Preface

Vision for This Book

The vision to create this book was conceived a decade ago. In Carlsbad, New Mexico, at the 1993 National Cave Management Symposium, Jim Werker and Jerry Trout presented papers on speleothem repair. A caver from the audience stood up and stated:

_You two guys should put together a book on formation repair._

Trout and Werker glanced at each other and shrugged. But the idea kept nudging them and the two guys kept talking. They took the bait and started to think about organizing a manual on formation repair. While composing a list of repair subjects, it grew apparent that cave restoration techniques should also be addressed. The topic list doubled.

Both Trout and Werker spend a good deal of their lives outdoors—they both prefer being in caves rather than sitting at a computer wrestling with a book. So they decided to cajole other cavers into the joy of writing many sections for the book. Their hope was to speed up the project.

While the concept of a simple book on speleothem repair was growing into a labyrinth with a life of its own, real life events were moving along for both Trout and Werker. Jerry moved from New Mexico to Arizona and was named the USDA Forest Service National Cave Coordinator.

Back in New Mexico, Jim and Val found each other in a cave, started working together on restoration, repair, and photomonitoring, eventually fell in love, and tied the knot. After they married, Jim and Val launched the daunting task of editing a multi-author technical book.

Content Doubled Again

Meanwhile, fresh, new ideas were churning for the book. Naturally, a how-to book on restoration and repair should include strategies for intervention and ways to prevent damage. The content doubled again, and cave scientists from various disciplines came aboard.

While chapters were growing in the wombs of cavers’ computers, more surprises were in store. The authors obviously wanted to present state-of-the-art philosophy and methods, but new research was exploding with new speleological data. The new information led to improvements in restoration techniques and current best practices had to be redefined for many of the topics.

During the editing process, we realized that many chapters were skirting around the edges of important conservation concerns. In the speleological community it is often counterproductive to profess definitive recommendations about cave practices, even when the stated objective is to define current best practice.

All the authors for this book are cavers—each is intently aware that few absolutes exist when it comes to cave management practices. The only absolute fact is that no two caves are alike. Cave characteristics and contents vary tremendously. Likewise, conservation concerns and techniques vary widely.
Caves differ in their genesis, fragility, and impact management needs. Conservation and restoration tasks must be planned and executed in accordance with the unique values of each cave.

Caves, karst, and psuedokarst form through an intriguing variety of geologic processes. Caves differ in their genesis, fragility, and impact management needs.

In some cave and karst systems, water frequently flows and rejuvenates passages. In other caves, water occasionally flows and promises only slight potential of erasing human impact. And in caves located beneath arid surface terrain, water rarely flows, leaving passages and speleothems dry, fragile, and easily damaged. Adjacent caves can house extremely different resources. Each cave should be managed according to its own unique characteristics.

It follows that restoration tasks must be planned and executed in accordance with the unique values of any given cave. Footprints, trails, and conservation decisions depend on the nature of each cave. The inherent diversity makes the tasks of cave conservation, restoration, and repair ever changing and always challenging.

The team of NSS authors, reviewers, and editors present the speleological community with the best of what we know at this time. Be assured, recommendations will change. New scientific information will lead to new conclusions. Best practices will evolve. In this book we hope cavers will find useful state-of-the-art information, but not the last word in cave restoration.

We present what we know today as the current best practices. We encourage all to keep exploring new passages and improving techniques through new layers of research and experience. We urge implementation of better methods as new information comes to light.
About This Book

In Walt Kelly’s 1971 Earth Day cartoon Pogo proclaimed:

We have met the enemy and he is us.

The enemy is us. Humans are the nemeses of cave systems. Pogo’s insight aptly serves our subsurface world of caves and cavers and introduces the ubiquitous message of this book.

Cave conservation is a lot like treating a dreaded chronic disease. With human affliction, once you recognize that you have a constant or recurring condition, you have the obvious opportunity to make necessary changes and take really good care of yourself.

Cave conservation is similar. In the rich archival darkness of cave and karst systems, human presence creates the malady of negative impact. Once we recognize the symptoms, we have the manifest opportunity to make changes, influence ethics, and take really good care of our Under Earth. This book is about realizing those opportunities—it is about taking care of caves and the resources within.

