CULTURAL RESOURCES DATA SYNTHESIS WITHIN THE COLORADO RIVER CORRIDOR, GRAND CANYON NATIONAL PARK AND GLEN CANYON NATIONAL RECREATION AREA, ARIZONA

Cooperative Agreement No. 1425-98-FC-40-22730
National Park Service Research and Collecting Permit No. 9808-21-001

Prepared for

GRAND CANYON MONITORING AND RESEARCH CENTER
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SWCA Project No. 2269-1383
SWCA Cultural Resources Report No. 98-85

March 10, 2000

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ABBREVIATIONS AND ACRONYMS USED IN THE REPORT

AGU	American Geophysical Union
AMP	Adaptive Management Program
AMWG	Glen Canyon Adaptive Management Work Group
ASM	Arizona State Museum
BOR	Bureau of Reclamation
CFS	Cubic feet per second
CRATT	(Hopi) Cultural Resources Advisory Task Team
EIS	Environmental Impact Statement
GAO	(U.S.) General Accounting Office
GCES	Glen Canyon Environmental Studies
GCMRC	Grand Canyon Research and Monitoring Center
GCPA	Grand Canyon Protection Act
GLCA	Glen Canyon National Recreation Area
GRCA	Grand Canyon National Park
HCPO	Hopi Cultural Preservation Office
HPP	Historic Preservation Plan
IO	Isolated Occurrence
NAU	Northern Arizona University
NHPA	National Historic Preservation Act
NPS	National Park Service
NRC	National Research Council
NRHP	National Register of Historic Places
PA	Programmatic Agreement
RCMP	River Corridor Monitoring Program
RFP	Request for Proposals
SHPO	State Historic Preservation Office/Officer
TCP	Traditional Cultural Property (Place)
TWG	Glen Canyon Technical Work Group
USDI	U.S. Department of the Interior
USGS	U.S. Geological Survey
WAPA	Western Area Power Administration
ZCP	Zuni Conservation Projects

ACKNOWLEDGMENTS

As is usual in an acknowledgments section, we have a fair number of people to thank for making this synthesis possible. First of all, without the unwavering cooperation of GRCA/NAU and GLCA RCMP staff, we would have very little data to present; specifically, the aid and knowledge of Lisa Leap, Nancy Andrews, Duane Hubbard, and Jen Kunde of GRCA and Tim Burchett and Chris Goetze of GLCA were invaluable in successfully acquiring the various forms of survey and monitoring data and answering never-ending questions related to the RCMP and the gathered data. Jan Balsom, GRCA Park Archaeologist, was also consulted on several occasions concerning the whereabouts of documents and to answer questions. Helen Fairley, Project Director for the corridor survey, and Chris Coder, a Crew Chief on the survey, were contacted to elicit information related to recording standards employed, and they both were helpful. Big thanks go out to all the tribal representatives who provided information and insight into the project. Chris Brod, contracted surveyor for GCMRC at the time, was instrumental in providing examples of the total station maps that have been generated for several of the corridor sites. Dan Spotskey, GRCA GIS guru, provided SWCA with a copy of his ArcInfo datafile of UTM coordinates for 485 points representing archaeological sites. Chris Brod also provided UTM files for his total station work, and Mike Yeatts of the Hopi Cultural Preservation Office gave SWCA a GPS file for work he had done at corridor sites. Signa Larralde of BOR supplied SWCA with PA meeting minutes that had accumulated over the years. Kate Thompson, Principal Investigator for the GCMRC-sponsored Geomorphic Model project, provided SWCA with progress reports on the geomorphology work, as well as personal insight into predicting impacts to sites based on geomorphic and vegetation data. Overall, a general thank you goes out to those who offered their data and opened their files for us to plunder and pillage, at least those files you wanted us to see! Special thanks go out to Ruth Lambert of GCMRC for her patience and administrative support for the project's duration. The GCMRC library also turned out to be a valuable source of tribal data.

Several in-house staff contributed significantly to the completion of this project and the accompanying document. Josh Edwards spent tireless hours at the copier copying and collating original documents on loan to SWCA from GRCA RCMP's Flagstaff office. Mark Cederholm worked diligently to complete a synthesized GIS database for the 478 archaeological sites located in the corridor, combining four databases to create a master database. Serena Roseke, editorial assistant, was instrumental in creating the four annotated bibliographies for the report, with assistance from Jean Ballagh and Lisa Kearsley. Serena and Laura James were primarily responsible for the production of the first draft report and did a great job under pressure. Aron Hauser and Lisa Kearsley produced all and drafted some of the fine graphics included in the draft reports, and John Douglass and Rebecca Seago produced these graphics for the final report. Jan Robinson was of major assistance, incorporating edits, formatting the document, and coordinating the report's final draft production, and Jean Ballagh, production manager, and Jenna Neves, editorial assistant, coordinated the production of the final report. Lynn Neal served as "guest" technical editor for the draft report, but gratefully passed the baton back to Jean, our real technical editor, for the final draft report. Lynn Neal and Dennis Gilpin were responsible for responding to the rounds of comments and making edits to the final document.

EXECUTIVE SUMMARY

Glen Canyon Environmental Studies (GCES) was established in 1982 to study the effects of the operation of Glen Canyon Dam on the environment of the Colorado River below the dam. From August 1990 through May 1991, archaeologists from Grand Canyon National Park (GRCA) (in cooperation with GCES) conducted an archaeological survey of both sides of the Colorado River from Glen Canyon Dam to Separation Canyon (255 miles), recording 475 archaeological sites (Fairley et al. 1994). Of these sites, the survey staff determined that 336 existed in locations that could potentially be adversely affected by changing water releases from the dam; 322 of these sites were further described as being potentially eligible to the National Register of Historic Places. Starting in fiscal year 1992, staff of the National Park Service's (NPS) River Corridor Monitoring Program (RCMP) (in cooperation with Northern Arizona University) began by monitoring the condition of the 322 eligible sites, and, with the help of geomorphologists, they have also refined the site impact categories initially identified by Fairley et al. (1994). Currently, 478 sites have been recorded, 317 of which are considered to be in the Area of Potential Effect of Glen Canyon Dam, 264 sites in the Grand Canyon and 53 in Glen Canyon. (At the time of this report, however, Glen Canyon was actively mitigating potential impacts to the sites in the river corridor under their management and planned to cease monitoring activities [Chris Goetze, personal communication, February 2000]). To date, approximately 87 sites have been placed on GRCA RCMP's inactive monitoring list for various reasons, leaving 177 sites that are actively monitored.

Concurrent with the archaeological studies, through the GCES process the Bureau of Reclamation involved seven Native American groups (the Havasupai Tribe, the Hopi Tribe, the Hualapai Nation, the Navajo Nation, the San Juan Southern Paiute Tribe, the Southern Paiute Consortium [including the Kaibab Paiute Tribe, and the Paiute Indian Tribe of Utah for the Shivwits Band], and the Pueblo of Zuni) in studies to identify places significant to these groups. In their 1994 Programmatic Agreement (PA), the signatories requested a synthesis and evaluation of the data produced by these various studies. The Grand Canyon Monitoring and Research Center's (GCMRC) Request for Proposals for the cultural resource data synthesis listed seven objectives: (1) synthesize existing NPS RCMP and tribal databases; (2) synthesize data on isolated occurrences; (3) synthesize information on cultural resource management activities conducted to date; (4) summarize and evaluate results of ancillary studies such as geomorphic studies, ethnobotany, and mapping; (5) summarize public information and education efforts; (6) evaluate available management data; and (7) synthesize the results of data recovery conducted to date.

SWCA, Inc., Environmental Consultants (SWCA), proposed to accomplish these objectives in a four-phase program of data collection, data analysis, report preparation, and archive transfer. In the first phase, SWCA acquired databases and reports from the National Park Service (GRCA and Glen Canyon National Recreation Area) and contacted tribal cultural resource management personnel to find out what information the tribes have and what restrictions they have placed on this information. SWCA also conducted our own archival research to retrieve available tribal-generated documents and information pertaining to corridor work conducted by the tribes. At the end of the first phase, SWCA produced and submitted for GCMRC review a preliminary annotated bibliography summarizing various databases and reports. In the second phase, SWCA produced cross-tabulations of data on the frequency of and schedule for monitoring at each site; remediation recommendations and efforts at each site; effectiveness of remediation; evaluations of data recovery results; types, date, cultural affiliation, and locations of isolated occurrences; and so forth. As part of the analysis, SWCA compared observations on the condition of a sample of repeatedly visited sites to test observer consistency. SWCA also tracked the success of remediation efforts in relation to site condition over time.

In the third phase, SWCA produced a draft report, final draft, and perfect-bound final report of their findings. SWCA has also presented three papers and a poster at professional meetings or symposia, and we hope to submit a professional paper for publication in an appropriate journal. In the fourth phase, SWCA will transfer to GCMRC all the data and metadata produced by the project, with the understanding that their information will be made available to all PA signatories, particularly the main land managing agency (NPS) and tribes. Dennis Gilpin and Lynn Neal were Co-Principal Investigators for the project, with Dr. Lilian Jonas, Jean Ballagh, Kate Thompson, Mark Cederholm, Rebecca Seago, and several production assistants of SWCA serving as professional support staff.

SWCA's research was designed to synthesize and summarize data generated mostly from 1992-1998 by both Bureau of Reclamation-funded NPS archaeologists and the tribes. The data was collected from 322 archaeological sites and a variety of other locations containing traditional cultural places and resource gathering areas during at least 930 monitoring and data collection sessions. SWCA set out to determine whether monitoring and data collection procedures were gathering the data needed to effectively evaluate the sites and impacts to them. In examining the NPS monitoring data, we found that in the Grand Canyon 94 sites were considered inactive while 66 had extensive impacts, equivalent to the "most disturbed" sites. For Glen Canyon, 15 of the monitored sites were inactive and 12 were in immediate need of remedial actions (most disturbed). (These numbers have since been updated in a site-by-site monitoring data synthesis prepared by Leap et al. [2000] using data through FY1999, but the overall numbers and percentages remain similar.)

The data collected by NPS and tribal monitoring personnel necessitated a shift in emphasis in the last several years from monitoring to the completion of preservation and data recovery efforts. Approximately 96 sites have received preservation treatment and 42 have undergone some form of data recovery, with 20 of these consisting of the retrieval of carbon samples for radiocarbon dating (Leap et al. 2000). By focusing monitoring efforts on a smaller number of sites, NPS staff have been relatively successful in differentiating between those sites that are most disturbed and those that have proven to be consistently inactive. With this change in emphasis from monitoring to carrying out management recommendations, what is now required before essential and unavoidable data recovery efforts continue is a corridor-specific Research Design using the collected corridor site data to guide any excavations.

In determining which sites are truly being eroded by the operation of Glen Canyon Dam, recently completed geomorphological research that has resulted in a vulnerability rating for drainage catchment areas containing archaeological resources will indicate in some cases which site impacts from terrace-based drainage systems are exacerbated by the dam's operation. Currently, GRCA RCMP monitoring data show that about 70 of the 264 monitored sites have river-based drainages and 70 have terrace-based drainages. Sites with river-based drainages are considered to be directly impacted by dam operations and those with terrace-based sites to be indirectly impacted. Six additional sites have side canyon–based drainages cutting them, and these drainages follow a drainage development pattern similar to that of river-based drainages, since the side canyons themselves are river-based drainage systems. Overall, 86% of the sites with river-based drainages are in fair to poor condition and 67% are actively eroding. Sites with terrace- and side canyon–based drainages are commonly in good to fair condition (with only four sites in poor condition and only one of these actively eroding), but 38% show signs of active erosion (Leap et al. 2000:xii). Fourteen of the 118 sites with undeveloped drainages are in poor condition; however, only one site of the 14 is physically eroding. Thirteen other sites are reported to be in poor condition because of visitor impacts. Therefore, 91 sites are considered to be in poor condition, and many of these are actively eroding due to physical and visitor impacts.

PREFACE

Dennis Gilpin and Lynn A. Neal

In addition to being one of the great scenic wonders of the world, the Grand Canyon of the Colorado is significant for its human history and its ongoing role in the lives and traditions of Native Americans of the Colorado Plateau. Archaeologists generally divide the nearly 12,000 years of human history in the American Southwest into four broad periods, all of which are represented at the Grand Canyon.

The earliest period, called the Paleoindian period by archaeologists, is generally accepted as lasting from at least about 11,500 to 8500 years before present (B.P.), or 9500-6500 B.C. During the Paleoindian period, small, highly nomadic bands of people hunted now-extinct Ice Age mammals, such as woolly mammoths and long-horned bison. Sites of these early hunters are extremely rare, and evidence for the presence of these people at Grand Canyon is limited to a single spear point of the Folsom style (Ahlstrom et al. 1993:69), which elsewhere was used to kill long-horned bison in the period from about 8800 to 8000 B.C.

