal perspectives that embody the meaning of certain objects will nurture the relationship an institution has with a community and possibly help define its treatment and care of said object whether it is repatriated or remains in a collection."

All of the non-tribal museum accounts follow the same basic guidelines: 1) wear protective personal equipment, and 2) contain and clearly label contaminated materials. Because the successful removal of 100 percent of pesticides is not possible at present, museum staff should work in partnership with tribes to make handling guidelines better reflect cultural sensitivities. Tribes and museums are at this intersection now and ready to move ahead.

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General.—It is strongly recommended that, before submitting a paper, the author ask qualified persons to appraise it. The author should submit **four copies** of the manuscript printed with a letter-quality printer. **All parts of the manuscript must be double-spaced** on 8½ × 11 in. (21.6 × 27.9 cm) or A4 paper with at least one-inch (2.5-cm) margins on all sides. Each page of the manuscript should be numbered. Do not hyphenate words at the right-hand margin. Each table and figure should be on a separate page. The ratio of tables plus figures to text pages should generally not exceed 1:2.

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Jones, E.M. and R.D. Owen. 1987. Fluid preservation of specimens. Pp. 51–64 in *Mammal Collection Management* (H.H. Genoways, C. Jones, and O.L. Rossolimo, eds.). Texas Tech University Press, Lubbock, Texas. 219 pp.

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(Special Proceedings Volume)

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