Although mainly a how-to manual on cave restoration and repair, this volume is also about becoming more conscious of the impacts that create needs for conservation actions. Caves do fine when left on their own to follow nature’s intended path. But interference from people can produce irreparable alterations in cave systems.

Harm is certainly caused by detrimental behaviors from individuals who visit the underground, but damage is also incited by municipal, industrial, and agricultural enterprises on the surface. The intent of this manual is to help all become more mindful of conditions that call for human conservation intervention and resource management.

For every decision related to a cave, the foremost concern should be the perpetuation of speleological processes, values, and resources. As cavers, cave managers, landowners, project leaders, and speleologists, what factors should we consider when making decisions about cave systems? Crafted to explore questions and formatted to use as a field manual, this book describes the current best practices in cave conservation and management. Information is presented in easy-to-identify sections.

Representatives from various scientific disciplines within speleology explain their conservation and preservation concerns. Tools and proven methods are presented for cave restoration and speleothem repair. Encouraging low-impact ethics, this book covers techniques that any caver can use in protecting, understanding, restoring, and conserving cave environments.

The further intent of this book is to encourage all to focus beyond individual areas of interest and expertise—to become more mindful of the often overlooked, intricately interrelated aspects of ecological balance and resource values in cave systems. Increased awareness of subterranean values may bring us to deeper stewardship of Earth’s balances. Understanding the mysteries of the subsurface may also help us reach beyond in responsibly exploring the secrets of extraterrestrial realms.

Ultimately, if we can avoid unnecessary impacts to caves—if we can move safely and softly—we will minimize the need for restoration.

Caves do fine when left on their own to follow nature’s intended path. But interference from people can produce irreparable alterations in cave systems.

Mainly a how-to manual on cave restoration and repair, this volume is also about becoming more conscious of the impacts that create needs for conservation actions.
How to Use This Book

Sections in this volume focus on techniques for accomplishing cave conservation, restoration, speleothem repair, and minimum-impact ethics. We expect this publication to be used as a manual or handbook—it will be hauled in packs, tossed in backseats, and found on library shelves.

Cave Conservation and Restoration is divided into four parts with contributions from more than 40 authors. The introductory material is followed by three major parts divided into chapters. Easily located headings and subheadings, cross-references, and the index are designed to guide readers to desired information.

Cross-references throughout the text refer readers to other chapters where concepts and techniques are more thoroughly explained. In addition to black-and-white photos and illustrations within the chapters, selected photos are in a full-color insert. These photos are also cross-referenced.

Units of measure are written in both metric and English throughout this volume. Because construction materials are sold in English units in the United States, dimensions for construction materials deviate from the standard metric/English format used elsewhere in this book.

Contributions were critiqued and revised through peer review processes. A team of style and copy editors performed final reviews. Coordinating the effort, Jim and Val reviewed and edited all submissions.

In composing a manual of this nature, redundancy factors into the equation. Because we expect most readers will browse to find subjects for the moment, some repetitious material intentionally remains. To those who read straight through, we ask your tolerance for the redundancy inherent to our subject matter.

The editors, contributing authors, and reviewers offer this handbook to the caves, cavers, and speleologists of the world. We hope all of you will find helpful information in this volume.

- Cavers, cave managers, and cave owners
- Commercial cave personnel
- People involved in cave restoration projects
- Cavers interested in formation repair
- Government land managers
- Natural resource personnel
- International environmental conservation community
- Libraries in areas with cave interests
- University libraries
- NSS internal organizations, such as regions, grottos, conservancies, and task forces
- Speleological organizations in other countries
Acknowledgements

We gratefully acknowledge the support and funding of the National Speleological Society, Inc. in publishing this volume, and the National Institute of Cave and Karst Research for providing additional funding to support the full-color inserts.

We extend deep gratitude to the many authors, photographers, illustrators, reviewers, and graphic artists who participated in this publication. Each task and each stage leading to publication was accomplished through their volunteer efforts.

We extend our thanks to long-time cave conservation leaders in the National Speleological Society (NSS)—Albert A. Krause, George N. Huppert, Robert R. Stitt, and John M. Wilson—from the beginning, each individually took the time to encourage the continuation of our conservation efforts.