The end of the Ice Age brought many environmental changes to the Southwest, including expansion of grasslands and woodlands at the expense of forests and the extinction of many of the large mammals that had been hunted by Paleoindians. For the next 5000 years (from about 6500 to 1500 B.C., the period called the Archaic by archaeologists), descendants of the Paleoindians practiced a relatively stable way of life based on hunting smaller game, such as deer, antelope, and rabbits, and gathering a wide range of wild plants. Hunters used a spear thrower (called an atlatl) to throw darts, and plant gatherers collected seeds that they ground on milling stones (stationary metates and hand-held manos). Sites left by these people typically consist of fire pits, fire-cracked rock, grinding stones, dart points and other flaked stone tools, waste flakes from making tools, animal bones, and charred plant remains. At Grand Canyon some Archaic campsites have been identified (Ahlstrom et al. 1993:69-72), but perhaps more enlightening are sites where the apparently rich intellectual and spiritual lives of the Archaic people are evident. In 10 caves where Archaic people found bones of an extinct Ice Age bighorn sheep, they left offerings of split-twig figurines (Emslie, Euler, and Mead 1987:Table1), twigs twisted into the shape of the animal. At least one well-known site (A:16:1, called Shaman's Gallery by archaeologists) contains their painted images of the spirit world on an overhanging cliff face (Schaafsma 1990).

Beginning about 2000 B.C. and continuing for almost 2500 years (to about A.D. 500), peoples of the Southwest began to experiment widely with maize agriculture while continuing to rely most heavily on hunting wild animals and gathering wild plants. The addition of cultivated foods, however, led by A.D. 500 to the adoption of pottery and the gradual shift to settled village life, characteristics of the Formative period (A.D. 500-1540). In the Grand Canyon, villages were very small. Illustrative of these small, dispersed villages are the scattered dwelling sites of the Walhalla Glades (North Rim), investigated by Schwartz, Kepp, and Chapman (1981). Among the sites they studied, peak population occurred about A.D. 1050-1100, when 64 sites containing 116 rooms were occupied; village aggregation may have been greater (but population was smaller) about A.D. 1100-1150, when only 20 sites with 67 rooms (18 at Sky Island [GC-215] and perhaps 10 at Walhalla Pueblo [GC-212]) were occupied (Schwartz, Kepp, and Chapman 1981:40, Table 5). Tusayan Ruin (GC-1, C:13:124), on the South Rim, consisted of eight rooms and two kivas and has been tree-ring dated between A.D. 1170 and 1205 (Haury 1931). Unkar Delta (C:13:1), occupied from about A.D. 900 to 1150, covers some 125 acres and contains 52 individual dwellings, agricultural features, and other features (Schwartz, Chapman, and Kepp 1980). Starting with two early pit houses, this site eventually grew to five or six surface units of two to seven rooms, two with kivas. Furnace Flats (C:13:10) contains at least 11 structures (including three pit houses, seven surface rooms, and one block of three or four rooms) and 40 other features (including cists, rubble piles, bins, retaining walls, fire pits, and wall alignments) (Fairley et al. 1994:226-227). Numerous granaries can be found on sites and tucked away in overhangs throughout the Canyon (Fairley et al. 1994:Table 3). The ancestral Puebloan dependence on agriculture is evident in the number of agricultural terraces identified, especially on the Walhalla Plateau (Schwartz, Kepp, and Chapman 1981) and at such sites as Tusayan Ruin (Haury 1931), Unkar Delta (Schwartz, Chapman, and Kepp 1980), and Furnace Flats (Fairley et al. 1994:226-227; Jones 1986). Occupation of most of the Canyon ended by A.D. 1150 (Schwartz, Kepp, and Chapman 1981:40), but some areas were occupied until the early1200s (Fairley et al. 1994:108; Haury 1931). Clearly, at least some of the people moved to Hopi, and the Hopi continue to make trips to the Canyon, especially to the Sipapu and the salt mines (Ferguson 1998).

The Pai and Paiute probably began moving into the Grand Canyon about A.D. 1300 (Bettinger and Baumhoff 1982; Euler 1958), introducing a subsistence strategy based on hunting, gathering, and agriculture, with dispersed settlement and heavier reliance on hunting and gathering than agriculture. With at least one rockshelter, five wickiup rings, 14 roasting features, one bedrock mortar, and numerous scatters of fire-cracked rock and artifacts, Granite Park (G:3:3, 26, 27, and 28) is the biggest riverside example of a Pai/Paiute habitation (Fairley et al. 1994:241-243). Most archaeologists and historians believe that Navajos began using the Grand Canyon in the 1800s (Euler 1974), although the Navajo Nation has argued for an earlier date (Begay and Roberts 1996).

Most archaeologists believe that the Zuni culture represents an amalgamation of several archaeological traditions, including the Cibolan and Mogollon. From the late prehistoric period to first contact with the Spaniards in 1541, the Zuni population coalesced from numerous towns in the upper Little Colorado River basin into six pueblos near the present-day Pueblo of Zuni, which became the sole Zuni town after the Pueblo Revolt of 1680 (Kintigh 1985). In historic times, the territory controlled exclusively by Zuni extended as far northwest as the San Francisco Peaks (Ferguson and Hart 1985). According to Zuni origin and migration narratives, the ultimate origin point of the Zuni was at a place called *Chimik'yana'kya dey'a*, also known as Ribbon Falls on Bright Angel Creek, a major tributary of the Colorado River, west of the mouth of the Little Colorado River in the Grand Canyon (Ferguson and Hart 1985:126). This location is regularly visited by members of the Galaxy Fraternity, and sands, clays, willows, and herbs are collected here (Ferguson and Hart 1985:126).

When the Coronado Expedition entered the Southwest in 1540, Coronado sent Lieutenant Garcia Lopez de Cardenas to Hopi and Grand Canyon (Winship 1904). As documented by written records, the historical period witnessed ongoing Native American use, the Navajo arrival, and Euroamerican exploration, mining, power production, and tourism, all of which are represented by archaeological sites along the Colorado River corridor (Coder 1994).

The significance of the cultural resources of the Grand Canyon is manifold. Archaic ritual activities are better known in the Grand Canyon than in most other places, but except for Euler's Stanton Cave excavations (Euler 1984), there is not much information on subsistence, territories, or trade with other Archaic peoples. Formative period use of the Grand Canyon can be seen as part of a Pueblo II period expansion that occurred across the Colorado Plateau, a signal events in Puebloan history, that is not understood in terms of causes and effects. People moved into many niches as single-family or extended-family units. Archaeologists still want to know if they were being forced into niches by population growth or if they were experimenting in a time of favorable climate for agriculture (as Schwartz seemed to document in his Grand Canyon studies). If Pueblo farmers were expanding into diverse niches in a time of favorable climate, archaeologists want to know if this led to population growth (which could be indicated by the large number of little sites, although these may actually represent seasonal or short occupations). And did population growth lead to the next stages in cultural evolution on the Colorado Plateau? The Chacoan system—with its multistoried "great houses" scattered across much of the Four Corners country and connected by roadways—arose in New Mexico to organize these scattered communities. The organization of Chacoan communities and the Chacoan system has been the focus of much archaeological research, but archaeologists are also interested in how the communities beyond Chaco (including those in the Grand Canyon) were organized. Given that communities must contain approximately 475 people for everyone to be able to find an unrelated marriage partner (Mahoney 1998), it is clear that the settlements in the Colorado River corridor, even taken all together, must have been part of a larger community. Estimates of the date, length of occupation, household and family structure, and trade relationships of each dwelling within the Colorado River corridor are needed to understand the role of these settlements in the larger Grand Canyon.

The Puebloan expansion was followed by aggregation, and the causes and mechanisms of this aggregation—especially the social arrangements that had to be developed to organize larger settlements—are currently an important topic of investigation for archaeologists. Did people who left the Grand Canyon (and other places that were abandoned in the late prehistoric period) move in with relatives or trading partners, or just throw themselves on the mercy of the people living at Hopi? Studies of the community organization and trade relationships of the Puebloan occupants of the Grand Canyon would help answer this question. At about the time the last Puebloan settlements in the Grand Canyon were being abandoned, the Pai and Paiute were starting to move into northern and western Arizona. Some of the earliest radiocarbon-dated Pai and Paiute sites in Arizona are those in the Grand Canyon. In contrast with the Puebloan cultural trajectory, in which increasing dependence on agriculture apparently led to colonization and ultimately abandonment of the Grand Canyon, the Pai and Paiute practiced a subsistence strategy less reliant on agriculture and apparently far more stable, since the Pai and Paiute use of the Grand Canyon lasted from circa A.D. 1300 into the twentieth century. Another key issue is the Kirchoff (1954) distinction between village dwellers and ranchería dwellers. Leone (1995) has recently argued that the overarching research goal of historical archaeology should be to understand the spread of capitalism and its effects on workers. Euroamerican sites within the Grand Canyon are of interest as examples of this process, particularly in the mining, tourism, and power industries.

Archaeologists typically think about the significance of archaeological sites in terms of research potential, but other groups of people may have other points of view. For example, tourists on river-rafting expeditions value the experience of seeing unexcavated archaeological sites and observing intact features and artifacts still scattered across the surface. Native Americans see such sites as markers left by their ancestors, providing evidence of the ancestors' passage and continuing presence. Thus, archaeological sites have much value left in place.

Glen Canyon Dam was completed in 1963, and by the late 1970s, river rafters, park managers, scientists, and others familiar with the Colorado River in Grand Canyon became alarmed at how erosion was rapidly destroying beaches along the river. Since many of the beaches contained archaeological sites or protected archaeological sites from erosion, the loss of the beaches was a concern to archaeologists as well.

In 1982 the Bureau of Reclamation (BOR) established the Glen Canyon Environmental Studies (GCES) Program to study the effects of the operation of Glen Canyon Dam on the resources of Grand Canyon (Wegner 1995). During Phase I of the GCES studies, from 1982 to 1988, 39 technical reports were completed on terrestrial biology, aquatic biology, sediment and hydrology, recreation, and dam operations (Wegner 1995). During Phase II, from 1988 to 1995, additional studies were completed to evaluate hypotheses generated during Phase I about how the corridor operates as an ecological system (Wegner 1995). During Phase II, GCES began cultural resource studies, including the archaeological survey of the river corridor by archaeologists from the National Park Service (NPS) and Northern Arizona University (NAU) and consultation with Native American groups about their concerns. Cooperating agencies in the GCES research included the U.S. Department of Energy, BOR, NPS, U.S. Fish and Wildlife Service, Arizona Department of Game and Fish, Bureau of Indian Affairs, Havasupai Tribe, Hopi Tribe, Hualapai Nation, Navajo Nation, San Juan Southern Paiute Tribe, Southern Paiute Consortium (two groups), and Pueblo of Zuni. (*Note*: Although the Havasupai Tribe has never endorsed or signed any cooperating documents or agreements, they have an open invitation to join the process at any time.)

The National Park Service began to express concerns about the effects of the dam after the flood of 1983. When Secretary of the Interior Manuel Lujan authorized BOR to prepare an Environmental Impact Statement (EIS) in 1989, it was realized that a complete inventory of cultural resources along the Colorado River corridor below the dam and within Glen and Grand canyons was needed. Until this time, it had not been widely recognized that cultural resources were abundant in the corridor (only 118 sites had been recorded), nor had it been realized that they might be adversely affected by the operation of Glen Canyon Dam. The inventory was completed by Grand Canyon National Park archaeologists in conjunction with personnel from NAU; they identified 475 sites and 489 isolated occurrences within 10,506 acres (Fairley et al. 1994:151).

In addition to archaeological sites, Native American groups recognize sites that are important in their traditional tribal histories. These sites, which National Register Bulletin 38 (Parker and King 1990) called *traditional cultural properties* (TCPs), are also given consideration under the National Historic Preservation Act, and during Phase II research, GCES invited the Havasupai Tribe, Hopi Tribe, Hualapai Nation, Navajo Nation, San Juan Southern Paiute Tribe, Southern Paiute Consortium, and Pueblo of Zuni to document cultural resources of importance to them, including TCPs. All of the tribes except the Havasupai Tribe agreed to do so, and later the San Juan Paiute Tribe became dormant in their efforts.

The next steps were to evaluate the resources, determine the effects of the operation of Glen Canyon Dam on the resources, and mitigate any adverse effects. Guided by the provisions of the 1992 Grand Canyon Protection Act and the 1995 Environmental Impact Statement and its related Record of Decision (ROD), NPS, BOR, the Arizona State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation, in consultation with Native American tribes, developed a Programmatic Agreement (PA) to fulfill BOR's responsibilities under Section 106 of the National Historic Preservation Act. The PA was signed in 1994 by representatives of the BOR, Advisory Council on Historic Preservation, Arizona State Historic Preservation Office, Western and Rocky Mountain regions of the NPS, Hopi Tribe, Hualapai Tribe, Navajo Nation, Kaibab Paiute Tribe, Paiute Indian Tribe of Utah for Shivwits Band, and Zuni Pueblo. The PA provides a mechanism by which the BOR can assess the effects of the operation of Glen Canyon Dam on National Register–eligible properties. The PA signatories were to develop a historic preservation plan prior to the issuance of the ROD or December 1994, whichever came first. In the interim, they developed and implemented a Monitoring and Remedial Action Plan (MRAP) that established the River Corridor Monitoring Program (RCMP), funded by BOR but run by NPS (Grand Canyon National Park and Glen Canyon National Recreation Area). Furthermore, they were to produce a five-year synthesis of their work, which has recently been accomplished as seven- and eight-year syntheses by this document and the site-by-site synthesis of monitoring data by GRCA RCMP staff (Leap et al. 2000), respectively. Most of the participants in the PA are stakeholders in the Adaptive Management Work Group (which includes the Grand Canyon Monitoring and Research Center [GCMRC] as technical support responsive to AMWG but not as an actual member).