David H. Jagnow served as the NSS Conservation Division Chief and NSS Conservation Chairman from 1996 to 2001, and we extend gratitude to him for initiating our first proposals to publish this book through the NSS. Without Dave's support of this work and commitment to the NSS, this publication might have never been.

We gratefully acknowledge the commitment of NSS Executive Committee Members who served during the time we were composing and editing this manual. With their continuing support, this publication came to fruition. The NSS Conservation Division works most closely with the NSS Administrative Vice President (AVP). We thank Steve Ormeroid, Tom Lera, Thom Engel, Cheryl Jones, and Doug Medville who all served in the NSS AVP position during our work on this book—we appreciate the energy, honesty, and forthright character of each in supporting this cave conservation publication. The NSS Executive Vice President (EVP) is tasked with overseeing NSS publications—Gordon Birkhimer, Don Paquette, and Ray Keeler served in the EVP position while we were building this book—their continuing enthusiasm, support, and encouragement helped bring this publication to reality.

Also, we thank all the NSS Executive Officers and Board Members who supported this long-awaited publication with encouragement and budget commitment. Much thanks to NSS Presidents Bill Tozer, Scott Fee, Mike Hood, Fred Wefer, and President Pro Tem Hazel Medville for their leadership. Our thanks go to Tom Rea, Scott Fee, and Colin Gatlin, who served as NSS Operations Vice Presidents (OVP), for supporting and promoting NSS book publications and sales. We extend thanks to Paul and Lee Stevens for their decades of commitment to NSS resources and to David Irving and Ted Kayes for their continuing support.

Much gratitude goes to the NSS Special Publications Committee. We sincerely thank David and Janet McClurg for design, layout, and the tremendous work they contributed in the early stages of preparing this publication (and many NSS publications before this one). Through several decades of sincere commitment, David McClurg's continuing role in NSS publications has brought many important speleological books to press.

We extend deep gratitude to Tom Rea, current Chairman of the NSS Special
Publications Committee. We thank Tom for his timely responses to a myriad of pop-up questions along the way, for his forthright common sense, and for his persistence in seeing it through and making it right. Many thanks go to both Tom Rea and Gail McCoy for their consistent copy edits.

We extend sincere kudos and appreciation to Gus Frederick for his focused commitment of time, graphic energy, and design expertise. Gus completed the design, layout, and corrections, prepared the photos and the color insert section, reworked illustrations for digital layout and formatting, and coordinated the digital prepress for this publication.

We thank Bat Conservation International (BCI) for permitting the use of Merlin D. Tuttle’s photographs of bat species and other BCI photographs in this publication. We thank Jim Kennedy for facilitating our work and cooperation with BCI.

We extend much gratitude to Emily Davis and Michael Warner of Speleobooks for providing reference materials and making certain we had all the latest cave conservation publications at our fingertips.

To several friends, we extend especially deep appreciation. This publication reached completion because of their always-ready support, encouragement, time, expertise, and consultation. The following people deserve enormous thanks for their instant readiness at the other end of the phone or email.

We express especially big thanks to four writer friends who live in our charming, tiny town of Hillsboro, New Mexico. Through this book, they have become special contributors to speleological literature. We thank Harley G. Shaw for his thorough review of every chapter, his ruthless slashing of redundancy, and his rearrangements for improved organization. We thank Lydia Webster for her copyediting expertise and her amazing knack of coming up with quick fixes for awkward sentences. We thank Merideth A. Hildreth for her time, motivation, and perseverance in tediously comparing manuscripts, marking corrections, and persistently proofing chapters. We thank Patricia N. Woodruff for her eagle eye and care in proofreading the final formatted manuscript.

We appreciate Gus Frederick more-than-we-can-express for his successful rescue and marathon effort. We especially thank Gus for being a superb team player, a great guest in our home, and a persistent proponent of a get-it-done-right spirit. The caves thank you and we thank you for your time and devotion to making it all happen.

To Tom Rea we extend grateful appreciation for his unwavering support in this project—for quick replies, definitive action, and get-it-done commitment. Thank you for reviewing the manuscript and seeing this publication through the press process. Thank you for believing the NSS needs more books.

To our immediate family, relatives, and extended family of friends who shared their long-suffering support and enduring tolerance, we extend love and thank you. We especially thank Merideth for becoming our chief copy editor and bottle washer. Thank you for your Cuna Cueva Collaborative spirit in giving quiet, nourishing support and many weeks of work on this project.

To Billy and June Hoffman we give heartfelt gratitude for generously providing quiet days, warm hospitality, and supportive friendship during many important weeks in the stretches of completing this book.

To Jim “Crash” Kennedy, Ron Kerbo, and George Veni—who were always ready to answer questions, find references, and provide timely forthright reviews—we express deep gratitude.

We appreciate the support of friends at Carlsbad Caverns National Park. We thank Dale Pate, Stan Allison, Paula Bauer, Tom Bemis, Paul Burger, and Jason Richards for data and review.

To Penelope J. Boston we extend copious gratitude for graciously giving several weekends of tedious collaboration along with much phone time along the way to tweak sentences and concepts.
We extend big, warm thank yous to Diana E. Northup and Kenneth Ingham who shared their home, computers, and purring cats for many overnights, plus a grueling marathon weekend of laptops, keyboards, and edits at a critical stage during the development of this book. Many thanks to the marathon reviewers—Diana Northup, Kenneth Ingham, Dick Desjardens, Jill Desjardens, Mike Spilde, Penny Boston, and Ariel Boston.

We also extend sincere appreciation to Diana E. Northup for her untiring commitment in assuring the accuracy and completeness of references in this volume. She used the following resources to check most of the references in the chapters and sidebars:

- **Books:** OCLC Online Computer Library Center, Inc. produced the Worldcat database, which includes more than 52 million records for books, maps, proceedings, and other resources from more than 37,000 member libraries in the world. Information about conference proceedings was reformatted using data from the OCLC Worldcat in order to make it easier to find these references through interlibrary loan.

- **Journal articles:** References to articles were checked in the most appropriate subject database, including SciSearch, ArtIndex, BIOSIS, Georef.

In formatting the references and citations, we used a modified form of the reference style guide recommended by the Council of Biology Editors (CBE) in *Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers*, Sixth Edition, 1994, prepared by the Council of Biology Editors Style Manual Committee. Their sixth edition recommends both general and scientific publication style and formats for journals, books, and other types of publications. Minor reference style modifications deemed appropriate for this publication include italicized titles, complete journal titles instead of abbreviations, and Web addresses for some entries.

Rather than listing trademarks here, they are included throughout the text. While we have tried to include all registered (or applied for) trademarks, any omission of such marks from any product is regretted and is not intended as an infringement on such trademarks. Please contact us so we are sure to correct any omissions in future editions.
Not the Last Word—But a Call to the Future

The alternative to negative impact is no entry—no recreation, no science, no exploration, no survey, no maps, and no photographs.

As cavers, our goal should be balance—we want to limit detrimental consequences while we continue to visit caves. Underground environments can be protected and preserved if we learn to cave softly—and if we learn to minimize human impacts, both aboveground and below in the subterranean realm.

The authors, reviewers, and editors of this manual invite all cavers to explore ways to reduce or eliminate the need for cave and karst restoration. Albert Einstein summed it up with this admonition:

Problems cannot be solved at the same level of awareness that created them.

That’s the environmentally correct way of saying we can’t fix a mess at the same level of ignorance that allowed it to happen.

People do create impact in caves—but we can change habits, reduce impacts, and learn ways to mitigate cave damage.

For decades cavers promoted a follow-the-footsteps-of-others ethic. In the past, we would place our feet inside the original footprints of others to avoid causing new harm in pristine areas. More people are caving. Footprint pathways are expanding into multiple scars across cave floors. Out of necessity, ethics are changing.

Today, rather than retracing former impact, cavers are developing gentle ways to erase human damage. Minimum-impact etiquette is encouraging cavers to avoid creating new scars.

Even the traditional caver motto is changing—Take nothing but pictures. Leave nothing but footprints. Kill nothing but time. Many are now augmenting the axiom to reflect low-impact ethics.

Take nothing but conservation-wise photos.
Leave nothing but careful footprints on established trails.
Kill nothing but time.

Cave safely ... cave softly,
Val Hildreth-Werker and Jim C. Werker, 2006