Through the PA agreement, the RCMP was created to implement the stipulations of the PA and MRAP that are the responsibilities of NPS. The program is directed by a scope of work developed with BOR to meet the agency needs for the PA. The monitoring program officially began in 1992. Grand Canyon site monitors generally take four river trips per year, monitor an average of 116 sites per year, and conduct remedial action on 20 to 40 sites per year. In seven years, from 1992 through 1998, according to SWCA's data analysis. GRCA RCMP monitoring crews have conducted a total of 930 monitoring sessions (or episodes), visiting 322 sites during 29 monitoring trips, while GLCA staff have visited 54 sites. On average, each site was visited three times, but 113 sites were visited only once, and one or two sites were visited 11 to 14 times. In all, 264 Grand Canyon sites and 53 sites in Glen Canyon have been actively monitored to date. Currently, approximately 177 sites are monitored in the Grand Canyon (Leap et al. 2000:xiii) and none in Glen Canyon (Chris Goetze, personal communication February 2000).

Once on site, the monitoring crews typically spend 30 to 60 minutes at each site. At that time they fill out a monitoring form and take photographs. Grand Canyon RCMP has also completely mapped 68 sites using a total station, while 10 sites have been mapped by the same method in Glen Canyon. Stationary cameras have also been used to record erosion in both Glen and Grand canyons. Checkdams have been constructed, and emergency excavations have been conducted.

The monitoring program has generated immense amounts of data, including forms on each site visit, total station maps for 78 sites, over 9000 photographic images logged in Microsoft Access for GRCA and over1400 color photos tracked on typed photo logs for GLCA, over 8000 color photos from stationary cameras, databases, monitoring trip reports, data recovery and presentation proposals, treatment plans, and annual reports. The Grand Canyon RCMP team has just recently completed a site-specific synthesis of their monitoring data from 1992 to 1999 (Leap et al. 2000). This report utilizes the databases generated over the years and summarizes all trip and annual reports written to date. The monitoring photos are used regularly to assess change through time, but the bulk of the stationary camera photos, archived at NAU, remain to be systematically analyzed. RCMP staff for the Grand Canyon did conduct informal analysis of their stationary camera photos in 1996 and noted no changes to cultural features at six sites. At the end of fiscal year 1996, the staff recommended termination of the stationary camera program in Grand Canyon. It continues, however, in Glen Canyon, with two cameras "aimed" at two sites.

All PA signatories receive a copy of every trip report and every annual report that the RCMP staff generates. If comments are received, the reports are revised and redistributed. Ruth Lambert, Cultural Resources Program Manager for GCMRC, also receives copies of these reports. GCMRC offices are at the U.S. Geological Survey facility in Flagstaff. The Grand Canyon RCMP offices are in the anthropology laboratory at Northern Arizona University in Flagstaff. All annual reports, trip reports, databases, and most photographs for corridor sites are housed here. Grand Canyon RCMP has its own database manager and photo archivist. Glen Canyon RCMP data are kept at the Glen Canyon National Recreation Area headquarters in Page, Arizona.

The tribes have also generated significant amounts of data, which they control, and some of which is considered confidential and restricted. Each participating tribe produced a final report that is confidential, and all except one produced public versions of their final reports. All of the public reports are on file at the GCMRC library and at the Cline Library at Northern Arizona University. Other information that is not confidential can be found in quarterly reports, trip reports, and other correspondence on file at the GCMRC library.

In 1998 GCMRC issued a request for proposals to evaluate the cultural resources research that has been conducted to date in the Colorado River corridor through the Grand Canyon. In particular, the RFP requested (1) synthesis of databases; (2) summary of isolated occurrences; (3) synthesis of information on management activities, site condition over time, and remedial actions; (4) synthesis of ancillary studies (geomorphology, ethnobotany, and mapping); (5) summary of public education efforts; (6) evaluation of available management data relative to long-term management goals; and (7) synthesis of data recovery conducted to date.

Combining (1), (3), and (6), SWCA examined NPS, RCMP, GCES/GCMRC, and tribal program reports and databases. In general, SWCA found that the original survey successfully identified and recorded the sites. Monitoring efforts have achieved two important goals: (1) documenting the effects of the operation of Glen Canyon Dam on the cultural resources of the Grand Canyon, and (2) mitigating adverse effects to cultural resources by documenting these effects and conducting mitigative preservation and data recovery. SWCA found two problems with the RCMP: (1) the monitoring forms and procedures were designed to measure what types of impacts were most frequent but not what types of impacts were most severe, and (2) changes in the forms and monitoring procedures from year to year somewhat impaired comparison of site condition from year to year. Analysis of total station maps and photographs showing site condition is likely to be the most useful technique for documenting stability and change at sites. Tribal databases were not made available for inspection, but all of the tribes except the Hualapai have produced public reports that describe their research (Ferguson 1998; Hart 1995; Roberts, Begay, and Kelley 1995; Stoffle et al. 1994; Stoffle, Austin, et al. 1995; Stoffle, Loendorf, et al. 1995). The Zuni report (Hart 1995) is not very specific, focusing almost entirely on recommendations. Current status of tribal databases ranges from active management and current use to being in storage, unorganized, and not actively managed. SWCA recommended that tribes seek funding to actively manage their databases. With regard to monitoring site condition, the tribes have participated in RCMP river trips, but some of their most innovative work has concentrated on documenting changes in vegetation as an indicator of site condition (see below). Members of the Zuni Conservation Projects have also worked closely with GRCA RCMP staff to construct checkdams in an effort to stabilize the effects of physical erosion at some sites.

SWCA analyzed a list of 437 isolated occurrences in the Colorado River corridor through Grand Canyon, 436 recorded during the survey and one recorded by monitors. SWCA found that the definition of *isolated occurrence* was post hoc and subjective and that resources of particular dates or functional types were more often recorded as isolated occurrences than as sites. Second, isolated occurrences were only briefly described during the survey, and information was lacking on depositional environment and construction that would be needed to evaluate whether many of the isolated occurrences constitute resources meriting additional research or management. Third, analysis of the distribution of sites and isolated occurrences by river reach indicated that date and density of sites and isolated occurrences were correlated for most river reaches and that isolated occurrences most often represented more short-term, specialized, or marginal portions of settlement systems. SWCA recommended: (1) recording as sites two isolated occurrences that were described during survey as "unrecorded sites"; (2) revisiting, re-recording, and re-assessing six isolated occurrences that were described during survey as possible sites; and (3) revisiting, re-recording, and re-assessing about 38% of the isolated occurrences (particularly charcoal stains, cairns, rock piles, and rock alignments), focusing on depositional environment and construction to better evaluate whether the isolated occurrences might be (a) the earliest evidence of sites being exposed by erosion, (b) the last remnants of sites being eroded away, (c) older than 50 years, and/or (d) eligible to the National Register of Historic Places.

NPS RCMP staff have completed data recovery efforts at 42 Grand Canyon sites and at least five Glen Canyon sites. Data recovery efforts have consisted of surface collection of artifacts, collection of radiocarbon dating samples, testing of specific features, nature and extent testing of site boundaries and potential subsurface cultural deposits, and single feature excavations. No whole site or significant excavations have been conducted in the river corridor and reported since Jones' work at five sites in the mid 1980s (Jones 1986), Schwartz's work at the Bright Angel site (Schwartz, Marshall, and Kepp 1979) and Unkar Delta (Schwartz, Chapman, and Kepp 1980) in the late 1970s, and Euler's excavations and specialized studies at Stanton's Cave between 1969 and 1982 (Euler 1984). The most common data recovery activity that has occurred is carbon sample collection, particularly in the late 1980s and early 1990s in conjunction with Hereford's sedimentological and geomorphological research. Many of these carbon samples have been dated, but not many dates have been officially reported outside of those in Hereford et al. (1991, 1993) and other published data recovery work. The majority of feature testing that has occurred has been conducted on thermal and roasting features. All in all, data recovery efforts in the corridor have been limited in scope, and any significant excavations mostly have been confined to the eastern reaches of the Canyon primarily dealing with eroded Formative period Anasazi sites. As part of RCMP's efforts, total station maps have been prepared for 78 sites. SWCA considers total station maps to be the best archaeological documentation available for analyzing both causes and severity of impacts to sites. Furthermore, production of detailed site plans is the first step in data recovery at any archaeological site.

A recent geomorphic study sponsored by GCMRC and completed by SWCA was designed to address concerns about gully erosion and arroyo cutting associated with archaeological sites in the Colorado River corridor of the Grand Canyon below the dam and the need to further test the geomorphic pre-dam terrace hypothesis proposed by Hereford et al. (1993). This hypothesis suggested a causal link between Glen Canyon Dam operations and accelerated erosion of the pre-dam terraces containing archaeological sites, and the current geomorphic research supports the hypothesis but has refined it. The research of Thompson et al. (2000) provides a predictive model concerning the physical erosion of archaeological sites designed to streamline monitoring efforts and prioritize remedial actions along sites in the corridor. Thompson et al. (2000) have indicated that generally river-, terrace-, and side canyon-based stream erosion affecting over 100 archaeological sites in the corridor is exacerbated by dam operations. Therefore, these archaeological sites that were included in the studied catchment areas have been rated as to their susceptibility or vulnerability to degradation from various geomorphic processes. The report by Thompson et al. (2000) should be regarded as a companion document to this synthesis and that of Leap et al. (2000). The geomorphic hypothesis and derived conceptual model should be used specifically as the basis for making decisions concerning when to conduct preservation efforts at sites and when data recovery is the necessary action to mitigate indirect and direct dam-related impacts to cultural resources.

Ethnobotanical research was a cornerstone of many of the tribal studies conducted to date. Plant lists have been compiled and are listed in public reports (Hopi, Navajo, Southern Paiute Consortium) and trip reports (Hualapai). Only the Zuni, the fifth tribe that has conducted ethnobotanical research in the Canyon, have not produced a publicly available list of specific plants. The Hopi, Hualapai, and Southern Paiute Consortium continue to monitor changes in plant distribution, providing important ecological data and modeling to assess the effects of the operation of Glen Canyon Dam on resources significant to the tribes. SWCA synthesized the plant lists and summarized the research completed and in progress by the tribes. SWCA recommended that the synthetic plant list be maintained and updated, that monitoring should continue, that information concerning which plants are within the corridor should continue to be refined, and that native and non-native plant species should be distinguished in reports.

Public education has been one of the most successful aspects of the research along the Colorado River corridor, with both RCMP and tribal organizations contributing (see Chapter 8 for references). RCMP archaeologists have presented papers at professional meetings, published chapters in edited volumes, formally instructed river guides, and informally instructed river runners while monitoring sites along the river. The Hopi, Navajo, Southern Paiute Consortium, and Zuni have produced publicly available reports. The tribes have also presented papers at professional meetings and published chapters in edited volumes. The Southern Paiute Consortium has developed a formal public education program, and the Hualapai have produced an interactive instructional computer program. SWCA recommends the continual updating of bibliographies and records of public presentations.

CHAPTER 1

INTRODUCTION AND PROJECT OBJECTIVES

Lynn A. Neal and Dennis Gilpin

PROJECT JUSTIFICATION

Legislative Background and Conceptual Basis

The Bureau of Reclamation (BOR) operates Glen Canyon Dam and administers power revenues that fund, either directly or through a managing entity, research related to the effects of the dam on resources in Grand Canyon National Park (GRCA) and Glen Canyon National Recreation Area (GLCA) along the Colorado River corridor. The Glen Canyon Environmental Studies (GCES) program was established by BOR in 1982 to study the effects of the low and fluctuating flows of the Colorado River on natural resources downstream of Glen Canyon Dam. GCES was extended into Phase II in 1988 to deal with research questions related to the preparation of the Environmental Impact Statement (EIS) on dam operations. Among the issues considered during the GCES Phase II program was the effect of dam operations on cultural resources, including archaeological sites and locations significant to Native Americans. The initial cultural resources studies related to dam operations were conducted by the National Park Service (NPS), various tribes, and the U.S. Geological Survey through cooperative agreements with BOR, with GCES serving as the contracting entity.

From August 1990 through May 1991, archaeologists from GRCA and Northern Arizona University (NAU) conducted an archaeological survey of both sides of the Colorado River from Glen Canyon Dam to Separation Canyon (255 miles), recording 475 archaeological sites (Fairley et al. 1994). (Sixty-nine of these sites were recorded as being between Glen Canyon Dam and Lees Ferry within GLCA; the rest were within GRCA.) This initial inventory survey was done as part of BOR's Section 106 responsibilities under the National Historic Preservation Act (NHPA). Some 336 of these sites are within an area that had been flooded by pre-dam flows of up to 300,000 cfs or are on pre-dam alluvium and therefore subject to the potential impacts of dam operations (Coder, Leap, Andrews, and Hubbard 1994:1); 322 of the 336 sites were recommended as potentially eligible to the National Register of Historic Places. In fiscal year 1992, the National Park Service's (NPS) River Corridor Monitoring Program (RCMP), in cooperation with NAU and funded by BOR, began monitoring the condition of the 322 sites in the Area of Potential Effect (APE). From 1992 to 2000, the RCMP staff has produced a series of annual reports as shown in Table 1.1. Today, 478 archaeological sites have been recorded within the river corridor, and 317 of them are considered to be located within the APE of Glen Canyon Dam. Fifty-three of the sites are located within GLCA and are monitored by GLCA resources staff; however, at the time of this report, Glen Canyon was actively mitigating potential impacts to the sites in the river corridor under their management and planned to cease monitoring activities (Chris Goetze, personal communication February 2000). The other 264 sites are within GRCA and have been monitored by the GRCA RCMP staff. Since 1992, GRCA RCMP have been eliminating sites that did not show discernible changes and now focus their

Table 1.1. Annual Reports Produced under the River Corridor Monitoring Program, Fiscal Years 1992-2000

FY	Glen Canyon National Recreation Area	Grand Canyon National Park
1992	Neal and Leap 1992	Coder. Leap, Andrews. Kline, and Hubbard 1994
1993	Burchett 1993	Coder. Leap. Andrews, and Hubbard 1994
1994	Burchett 1995a	Coder. Leap, Andrews, and Hubbard 1995
1995	Burchett 1995b	Coder, Leap, Andrews, Hubbard, and Kunde 1995
1996	Burchett, Coder, and Leap 1996	Leap, Andrews, Kunde, Coder, and Hubbard 1996
1997	Burchett 1997	Leap, Andrews, Hubbard, and Kunde 1997
1998	Leap, Burchett, Kunde. Andrews, and Hubbard 1998	Leap. Burchett, Kunde, Andrews. and Hubbard 1998
2000		Leap, Kunde, Hubbard, Downum, Miller. and Balsom 2000

Note: Fiscal year runs from October 1 through September 30

monitoring efforts on approximately 177 sites. These sites have been selected based on their documented vulnerability to erosion and other considerations (Leap et al. 2000).

NPS's RCMP has been driven by the NHPA of 1966 and the National Environmental Policy Act of 1969. More recently, the project has operated under the provisions of the Grand Canyon Protection Act (GCPA) of 1992 and the 1995 EIS and its related Record of Decision (ROD). A crucial document that guides compliance with all of these legal mandates is the 1994 Programmatic Agreement (PA) regarding the operation of Glen Canyon Dam, signed by officials of BOR, the Advisory Council on Historic Preservation, the Arizona State Historic Preservation Officer, NPS, and six Indian tribes with a strong interest in the affected cultural resources. Since it was officially ratified, the PA has determined the actions of the RCMP and has facilitated compliance by BOR and NPS with a variety of legal requirements, including the provisions of NHPA and GCPA. Long-term monitoring and research associated with cultural resources within the APE are carried out in accordance with the approved PA. All provisions as agreed upon by the signing parties are implemented through a Monitoring and Remedial Action Plan (MRAP) and the Historic Preservation Plan (HPP), which will supercede and incorporate the MRAP when it is in final form; the HPP is currently being revised. The RCMP has also been shaped by a variety of legal requirements, policies, and directives issued by NPS regarding the preservation and management of cultural resources on NPS lands (Leap et al. 2000).

The archaeological inventory of the corridor was completed under Section 106 three years before the PA was executed. Shortly after the inventory was complete and in response to findings during the EIS process, through the PA program and to meet their Section 106 responsibilities, the BOR involved eight Native American groups (the Havasupai Tribe, Hopi Tribe, Hualapai Nation, Navajo Nation, San Juan Southern Paiute Tribe, Southern Paiute Consortium [including the Kaibab Paiute Tribe and Paiute Indian Tribe of Utah for the Shivwits Band], and Pueblo of Zuni) in its studies to identify places of cultural significance to Native Americans. Such places include archaeological and historical sites, traditional cultural properties/places (TCPs), and botanical, faunal, and physical resource areas. All of the tribes except the Havasupai conducted ethnographic studies, but the San Juan Paiute have also become dormant in their efforts. Each Native American group developed its own program for identifying and recording places significant to them and has maintained its own records. Annual reports are compiled that are a summary of the work completed each year, and the Hopi Tribe (Ferguson 1995a, 1998), Hualapai Nation (Jackson 1994; Jackson and Phillips 1996), Navajo Nation (Roberts, Begay, and Kelley 1995), Southern Paiute Consortium (Stoffle, Austin, et al. 1995; Stoffle, Loendorf, et al. 1995), and Pueblo of Zuni (Hart 1995; McKinley 1995a, 1995b) have prepared reports on their work. Some of these reports are public documents; others are considered confidential and can be used only with tribal permission. General conclusions by the Hopi, Hualapai, San Juan Southern Paiute, Southern Paiute Consortium, and Zuni are discussed in the draft Historic Preservation Plan (HPP) (Bureau of Reclamation [BOR] et al. 1997), but the draft HPP is currently being greatly modified and this same information may not appear in the final version. The Native American groups that participated in the inventory of cultural resources have since participated in the monitoring of cultural resources in the APE and have again maintained their own records. With tribal and agency approval, a synthesis and evaluation of existing cultural data and data-gathering processes, as well as ancillary studies related to cultural resources, was included as a requirement of the PA. The Grand Canyon Monitoring and Research Center (GCMRC) facilitated the contracting of this study. A site-by-site synthesis of monitoring data has also been recently completed by GRCA RCMP staff (Leap et al. 2000).

GCES was completed with the Environmental Impact Statement (EIS) in 1995. In fiscal year 1996, GCMRC was developed as an outcome of the EIS and the Grand Canyon Protection Act of 1992, which called for the creation of a long-term monitoring and research program related to operations of the dam and its adaptive management. The GCMRC is a component of the Adaptive Management Program (AMP) currently in the U.S. Department of the Interior under the Assistant Secretary for Water and Science. Its guiding legislation is the Grand Canyon Protection Act. The AMP consists of an Adaptive Management Work Group (AMWG), composed of resource managers and stakeholders; GCMRC, with its resource program managers; a stakeholders' Technical Work Group (TWG), and independent science review panels. The AMWG and TWG establish resource management goals and objectives. The GCMRC develops annual science projects and plans that will provide monitoring and research data to address stakeholders' objectives. The focus of the AMP is to assess the effects of dam operations on downstream resources in GLCA and GRCA.

A complete discussion of the legal background and organizational history leading up to the PA and NPS RCMP can be found in Leap et al. (2000:Chapters 1 and 2). Fact sheets handed out at a

September 1998 TWG meeting offer a good overview of the Adaptive Management Program and the processes for determining future operations of Glen Canyon Dam. Balsom and Larralde (1996a) in their Society for American Archaeology paper discuss the overall process and various roles involving cultural resources below the dam.

The flow chart below offers a visual breakdown of the different cultural resource responsibilities that fall under the PA signatories and those under GCMRC.

PA (including NPS RCMP and tribes)	GCMRC
• All work and management involving National Register–eligible archaeological sites and TCPs within the dam's Area of Potential Effect	Cultural Resources Program • TCPs not on the National Register • Ethnographies Biological and Physical Resources Program • Some studies indirectly relate to cultural resources (e.g., vegetation studies that can be used for reference in ethnobotanical studies, beach erosion research) Socioeconomic Resources Program • Recreational use studies provide information related to visitation to archaeological sites and visitor attitudes concerning their experience with and the accessibility of these resources.

Significance

The current document was designed to summarize work done by the PA participants and others (e.g., tribal work under a GCMRC-sponsored contract and other contracted work) so that future cultural resources studies can be developed. Although this report is expected to at least partially satisfy the five-year synthesis called for in the PA, it is not a substitute for an overall synthesis and evaluation of all cultural resources data collected to date. This report, however, combined with the recent site-by-site synthesis by Grand Canyon RCMP staff, does provide a seven- to eight-year synthesis.

The Request for Proposals (RFP) for cultural resource data synthesis listed seven objectives: (1) synthesize the existing NPS, RCMP (GRCA and GLCA), and tribal databases; (2) synthesize data on isolated occurrences; (3) synthesize information on NPS and tribal resource management activities conducted to date at all sites; (4) summarize and evaluate results of ancillary studies such as geomorphic studies, ethnobotany, and mapping; (5) summarize public information and education efforts accomplished to date; (6) evaluate available management data; and (7) synthesize the results of data recovery conducted to date at river corridor sites.

RCMP staff have recorded the archaeological data needed to accomplish much of these tasks and have prepared preliminary tabulations of their data. Synthesis of this data, along with tribal information and other ancillary studies (particularly geomorphological research) was a requirement of the PA, and was needed to provide a more holistic view of activities conducted along the river corridor related to cultural resources. The MRAP states that "the 5-year synthesis is aimed at addressing [issues of] management, methodology, theory, and education. The information utilized in the development of this report will draw on monitoring and remedial actions implemented up to that point. The data will be analyzed and evaluated in terms of the research domains for the Canyon discussed in the HPP." The GRCA RCMP staff has recently completed a site-by-site summary of their monitoring data and have compiled their results in a single comprehensive report (Leap et al. 2000). SWCA proposed to undertake the needed summaries and analyses and compile a report to summarize the history and results of the program to date, to analyze the data from the program from the standpoint of managing cultural resources along the river, to make recommendations for future work, and to provide an annotated bibliography of the literature relating to the project.

STUDY OBJECTIVES

As defined in the RFP, the objectives for cultural resources data synthesis were:

1. Synthesize the existing NPS and tribal databases from the Colorado River ecosystem on all inventoried resources by resource attributes such as site types, locations, and human and natural impacts resulting from dam operations.

2. Synthesize data on isolated occurrences (IOs) to assist in understanding site formation (and degradation) processes relative to dam operations, as IOs may represent the last remains of site materials or the first exposures of buried sites.

3. Synthesize information on NPS and tribal resource management activities conducted to date at all sites, including monitoring frequency and history, stabilization efforts, and remedial actions. Provide an assessment of site condition over time relative to activities conducted at that location, and formulate recommendations for future management activities.

4. Summarize results of ancillary studies (geomorphic, ethnobotanical, mapping) and evaluate this work relative to the overall objectives of the Programmatic Agreement (PA).

5. Summarize public information and education efforts accomplished to date through the PA program and make recommendations for future efforts.

6. Evaluate available management data relative to the long-term management goals discussed in the draft Historic Preservation Plan (HPP) (Final Draft, June 1997 [BOR et al. 1997]) developed under the PA for the study area.

7. Synthesize the results of data recovery conducted to date at river corridor sites. Evaluate these data relative to the research domains identified in the draft HPP ([BOR et al. 1997]) developed under the PA for the study area, and make recommendations for changes in the data recovery program that improve its utility in meeting PA program objectives.

Problems

The primary problems to be addressed in accomplishing the project objectives for the cultural resource data synthesis were twofold. First, much of the data are in records compiled and maintained by the six tribal entities with interests along the corridor. Besides the fact that these records are dispersed among the tribes in a great variety of formats, much of the information is of a confidential nature, and some tribes choose not to make these data available outside their own groups. Second, different recording systems have been devised through the years by NPS RCMP personnel, and data in these records had to be converted as much as possible to a common compatible format for synthesis and comparison. (Some of this work had been done by RCMP staff at Grand Canyon and Glen Canyon, but SWCA still spent a fair amount of time converting data to the same format.) Most of the monitoring data have not been quantitatively analyzed, however, to determine whether they are collecting the appropriate data to measure those variables most significant for understanding, monitoring changes in, and managing impacts of Glen Canyon Dam on cultural resources below the dam. (A limited number of sites have been quantitatively analyzed using time 1 and time 2 total station maps; see examples in Chapter 7.)

Scientific Issues

There was potential for a comparison of some of the cultural resources monitoring data with existing geomorphic data to determine the relationship between various river flows and erosion of beach sediments and terrace deposits containing cultural materials. Modeling and analysis of sediment dynamics and erosional processes on river terraces were proposed in two separate RFPs under GCMRC's Cultural Resources Program. SWCA cooperated with other contractors on these related topics, particularly the testing and application of a geomorphic model related to erosion of pre-dam terraces, since SWCA was also awarded this contract. The geomorphic data were presented in a final report dated February 2000 (Thompson et al. 2000). In this report, we only summarize this work and its value to cultural resources management along the corridor; we direct you to the actual report for details.

Value of Synthesis Results

This study resulted in the creation of a one-volume synthesis of much of the cultural resource investigations conducted by NPS, NPS RCMP staff, tribes, and others. This report includes a brief history of the project, the methods used, the results obtained, and a bibliography of reports by research area. This information was recovered from a variety of reports and databases archived in various locations. While the primary purpose of this project was to provide GCMRC with synthetic data so that they can develop future monitoring and research projects, easy access to this information is also valuable for other interested parties, archaeologists, and the public. A one-volume synthesis of multiple data sources also assists the PA in the continued monitoring and management of the cultural resources within the Colorado River corridor below Glen Canyon Dam. This synthesis offers a compilation of work done within the corridor related to cultural resources effected by the dam. The synthesis was also intended to incorporate the range of studies conducted relative to cultural resources and their results so that they could be reviewed and integrated.

BACKGROUND FOR EACH OBJECTIVE

Objective 1: Synthesize Databases

Since 1990, archaeological data have been collected by GRCA and the NPS RCMP (in cooperation with NAU in both instances) in two projects: (1) the initial inventory on the river corridor (Fairley et al. 1994) and (2) monitoring and remedial actions (see Table 1.1). Moreover, the site forms and site descriptions were all computerized in dBaseIII format, and the monitoring data from 1992 to 1997 were available in dBaseIII, Paradox, and Microsoft Access. Some additional data had also been computerized. For example, some information from sources other than site forms had been coded as a set of variables and entered in a SYSTAT file to provide management information, although specific research questions were not addressed. GRCA RCMP staff have also created summary tables for several different sets of monitoring data, including monitoring schedules and preservation and recovery options (which include priority rankings by site).

Furthermore, a number of articles and books summarize the history of archaeological research in the Grand Canyon and surrounding areas, but a more specific synopsis of the previous archaeological research focusing on the Colorado River corridor in Grand Canyon (prior to the survey beginning in 1990) is included in Fairley et al. (1994). SWCA's annotated bibliography in Appendix A offers a listing of reports and books that provide background information pertaining to cultural resources along the corridor. Limited data from this early body of work were incorporated into the database synthesis. In particular, it was not until 1953 that the first professional attempt at an archaeological inventory along the Colorado River in Grand Canyon was initiated by Walter Taylor (Taylor 1958). More intensive surveys along the river began during the late 1950s and early 1960s, and some excavations were also conducted in the 1960s. All information relevant to archaeological sites in GRCA has been included in some form of database since the early 1960s (Jan Balsom, personal communication 1998). Beginning in 1967, an archaeological research project involving survey, testing, and excavation at sites identified in the river corridor's eastern portion (within GRCA) was undertaken by Douglas Schwartz from the University of Kentucky. This work by Schwartz and GRCA Park Archaeologist Bob Euler was directly related to the possibility of constructing a dam at Marble Canyon; the work was sponsored by the Arizona Power Authority. (Schwartz later moved to the School of American Research where the excavation reports were completed.) The project produced a series of detailed descriptive reports documenting the architectural characteristics and artifact typologies of Puebloan period occupation in the eastern Grand Canyon. Euler and Chandler (1978) published a study of site distributions within GRCA, based on a compilation of data from various surveys completed up to that time. The first BOR-sponsored inventory as part of the GCES Phase I studies was conducted between Glen Canyon Dam and Lees Ferry in 1980, and the site and IO records that were generated were incorporated into a comprehensive summary of archaeological resources in the Lees Ferry area (Geib 1990) and the 1994 inventory report (Fairley et al. 1994). In 1984 an NPS-sponsored testing and stabilization program was initiated for five stratified sites in remote locations in the inner Grand Canyon that were being actively eroded (Jones 1986). Emergency data recovery efforts were necessary at one of these five sites (Furnace Flats) to preserve information before it was completely lost to erosion. This site was added at the last minute due to massive erosion caused by the 1983 unregulated flood. Since 1989, additional testing and C^{14} dating analyses have been carried out at selected sites along the river corridor (detailed below in Objective 7) in conjunction with geomorphological research.

The information collected by the tribes was recorded as they deemed appropriate, using methodologies developed by them; thus, whatever data were recorded are controlled by the tribes and may be used only with their permission. All of the participating tribes have prepared reports, some of which are available to the public: Ferguson (1998) for the Hopi; Roberts, Begay, and Kelley (1995) for the Navajo, Stoffle et al. (1994), Stoffle, Austin, et al. (1995), and Stoffle, Loendorf, et al. (1995) for the Southern Paiute Consortium; and Hart (1995) for the Zuni. While some information is on file with GCMRC, BOR, and NPS, other data were in reports on file with the tribes or, in some cases, not reported at all. SWCA needed to determine what reports were produced by the tribes, where these reports were located, the current status of the reports (never produced, draft, or final), and whether access is restricted. For example, Nason et al. (1995) include a bibliography of reports produced by the tribes. In some cases these were final reports, in other cases they were drafts, and in still other cases they were proposed reports that may never have been completed. Also, some draft reports that contained sensitive information and were classified as confidential (e.g., Ferguson 1994) have been replaced by final reports that are public (e.g., Ferguson 1995a, 1998). Thus, the confidential draft reports still exist in some instances and contain information not found in the final, public reports. One of the tasks of this project, therefore, was to consult with the tribes to clarify the nature and accessibility of databases and reports they control. Also, although some of the data collected by the tribes may be amenable to quantification, most of it has not been quantified.

Objective 2: Summarize and Record Isolated Occurrences

Data on the 489 IOs recorded during the survey have not been entered into a computerized database. Furthermore, data on IOs were not presented in the Grand Canyon survey report (Fairley et al. 1994) due to the confidentiality of the locational information, although a table of 437 IOs (see Appendix D) was created as part of producing the 1994 survey report. The list includes, for each site, field number, aerial photograph number (most IOs were plotted on aerial photographs), river mile, bank, map number, date recorded, description, and setting. The table was not sent out with the reports, but was included as a separate appendix in the mailings to the tribes.

Objective 3: Synthesize Information on (a) Management Activities and (b) Site Condition over Time and Effects of Remedial Actions, and (c) Make Recommendations

Data pertinent to parts (a) and (b) of this task were recorded on the computerized site databases of the NPS RCMP, and they were summarized in the annual reports and, to a limited degree, in early articles, books, and field reports produced prior to 1990 (housed at GRCA) and included in the annotated bibliography in Appendix A. Some preliminary tabulations addressing site condition over time and remedial action activities (including preservation successes and failures) had been generated by GRCA RCMP staff and the Zuni Conservation Projects. Other than management activities related to plant studies (see Chapter 4), the tribal data contained little information pertinent to parts (a) and (b). Information regarding management recommendations were obtained from both NPS and tribal sources.

Objective 4: Synthesize Ancillary Studies (Geomorphology, Ethnobotany, Mapping)

Geomorphological studies include dating of river terrace deposits and measurement of rates of erosion. Dating of river terraces was conducted by USGS geologists Hereford and Thompson, who have produced a number of reports (Hereford et al. 1991, 1993; Hereford et al. 1995, 1996) and maps (Hereford and Thompson 1993; Hereford, Thompson, and Burke 1994a, 1994b; Thompson, Burke, and Hereford 1996; Thompson, Hereford, and Burke 1995). The work by Hereford et al. in 1991 was not solely related to dating river terraces, but was originally designed to relate archaeological site erosion to river flow and dam operations. Ivo Lucchita of the USGS has also conducted geomorphic and geologic studies in the eastern Grand Canyon (Lucchita 1991) and the Granite Park area (Lucchita et al. 1995). Rates of erosion were measured in part through terrestrial photogrammetry, in which cameras were positioned to take photographs of various locations (including some archaeological sites) at regular (usually daily) intervals (Dexter and Cluer 1992).

Ethnobotanical studies have been conducted as part of the Native American studies, and some of this information was included in the reports prepared by the tribes. Again, while some of these reports are public, others are considered confidential and may be used only with tribal permission.

Archaeological sites have been mapped both specifically to record the archaeological materials and as part of other studies. Professional surveyors from GCMRC have used total stations to map archaeological sites that are on annual and semi-annual monitoring cycles and sites where preservation and data recovery activities have been undertaken. In addition, from 1989 to 1993-1994, Hereford used aerial photogrammetry to map areas selected for geomorphic studies. GCES/GCMRC surveyors have placed controls across and throughout the river corridor and have done contour maps for several cultural resources sites and for sediment and hydrological studies. Some work has also been done to add archaeological data to maps that were produced primarily for non-archaeological purposes. This work is being done by the geomorphic modelers, under contract with GCMRC, where archaeological sites fall onto their geologic maps.

Objective 5: Summarize Public Education Efforts

The draft HPP (BOR et al. 1997) notes that ongoing public education efforts are directed at several audiences. Information has been provided to professional archaeologists at the 61st (1996) symposium of the Society for American Archaeology (multiple references), the 1996 George Wright Society symposium (multiple references), a 1995 stabilization workshop, in the 1997 volume on the experimental beach/habitat building flow, at the 1997 Colorado Plateau Research Station symposium on the results of the habitat flow, and others (see Chapter 8). The general public has been addressed through participation in the Grand Canyon River Guides' Guides Training Seminar, and by GRCA and GLCA interpreters. Tribes have developed their own education formats that have included papers presented at professional meetings, articles in books (Begay and Roberts 1996) and journals (Stoffle, Halmo, and Austin 1997), books describing the results of ethnographic research (Loendorf and Bulletts 1997), youth education programs, and videos. Published works cited in Chapter 8 are included in the References Cited portion of this report.

Objective 6: Evaluate Available Management Data Relative to Long-Term Management Goals

Long-term management goals for the study area are discussed in the draft HPP (BOR et al. 1997) developed under the PA. The goals include (1) in situ preservation of cultural resources in the project area, recognizing both archaeological resources and places of Native American concern; (2) mitigation of adverse effects to those resources that cannot be preserved, incorporating scientific and traditional Native American values; (3) protection of and Native American access to cultural resources used for religious purposes; and (4) development of research strategies that maximize the value of data collected from monitoring and mitigation. Again, the data on archaeological sites can be found in the references and databases developed by NPS RCMP staff and associated entities, and the data on places of significance to Native American groups are controlled by the tribes and are summarized in this synthesis to the extent that the information has been made available.

Objective 7: Synthesize the Results of Data Recovery Conducted to Date

Preservation of river corridor sites is the primary goal of the PA program. Therefore, since the inception of the monitoring program in 1992, data recovery actions (surface collections, feature excavations, radiocarbon sampling, testing specific features for subsurface deposits) have been conducted at about 46 sites where erosion or other site impacts have posed an immediate threat to the loss of archaeological information and no other means of protection or preservation were available. These efforts include 13 feature-based excavation projects at 11 sites, 13 sites tested for depth and feature significance, 3 incidents of artifact collection or special documentation, 21 sites where carbon samples were collected, 1 site with testing and feature excavation, 1 site with artifact collection and testing, and 1 site with artifact collection, testing, and excavation. (Five site counts are duplicated under carbon sample collection.) Documentation of sites where remedial actions were taken is most often accomplished by photographing each site prior to and after conducting the remedial actions and completing a Remedial Action Documentation form. Total station mapping is also completed at a site prior to and after undergoing checkdam building, and before any data recovery, testing, or sampling. Charcoal samples have been taken from several sites as an emergency treatment measure by monitoring program staff, but analyses of some of these have yet to be completed due to a lack of funding. Charcoal samples were taken from 20 sites within the APE prior to the monitoring program's efforts. Specifically, Richard Hereford collected a number of charcoal samples from sites in the Nankoweap, Unkar Delta, Furnace Flat, Granite Park, Tanner, and Palisades areas as part of his geomorphic research. Radiocarbon analysis of Hereford's charcoal samples provided dates for both archaeological sites and the sedimentary deposits in which the sites occur. A summary of data from earlier testing and excavation projects conducted prior to 1989 and discussed above under Objective 1 was also included in Chapter 7 of this synthesis.

REPORT ORGANIZATION

The overall organization of this report is by task, and each task is discussed in terms of the relevant objectives and types of information and data available. Chapter 2 outlines the general methods used to achieve each of the seven study objectives and describes a plan of work consisting of four phases or tasks. Chapter 3 contains the results of tribal research and a synthesis of the data generated (Objective 1), which is followed appropriately by Chapter 4 on ethnobotany (Objective 4), the data for which were generated from the tribal records. Chapter 5 is a preliminary synthesis of geomorphic studies and other corridor-related geologic studies (Objective 4). Chapter 6 consists of a summary and evaluation of isolated occurrences recorded during the initial archaeological survey of the river corridor (Objective 2). The synthesis, analysis, and evaluation of the NPS RCMP monitoring data (Objective 1) are in Chapter 7. Since mapping, listed as an ancillary study in the RFP (Objective 4), is directly related to and generated as a part of the monitoring program's efforts, this discussion is also included in Chapter 7. In addition, since site condition over time was assessed relative to preservation and data recovery efforts (Objective 3b), data recovery activities conducted to date (Objective 7) are summarized and evaluated in this chapter as well. Public education efforts (Objective 5) are highlighted in Chapter 8. Chapter 9 contains summaries of NPS and tribal resource management activities (Objective 3a), an evaluation of management data relative to long-term project management goals (Objective 6), and recommendations for future management activities (Objective 3c).

References cited in the text are at the end of the body of the report; they are followed by Appendixes A–M. Appendix A, referenced in Chapters 1 and 2, consists of four partially annotated bibliographies pertinent to (1) archaeology on the river corridor, (2) tribal documentation, (3) geomorphology, and (4) corridor-related background documents. Tribal response letters and records of telephone conversations, referenced in Chapter 3, appear in Appendix B. Appendix C is a per-catchment data sheet used during the current Geomorphic Model project, referenced in Chapter 5. Appendix D, a table of isolated finds (occurrences), is referenced in Chapter 6. The RCMP monitoring forms used from 1992 to 1998 and discussed in Chapter 7 are in Appendix E. Appendixes F–L contain various database reports that were created during analysis of the monitoring data and are referenced in Chapter 7. Appendix M, also referenced in Chapter 7, is the current GRCA RCMP Remedial Action Documentation Form.

CHAPTER 2

PROJECT METHODS AND PLAN OF WORK

Lynn A. Neal and Dennis Gilpin

METHODS BY OBJECTIVE

Objective 1: Synthesize Databases

SWCA acquired reports, computerized databases, and other data from RCMP staff at the GRCA and GLCA offices, GCMRC, and BOR. SWCA invited the involved tribes to provide whatever data they had and were willing to share. SWCA anticipated that the NPS RCMP data would already be in relatively compatible formats; however, a fair amount of variation was expected in tribal databases. Lilian Jonas, a statistician with a doctorate in sociology, described these databases in terms of content and format and evaluated what would have to be done with the databases to perform different types of statistical analyses (see Chapter 7). A preliminary evaluation showed that most of the quantitative data on the River Corridor Archaeological Site Monitoring Forms were nominal (categorical) in nature. The only types of interval data present on all forms are river-mile site locations and survey dates. On forms written prior to 1994, much of the natural and human-caused impact data are ordinal (rank ordered). Based on these observations alone, with the assumption that the data were both valid and reliable, the types of statistical tests that could be performed were limited. The possibilities included: descriptive statistics; frequency distribution tables or bar graphs; contingency tables or Chi Squares; and, to a limited extent, analysis of variants and/or non-parametric statistics (Kruskal-Wallis and/or Mann Whitney tests). None of these analyses were performed, however, since there were far too many inconsistencies in the databases. Instead, SWCA's efforts were concentrated on sorting out these inconsistencies to prevent the continued collection of noncomparable data.

SWCA's methods for consulting with Native American groups ensured that any wishes of the tribes to restrict dissemination of sensitive information were respected. While conducting records checks at the various federal agencies, SWCA compiled a bibliography of reports produced by the tribes. Once this preliminary bibliography was completed, SWCA contacted the tribes to determine if they wanted to delete or add any reports and if they had any additional information that they wished to have included in the report. This process of archival searching and tribal consultation should guarantee that only the tribal data that the tribes want to be made public appear in this report. At the same time, the comprehensiveness and number of reports previously published by the tribes indicated that a sufficient amount of non-confidential information was available to accomplish project goals. SWCA then summarized the types of data that had been collected by the tribes and made recommendations for putting tribal data into a common and, to the extent possible, quantitative format. For example, it was possible to consolidate plant species identified as culturally significant by four of the tribal groups into a single reference table. If certain types of tribal information are released, it may also be possible to compile one table that indicates whether information on tribal oral history has been recorded about specific sites, another table that indicates what types of traditional cultural properties (TCPs) have been recorded by each tribe, and another that indicates, by type, which archaeological sites are considered to be TCPs. (Recent strides have been made to make the entire Grand Canyon, from rim to rim, a TCP, so the need to identify individual TCPs or resource areas will be nullified.)

Objective 2: Summarize and Record Isolated Occurrences

SWCA compared the distribution of IOs and sites by date, cultural affiliation, type/function, and location. Since data on isolated occurrences had never been evaluated, these data were evaluated to see if isolated occurrences were likely to offer any important new information on the prehistory and history of the Grand Canyon. There are two ways of approaching this issue. The first is to ask whether isolated occurrences represent the same or different periods of occupation and activities as sites. If isolated occurrences represent different periods of occupation and different activities than sites, then they offer information on the history of the Grand Canyon that is not available at sites. Second, are isolated occurrences likely to be the last remnants of sites that have been destroyed by erosion (in which case they offer little new information) or are they evidence of sites that are just being exposed by erosion (in which case they may offer new information).

In order to test whether isolated occurrences and sites represented similar or different periods of use and similar or different activities, SWCA first compared the overall distribution of isolated occurrences by date, cultural affiliation, function, and location with the overall distribution of sites by date, cultural affiliation, function, and location and found that cultural resources of certain time periods (the historic period, for example), cultural affiliation (Euroamerican, for example), and type or function (cairns, rock piles, rock alignments, and isolated charcoal deposits) were more likely to have been recorded as isolated occurrences rather than sites. Thus, the isolated occurrences provide information about the history of the Grand Canyon that is not available at sites. SWCA further hypothesized that if isolated occurrences represented the same periods of occupation, cultural affiliation, and activities as sites, they would occur in similar frequencies as sites in specific river reaches. SWCA therefore compared the frequencies of isolated occurrences and sites in each river reach. Where significant differences were found, the differences were evaluated in terms of the various hypotheses that would account for variability: (1) the isolated occurrences represent some specialized activity not found at sites, (2) isolated occurrences are smaller versions of sites, or (3) isolated occurrences represent sites that have been affected by different geomorphological processes than recorded sites.

This third hypothesis gets back to the issue about whether isolated occurrences might be the remnants of sites that have been destroyed by erosion or the earliest indications of sites that are being exposed by erosion. Originally, SWCA planned to base its assessment of the possibility of site status for some isolated occurrences on the environmental setting of isolates occurrences, but found that even the location of some isolated occurrences was not recorded and was not readily accessible in a computerized format similar to the GIS database for sites. Therefore, SWCA had to base its assessment of site status for isolated occurrences on the physical characteristics of isolated occurrences. SWCA found that some isolates had been described as "unrecorded sites" during the original survey, some classes of isolated occurrences (cairns, rock piles, rock alignments, and such) would probably have been recorded as sites if sites had been defined as they are by most institutions (see the Arizona State Museum and Navajo Nation definitions as examples), and still other classes of isolated occurrences (e.g., charcoal deposits and stains) seemed most likely to be the last remnants of sites destroyed by erosion or the earliest evidence of sites being exposed by erosion, but, in the absence of location data, information on setting, and dates, however, the possibility of site status for some isolated features could not be specifically determined but has been suggested in Chapter 6.

Objective 3: Synthesize Information on (a) Management Activities and (b) Site Condition over Time and Effects of Remedial Actions; (c) Make Recommendations

SWCA viewed this task as the most demanding objective of the cultural resources project. In order to obtain information on resource management activities, SWCA first acquired GIS and other computerized databases referenced in various reports (for archaeology these were the NPS RCMP reports listed in Table 1.1; for the tribes they were Anyon and Hart 1994; Ferguson 1995a, 1998; Jackson 1995; Nason et al. 1995; Roberts, Begay, and Kelley 1995; Stoffle et al. 1993; Yeatts 1995a). Baseline data on each site were available in Fairley et al. (1994) and from the IMACS site form database, and the monitoring reports and other documents provided significant supplemental data for the history of research. monitoring, stabilization, remedial actions, and condition at each site. The results of this objective are mostly discussed in Chapters 7 and 9.

Objective 4: Synthesize Ancillary Studies (Geomorphology, Ethnobotany, Mapping)

Reports (Hereford et al. 1991, 1993; Hereford et al. 1995, 1996) and maps (Hereford and Thompson 1993; Hereford, Thompson, and Burke 1994a, 1994b; Thompson, Burke, and Hereford 1996; Thompson. Hereford, and Burke 1995) on the geomorphological studies were listed and the overall conclusions as they related to cultural resources studies were summarized, including the recently completed GCMRC-sponsored Geomorphic Model project by Thompson et al. (2000). Summarizing the terrestrial photogrammetry involved acquiring an inventory of photographs taken at the various archaeological sites. To aid in the synthesis and summary of related data, SWCA used the services of geomorphologist Kate Thompson and geologist Gary O'Brien, who were working on the GCMRC Geomorphic Model project and were familiar with the geomorphology database.

SWCA summarized and analyzed all of the publicly available ethnobotanical information and as much of the confidential information as the tribes would release. SWCA also asked the tribes if there was any other information not currently in reports that they wished to add. SWCA proposed to produce cross-tabulations of the plants reported to be used by the various tribes. the uses of the plants, and where those plants are found within the river corridor. The only consistently obtainable information. however, was plant lists; plant use and location were not always recorded.

Finally, SWCA compiled an inventory of relevant maps. The inventory includes what archaeological areas have been mapped, why these areas were chosen for mapping, and how these maps might be relevant to cultural resources studies. This discussion is in Chapter 7.

Objective 5: Summarize Public Education Efforts

SWCA compiled a comprehensive annotated bibliography (included in this report as Appendix A) of references to the ongoing public education efforts summarized in the draft HPP. Information on and references to public education efforts were identified through bibliographical research, interviews with representatives of the PA signatories, and comments on the draft final report. Both NPS and RCMP personnel and employees of tribal participants in the PA have made numerous and wide-ranging efforts in public education, including public reports by the tribes, articles in professional journals and newsletters, papers and poster sessions presented at professional meetings, instruction to river guides, at least one interactive computer program, classroom and in-field instruction to Native American youth, and relatively informal instruction along the river. Furthermore, the Arizona State Historic Preservation Office (SHPO) has recommended the publication of popular versions of various reports that would focus on the cultural history of the Grand Canyon from archaeological, tribal, historical, and environmental perspectives. SHPO also recommended the production and presentation of "interpretive videos, displays, mobile exhibits, schoolroom presentations, slide show programs, evening lecture series," and so forth (BOR et al. 1997). All of these educational efforts would need to be developed in concert with the tribes, who are extremely concerned about releasing some information but also welcome the opportunity to tell their own stories. For example, Roberts, Begay, and Kelley (1995) note that the story of Navajo history at Grand Canyon has been ignored in public education and advocate recognition of historic Navajo use of and traditions about the canyon. SWCA inventoried and summarized the efforts completed thus far and made specific recommendations about programs that could be completed in the future. One of the survey/monitoring reports describes how river runners are attracted to archaeological investigations, which has the advantage of providing an opportunity to educate the public about the cultural resources of the Grand Canyon but has the drawback of attracting attention and future visitation to fragile sites. The descriptions and photographs in the monitoring reports showing how sites are impacted by natural erosion, Glen Canyon Dam operations, and human visitation are interesting and could be used in visitor center exhibits, booklets, and brochures that would educate the public about the values and fragility of cultural resources, the effects of visitors on these resources, and the relatively simple steps visitors could take to minimize their impacts on cultural resources.

Objective 6: Evaluate Available Management Data Relative to Long-Term Management Goals

Long-term management goals are discussed in the draft HPP (BOR et al. 1997) developed under the PA for the study area. The priority is to preserve cultural resources, conducting mitigation of adverse effects only when such effects cannot be avoided. Other goals include facilitating Native

American access to cultural resources used for religious purposes and maximizing the value of data collected from monitoring and mitigation. Evaluating NPS RCMP efforts at preservation involved (1) assessing whether the data currently being collected actually measure the stability of sites and (2) assessing whether remediation strategies actually preserve sites. The RCMP data that were analyzed were available on the cultural resources inventory and monitoring forms and in trip and annual reports on monitoring and remedial actions. SWCA assessed data collection strategies and how data were collected by multiple methods: (1) evaluating the consistency and accuracy of monitoring schedules and remedial actions for all sites; (2) selecting a sample of sites that have been visited repeatedly during inventory and monitoring and then examining evaluations of site conditions made during the various visits; and (3) comparing the site-condition evaluations to a few photographs and maps to test observer consistency. The effectiveness of remediation strategies was evaluated by similar tracking of remediation efforts, their effects, and how often remediation needs to be undertaken or repeated. SWCA's assessment of observer and recorder consistency contributes to the evaluation of the value of data currently being collected, which was also evaluated as part of Objective 7 (below). SWCA also assessed whether the data being collected address Native American concerns as reflected in the draft HPP and various tribal reports.

Objective 7: Synthesize the Results of Data Recovery Conducted to Date

SWCA compiled the data from monitoring reports, computerized databases, and other data obtained from all sources during the course of the project. These data were synthesized and evaluated to provide a summary of all data recovery work completed within the Colorado River corridor below Glen Canyon Dam. SWCA also briefly discussed how data recovery has addressed the research goals summarized in the draft HPP: theoretical research domains (dating and chronometrics; demography, settlement systems, and cultural affiliation; socio-political-ideological research; technology and industry; exchange, trade, and commerce; subsistence; transportation and communication; and government) and methodological research domains (site formation processes, monitoring technologies, and remediation technologies). SWCA discussed in narrative form how the data recovery projects have generally addressed these research issues and summarized this information. In similar fashion, SWCA discussed and summarized how data recovery efforts have incorporated Native American values.

PLAN OF WORK

SWCA proposed a four-stage program for accomplishing the objectives of the cultural resources data synthesis project:

Phase 1: Archival Process/Data Acquisition and Creation of Annotated Bibliography

First, SWCA acquired the various databases discussed above. This task consisted of two subtasks: (1) acquiring computerized archaeological data and printed reports and documents from

NPS, RCMP staff, GCMRC, and BOR, and (2) consulting with tribes to find out what types of data and reports they have and which data and reports are public and which are confidential. Most archaeological data were computerized.

Toward the end of the data-acquisition phase of the project, after a draft bibliography had been compiled, SWCA contacted tribal representatives to (1) review the existing bibliography for their reports, (2) request permission to use existing confidential reports, and (3) acquire any additional data the tribes wished to provide. As part of this task, SWCA compiled a tribal annotated bibliography and a list of reports that had been proposed (some of which were cited, even though final reports were never written). The complete tribal bibliography is attached as the second of four parts of Appendix A. SWCA had proposed to meet with individual tribal cultural resource managers either at the tribal offices or in SWCA's Flagstaff office, as they preferred, but this meeting was determined not to be necessary for obtaining the appropriate tribal data.

At the conclusion of the data-gathering phase of the project, SWCA submitted the annotated bibliography (Appendix A) to GCMRC listing and describing the reports, databases, metadata, and archival sources that were identified, the locations of these materials, their status with regard to confidentiality (for tribal documents), and their status with regard to stage of completion (never produced, letter report, draft report, final report, etc.). SWCA decided to divide the bibliography into four parts—Archaeology, Tribal, Geomorphology, and Corridor-Related Background Documents (with four subparts: archaeology, history, tribal, and general corridor)—for ease of reference. GCMRC was given an opportunity to comment on the bibliography while the remaining tasks were being completed.

Phase 2: Data Synthesis, Analysis, and Evaluation

The second phase of the project involved the synthesis and analysis of the data. Several databases, archaeological (survey data, monitoring and remediation data, ancillary data) and ethnographic (oral history data on archaeological sites, information on traditional cultural properties, ancillary ethnobotanical data), were analyzed. The synthesis of these data involved generating a number of tables summarizing the frequency and dates of sites monitored, preservation and data recovery recommendations, and preservation and data recovery accomplished at each site. Analysis of the data involved assessing how consistently data were being recorded, how well monitoring schedules were a reflection of remediation priorities, how well remediation recommendations reflected the actual work completed, and how well remediation techniques preserved or mitigated sites.

SWCA analyzed archaeological site data from the inventory and monitoring and remediation efforts, and isolated occurrence data from the inventory. For the sites, SWCA evaluated location; history of research; history of monitoring, stabilization, data recovery, and condition (causes of disturbance and area and depth affected by the disturbances); history of remedial actions; and effects of remedial actions (how often remedial actions have to be undertaken, repeated, or maintained). As part of the analysis, SWCA also proposed to generate a number of cross-tabulations of data on monitoring frequency and schedule at each site, causes of disturbance to each site or each site type, remediation efforts at each site, effectiveness of remediation, evaluations of data recovery results, and so forth.

Monitoring data from a sample of sites were analyzed to see if variables are being recorded consistently. For example, causes of disturbance are generally classified as physical (surface erosion, arroyo cutting, beach erosion, animal trails and burrows) and visitor related (devegetation, trails, moving artifacts, pothunting, graffiti). The most recent monitoring form asks researchers to describe disturbance as absent, active, or inactive based on what types of physical impacts are occurring and what types of archaeological features are being impacted. Earlier forms asked researchers to record physical impacts as none, minor, moderate, or extensive. To measure whether fieldworkers are recording disturbances consistently, information that NPS RCMP researchers need to know, SWCA compared the records of a sample of sites that had been repeatedly monitored to see if written records indicated stability or change. As another example, monitoring reports showed several types of remedial actions: scattering artifacts from collection piles, building checkdams, revegetating areas, obliterating and rerouting trails, etc. The reports suggested that collection piles continue to grow if left alone and return, but more slowly, if scattered. Monitoring reports also showed that checkdams can be washed out and that trails reappear. SWCA compiled statistics on the effects of remediation and on how often remediation has to be repeated. As part of the analysis phase, SWCA also evaluated how data recovery efforts contribute to the management goals set forth in the draft HPP.

The rationale for research on isolated occurrences has been described above. The basic data on isolated occurrences were provided in a summary table on isolated occurrences prepared by Jan Balsom and Christopher Coder in May of 1994 and presented in Appendix D. Using data from this table, the distribution of isolated occurrences by date, cultural affiliation, type or function, and location was summarized and compared to the distribution of sites by the same variables. As mentioned above and discussed in Chapter 6, during the original survey most, but not all, of the isolated occurrences were plotted on aerial photographs but were never transferred to USGS quadrangle maps. Therefore, to analyze the variability in isolated occurrence locations, SWCA grouped isolated occurrences by river reach. SWCA asked two general questions in comparing isolated occurrences and site distributions: (1) does the density of isolated occurrences in each river reach approximate the density of sites in that reach; (2) does the distribution of isolated occurrences in each river reach approximate the distribution of sites in that reach in terms of date, cultural affiliation, function, etc.?

With regard to ancillary data, the reports of Hereford and others on geomorphology were listed in the annotated bibliography (Appendix A, Part 3), and their overall conclusions, as they relate to cultural resources studies, were summarized. With regard to ethnobotanical studies, all of which were conducted by the tribes, SWCA summarized and analyzed all of the publicly available information and as much of the confidential information as the tribes would release. SWCA also asked the tribes if they wished to add any other information that was not currently in reports. SWCA produced cross-tabulations of which plants were reported to have been used by the various tribes.

Phase 3: Synthesis Report Preparation

The third phase of the project was report preparation. SWCA proposed to produce a report that included (1) a history of RCMP cultural resources investigations by PA participants, and GCES- and GCMRC-sponsored ethnographic studies performed by PA tribal participants; (2) a discussion of field methods, recording forms, and instruments used during inventory survey, mapping, monitoring, stabilization, data recovery, and ethnographic research; (3) a summary of the range and numbers of archaeological sites recorded and documented ethnographically; (4) a summary of the range and numbers of isolated occurrences and comparison with the range and numbers of archaeological sites; (5) a summary of sites and localities identified only through ethnographic research; (6) a summary and analysis of the impacts to sites; (7) a summary of attempts to stabilize sites and the results of these stabilization efforts; (8) a review of data recovery programs; (9) a description of efforts at public education; (10) recommendations for modifying field methods and recording forms and for stabilization techniques, data recovery efforts, and public education; and (11) an annotated bibliography.

Phase 4: Final Products and Data Curation

Progress reports were submitted to GCMRC on March 5, June 15, and September 3, 1998, detailing work accomplished during each period. A copy of the four-part annotated bibliography was submitted to GCMRC with the June 15 progress report. An interim report was originally proposed to be submitted to GRMRC and the PA signatories on June 1, 1998. This report was to consist of preliminary information concerning the synthesized data, including tables, maps, and figures, and preliminary recommendations based on the work to date. The annotated bibliography submitted to GCMRC prior to submittal of the interim draft report was also to be included. SWCA and GCMRC agreed that the interim report was not necessary and that efforts could be concentrated on completing a complete draft report.

Twelve copies of a draft report were completed on October 6, 1998, and were submitted to GCMRC for distribution to all PA signatories and others for review. The final draft report, incorporating the comments of the various reviewers and some results from a draft of the Grand Canyon RCMP's recent synthesis report (Leap et al. 2000), was submitted to GCMRC on September 20, 1999. Fifteen copies were delivered for review distribution. The final draft report included an executive summary or preface appropriate for dissemination to management entities. The perfect-bound final report, this version, was completed in February 2000, with 15 copies being delivered to GCMRC for distribution.

As requested in the RFP, SWCA presented a paper (Neal and Gilpin 1999a, 1999b) on our project in February 1999 at the Glen Canyon Dam Adaptive Management Program's Colorado River Ecosystem Science Symposium, and at a Technical Work Group meeting in March 1999. Neal (1999a, 1999b) also presented a summary of SWCA's findings at the land session of the Grand Canyon River Guides Training Seminar in March 1999 and in a poster session at the August 1999 Pecos Conference. In addition to providing the technical synthesis report, SWCA will also make every effort to disseminate the monitoring and research data in appropriate peer-reviewed journals and volumes, subject to government and tribal restrictions on sensitive information.

SWCA will archive all of the data and metadata produced by the project and submit it to GCMRC and NPS in all necessary formats. All data to be archived will be compatible with existing GCMRC and NPS electronic formats, such as Microsoft Access, Microsoft Word (or a close equivalent in WordPerfect 8.0), ArcInfo, and ArcView. Databases will be delivered with the final report at the close of the contract. Originals of all reports, maps, raw data sheets, photographs, and any other data collected to fulfill the requirements of the contract and related to archaeological sites in NPS units (GRCA and GLCA) will be returned to NPS after the report is finalized. Copies of any relevant materials will be given to GCMRC.

CHAPTER 3

SOLICITATION OF TRIBAL RESPONSES, THE RESULTS, AND SUMMARY OF TRIBAL ACTIVITIES

Dennis Gilpin

INTRODUCTION

Among the cooperating agencies in the preparation of the EIS for the operation of Glen Canyon Dam are eight Native American tribal governments, representing Native America groups with historic ties to the Grand Canyon. These tribal governments are the Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Navajo Nation, Kaibab Paiute Tribe, Paiute Indian Tribe of Utah for the Shivwits Band, San Juan Southern Paiute Tribe, and Zuni Pueblo. Tribal names appear as they are on the signature line of the 1994 Programmatic Agreement (PA). Since then, the Hualapai Tribe has become the Hualapai Nation, and the Kaibab Paiute Tribe is now the Kaibab Band of Paiute Indians. The Pueblo of Zuni is incorrectly identified as Zuni Pueblo on the agreement. All of these tribes were invited to participate in research as cooperating agencies in the preparation of the EIS for the operation of Glen Canyon Dam (Bureau of Reclamation [BOR] 1995), and all except the Havasupai agreed to participate. The Kaibab Paiute Tribe and the Paiute Indian Tribe of Utah for the Shivwits Band formed the Southern Paiute Consortium. The San Juan Southern Paiute dropped out of the research program after two years because of pressing tribal business.

The tribes' involvement consisted of PA progress meetings, conferences, river trips, library research, report preparation, and report review. River trips were conducted to acquire and compile data on TCPs and ethnobotany, as well as to visit archaeological sites. The Hopi Tribe has also done some archaeological testing and data recovery (Leap et al. 1997; Yeatts 1998; Yeatts and Leap 1996, 1997). A number of the tribes, especially the Hopi, Navajo, and Hualapai, used the program to establish personnel positions and strengthen their tribal historic preservation departments. Initially, research by the tribes was directed toward the completion of the EIS (BOR 1995); in 1994 the tribes signed a PA to continue research, monitoring, and report production as required under Section 106 of the National Historic Preservation Act, as amended in 1992 (U.S. General Accounting Office [GAO] 1996:70). All of the tribes except the Hualapai have produced both confidential and public reports (see below under Dissemination of Results). The Hualapai produced only a confidential report (Hualapai Cultural Resources Division [Hualapai Tribe] 1993). The National Research Council (NRC) has published a summary and evaluation of the cultural resource assessments conducted by the tribes based on information available as of about 1995 (NRC 1996). The GAO assessment of the Glen Canyon Dam EIS (GAO 1996) includes an evaluation of cultural resource management research, including tribal participation.

Two conditions of the tribal research during the EIS process were (1) to allow the tribes to design their own research programs and (2) to allow the tribes to control confidential data. Both of these goals were absolutely essential to gaining the tribes' participation, but meeting them has led to some problems in summarizing results and recommendations. For example, tribes varied in their definitions and counting of cultural resources. However, all of the tribes agreed in viewing cultural resources in the canyon as comprising natural resources used by native peoples as well as the archaeological sites and TCPs that most archaeologists and cultural resource managers tend to include in "cultural resources."

Through the PA process, tribes initially identified cultural resources. Prior to 1995, tribal representatives went on NPS RCMP river trips; after about 1995 (or so), all trips were funded through the GCES program (later GCMRC). On most of these trips, tribal representatives stopped primarily at previously recorded archaeological sites, but they also identified a few previously unrecorded TCPs. Although the named TCPs (like the Salt Mine, Hematite Mine, Sipapu, and Vulcan's Anvil) are individually significant, most of the archaeological sites and "natural" resources were considered samples of a larger cultural landscape that was significant as a whole.

The Hopi Tribe generally identified two types of cultural resources within the study area: (1) sites mentioned in Hopi traditional and sacred history and (2) ancestral cultural properties, mostly Puebloan sites dating prior to A.D. 1200 and mostly in the eastern portion of the Grand Canyon. The Hopi Tribe also identified water and springs, minerals, plants, and animals as significant cultural resources within the river corridor (Ferguson 1998).

The Hualapai Tribe documented both archaeological sites and TCPs (Hualapai Tribe 1994a; Jackson 1994; Stevens 1996). The tribe also identified specific plant resources within the study area, studied the effects of the 1996 experimental habitat-building flow on vegetation at five sites (Hualapai Tribe 1995; Phillips and Jackson 1996, 1997, 1999), and assessed and stabilized the historic Goodding Willow at Granite Park (Jackson 1999; Jackson, Mayo, and Phillips 1997; Thompson 1997).

Faced with some skepticism about how extensively and how far back in time the Navajo had used the Grand Canyon (see, for example, Euler 1999; NRC 1996:142-143, 161), the Navajo Nation took the approach of identifying specific places, documenting specific individuals associated with those places (whenever possible), and dating the Navajo use of those places. Arguing that the river corridor was just a portion of a cultural landscape encompassing the entire Grand Canyon region, and that disturbance of a portion of that landscape would have effects on the landscape as a whole, the Navajo Tribe also documented cultural resources throughout the region, not just the river corridor (Roberts, Begay, and Kelley 1995).

The approach of the Southern Paiute Consortium was not so much to identify specific sites as to identify patterns of use and the effects of the dam on the types of resources that were used historically, are currently used, and can be expected to be used in the future. The focus of Southern Paiute Consortium research thus was on plants, animals, minerals, and rock art, limited for the most part to the river corridor (Stoffle et al. 1994; Stoffle, Austin, et al. 1995; Stoffle, Loendorf, et al. 1995).

The Pueblo of Zuni report (Hart 1995) was more general and focused on recommendations. The Zuni discussed plants as a general category, mentioned 20 mineral deposits, described how rain priests collect water from streams, and discussed nearly 50 Puebloan sites concentrated in the vicinity of the Little Colorado River's confluence with the Colorado River.

Given that some sites or locations were identified by more than one tribe and that several of the tribes felt that they had inspected only a sample of sites, sites within the Colorado River corridor identified by the tribes numbered somewhere in the neighborhood of 106. During their research, the Hopi Tribe stopped at 50 locations; the Hualapai Tribe identified 18 sites; the Navajo Nation identified 93 significant sites, of which 24 were within the river corridor; the Southern Paiute Consortium stopped at 24 locations, but these were considered just a sample of what is there; and the Pueblo of Zuni stopped at approximately 50 sites. Each tribe had its own way of classifying or categorizing cultural resources, so it is not possible to break down the number of sites by site type.

The effects of the operation of Glen Canyon Dam on cultural resources significant to Native Americans are not well documented. Although the tribes were provided the opportunity to develop their own monitoring procedures, much of the tribal monitoring has focused on accompanying RCMP personnel and visiting the sites monitored by RCMP. RCMP monitoring procedures are, of course, designed to collect data on archaeological sites, which are only one type of cultural resource identified as significant by the tribes. Procedures thus need to be designed that facilitate recording of information on the effects of the operation of Glen Canyon Dam on sacred sites, plants, minerals, and so forth. General models of effects, like the one produced by Stoffle, Austin, et al. (1995:Figure 1.3), and specific studies of plant communities, like those conducted by the Hualapai Tribe (Phillips and Jackson 1996, 1997, 1999) are examples of the types of studies that are needed. Given the current lack of consensus regarding the effects of the operation of Glen Canyon Dam on cultural resources significant to the tribes, proposals to mitigate the effects have been fairly ad hoc and need to be better evaluated.

In a more general sense, however, one of the most significant outcomes of the GCES research is the extent to which participants have held it up as exemplary of how Native American cultural studies can be done and should be done, by involving and communicating with Native Americans (see Anyon et al. 1996; GAO 1996:71; Jackson and Stevens 1997). The tribes, through the PA program and GCES and with assistance from BOR, NPS, and, more recently, GCMRC, have (1) identified cultural resources significant to Native Americans that might be affected by the operation of Glen Canyon Dam, (2) begun to document the effects of the operation of the dam on these resources, and (3) proposed some measures to mitigate the anticipated effects. As mentioned in the previous paragraph, future work should focus on upgrading documentation of dam effects and improving mitigation.

CORRESPONDENCE BETWEEN TRIBES AND AGENCIES

Methods Used in Compiling This Synthesis

In order to document the cultural resources research conducted by the tribes, SWCA compiled a bibliography based mostly on reports in the GCMRC library, contacted each tribe about their research, and summarized and synthesized the reports prepared by the tribes and their responses to us.

The first step involved compiling a draft bibliography based on reports in the GCMRC library. The GCMRC library had two ways of accessing data: a printout that lists reports by author and title, and direct examination of what is on the shelves. Confidential reports are represented on the shelves by folders with the title page, abstract, and table of contents; the text of these reports is not in the library and can be accessed only with permission from the tribes.

Once draft bibliographies had been compiled for each tribe, SWCA sent letters to each of the tribes (see Appendix B), with the preliminary bibliography, describing the project and asking each tribe if they wanted any references added or deleted. SWCA also asked the tribes for any other information they might wish to provide. SWCA received telephone responses from the Havasupai (Mr. Roland Manakaja), Hopi (Mr. Kurt Dongoske), and Zuni (Mr. Joe Dishta) (see Appendix B). SWCA was also able to contact representatives of the Hualapai (Mr. Monza Honga), Kaibab Paiute (Mr. Carlos Mayo), Navajo (Mr. Richard Begay), and Zuni (Mr. Joe Dishta and Mr. Dan Simplicio) by follow-up telephone calls (see Appendix B).

Based on the initial examination of reports and initial contacts and discussions with each tribe, SWCA wrote a summary and bibliography for each tribe, describing each tribe's research methods, results, and recommendations. SWCA then cross-tabulated methods, results, and recommendations. As data from various reports were compiled and analyzed and writing of the final draft report progressed, SWCA continued to call representatives of the different tribes with more specific questions.

Tribal Responses

All records of telephone conversations with tribal representatives are included as Appendix B. No other responses were received.

Havasupai

On the morning of February 18, 1998, Mr. Roland Manakaja of the Havasupai Indian Tribe called SWCA in response to Dennis Gilpin's letter of February 12, 1998. This was the only contact with the Havasupai Tribe.

Hopi

Gilpin spoke with Mr. Kurt Dongoske of the Hopi Cultural Preservation Office (HCPO) about the project on March 5 and June 2, 1998, and he asked to review a copy of SWCA's proposal for the synthesis project. On March 17, 1998, SWCA sent HCPO a copy of the proposal. In a telephone conversation on June 2, 1998, Mr. Dongoske said that the HCPO found the proposal satisfactory and agreed to send SWCA the Hopi Tribe's public report. In fact, SWCA used a copy of the report placed on file in the GCMRC library on October 1, 1998.

Hualapai

Gilpin spoke with Mr. Monza Honga on September 18, 1998. Mr. Honga said he would have Ms. Loretta Jackson contact SWCA with further information. Although Ms. Jackson never responded directly, the Hualapai Tribe did comment on the draft final report, and these comments have been addressed in this final report.

Navajo

Gilpin talked with Mr. Richard Begay about the project, informally on February 25, 1998, and more formally on September 18, 1998.

Southern Paiute Consortium

On March 5, 1998, Gilpin called Mr. Carlos Mayo of the Kaibab Paiute Indian Tribe. Mr. Mayo provided some information about recommendations.

Zuni

On February 20, 1998, Mr. Joe Dishta of the Zuni Heritage and Historic Preservation Office called to say they had received Gilpin's letter and would review it and respond the following week. On September 18, 1998, Gilpin talked to Mr. Dan Simplicio, who said he would get back to SWCA. On May 14, 1999, Gilpin talked to Mr. Loren Panteah.

Tribal Activities

Havasupai

In Gilpin's telephone conversation with Mr. Roland Manakaja on February 18, 1998, Manakaja first noted that the current tribal chairman is Mr. Lincoln Manakaja. Second, he informed Gilpin that the Havasupai Tribe did not sign the PA with the BOR for two reasons, one pragmatic, the other spiritual or philosophical.

Pragmatically, the Havasupai note that even in the absence of a PA, the BOR has to consult with the Havasupai Tribe on a government-to-government basis as well as under the federal government's trust responsibilities with Indian tribes. Currently, the BOR provides the Havasupai with the same documents (including reports, minutes of meetings, and records of decisions) that they provide to PA signatories, and the Havasupai can comment on these documents. The Havasupai also attend meetings when they decide it is necessary. The Havasupai sometimes prefer to consult with other tribes rather than with the BOR and to make their concerns known in concert with and through the other tribes. The Havasupai are satisfied with the current arrangement, but R. Manakaja emphasized that the BOR has always left the door open for the Havasupai to sign the PA at any time, as well as to withdraw from the PA.

On a more spiritual or philosophical level, the Havasupai believe that everything on the earth has a purpose and that it is not possible to distinguish certain things as sacred and other things as not sacred. Furthermore, no one other than the medicine people (shamans, song makers, drum keepers, and others) who use various sites or items has the authority to provide information on those sites or items or to decide how they should be used. The Havasupai prefer that sacred sites and items (as they might be described by non-Havasupai bureaucrats) not be recorded. The Havasupai receive numerous requests from a variety of federal and private agencies (Mr. Manakaja specifically mentioned BOR, the Bureau of Land Management, and the Grand Canyon Trust) for information on sacred sites. If the Havasupai were to provide this information to everyone who requested it, the people who have the authority to make decisions about the use of the sites would lose control over the sites because agencies would be able to make decisions about them without consulting the proper authorities (the medicine people). Furthermore, agency personnel change with transfers, promotions, and so forth, and therefore, over the long term, the Havasupai have no way of knowing who would be getting the information recorded.

Gilpin asked Mr. Manakaja whether the Havasupai Tribe had ever put the above principles and explanations in writing to the BOR, and he said that they had gone on record in a meeting and that Signa Larralde might have the minutes from that meeting. The Havasupai Tribe has also submitted statements to the U.S. Forest Service (USFS), specifically Larry Lesko, John Hanson, and Renee Takolai, expressing these same principles. The Havasupai Tribe has also provided Jan Balsom (Grand Canyon National Park) with ethnohistoric information and oral history related to the establishment of the park.

Hopi

The Hopi Tribe's participation is summarized in Ferguson (1998). The final report consists of an introduction, a methodology chapter, and chapters on the cultural importance of the Grand Canyon, clan migration, traditional narratives that take place in the Grand Canyon, documentary Hopi history, ethnohistory, Hopi values and natural resource use, Hopi views on management, lists and descriptions of TCPs and other sites, Hopi views on recreation, and conclusions and recommendations. Among the resources of the Grand Canyon that are important to the Hopi are water and springs, minerals, plants, and animals (including eagles). The report also considers Hopi attitudes about endangered species, reintroduction of the California condor, and erosion.

The Hopi research also included studies of the Little Colorado River. Personnel from the Hopi Cultural Preservation Office (HCPO) conducted an archaeological survey of 12 miles of the Little Colorado River above its confluence with the Colorado on June 16-18 and August 3-11, 1991. On September 14, 1991, October 5, 1993, April 29, 1994, and October 9, 1994, members of the Hopi tribe who were on river trips made one-day trips up the lower reaches of the Little Colorado River (LCR) to identify places known through traditional knowledge. In all, the Hopi Tribe identified six archaeological sites, five TCPs, five isolated occurrences, and two resource procurement locations on the LCR. The Hopi researchers also recorded 27 plant species, 19 of which had Hopi names and uses (Yeatts 1995a:Table 1). Yeatts's LCR survey report exists in public (Yeatts 1995a) and confidential (Yeatts 1995b) versions; the only difference between them is that the public version does not have site locations (Kurt Dongoske, personal communication 5 March 1998).

Kurt Dongoske (personal communication 5 March 1998) says that other reports listed in various bibliographies and finding guides—labeled n.d. (no date) in SWCA's bibliography—do not exist. They were probably proposed reports that were never actually prepared. One undated report attributed to Mr. Kuwanwisiwma (formally Jenkins), four attributed to Mr. Dongoske, and one attributed to Dr. T. J. Ferguson (Pisis'vavu) do not exist. Dr. Ferguson's proposed Pisis'vavu report became the 1994 *Öngtupka* report (which does exist), which became the 1995 *Öönga, Öngtupka, Niqw, Pisis'vavu* report. SWCA's bibliography also has a report by the Institute of the NorthAmerican West summarizing Hopi involvement in the GCES research process that Mr. Dongoske says the Institute would not have written. Instead, he says his Final Progress Report (No. 16, August 18, 1995) would have covered this information.

The Hopi research reported in 1998 included five river trips in which 22 cultural advisers participated, interviews with 72 people from 11 Hopi villages, and discussions with 67 people at 28 meetings of the Hopi Cultural Resources Advisory Task Team (CRATT). On the river trips, some 50 locations were visited, mostly Puebloan archaeological sites dating before about A.D. 1200. A GRCA RCMP staff member accompanied the Hopi on these river trips. The Hopi Tribe tended to classify sites as either sacred sites or ancestral cultural sites. Based on petroglyphs and traditional stories, the Hopi attempted to reconstruct how different sites figured in clan migrations. They also identified 77 plants with Hopi names during the EIS process and have proposed additional work on ethnobotany, having completed a river trip devoted to ethnobotanical research in September 1998 and another in the spring of 1999. After the September 1998 trip, 17 plant species were added to the list, with 14 more identified in spring 1999, for a new total of 108 identified species that are culturally significant. The Hopi have also identified 54 animals and nine minerals that are culturally significant. Furthermore, the Hopi emphasized the significance of water and springs within the canyon.

Hualapai

Hualapai cultural resources work was conducted by the Hualapai Cultural Resources Division. The final report on their work (Stevens 1996) is listed as confidential, but their overall research can be reconstructed from their quarterly reports, trip reports, and papers presented at professional meetings (Jackson 1999). From July 30 to August 6, 1993, Hualapai Cultural Resources staff took a river trip from Lees Ferry to Diamond Creek (Jackson 1994; Jackson and Stevens 1994). The goals of this trip were (1) to show cultural resource sites to elders, (2) to elicit evaluations on the significance of the sites from the elders, (3) to identify native plants and their uses, (4) to record Hualapai place names, (5) to obtain oral history on the significance of canyons, rivers, and springs, (6) to record oral history on relationships with other tribes, and (7) to elicit comments and opinions from the elders on the management of cultural and natural resources (Jackson 1994). Jackson commented on 18 cultural resource sites, including Hualapai habitations (4), a place associated with well-known Hualapai people (1), rock-writing sites (3), a burial site (1), a Puebloan site (1), the salt mine, the hematite mine, boundary lines and markers (3), a natural landmark of cultural significance to the Hualapai (1), and springs (2).

In 1995 personnel from the Hualapai Cultural Resources program and Chris Coder of the GRCA RCMP surveyed archaeological resources from Separation Canyon to Pearce Ferry (GRCA had surveyed as far as Separation Canyon), recording nine archaeological sites (Hualapai Tribe 1994b). Staff from Hualapai Cultural Resources have also accompanied at least 10 GRCA RCMP monitoring trips since 1992 (Bender 1994; Leap et al. 2000).

As described more fully in Chapter 4, Hualapai Cultural Resources studies of the ethnobotanical resources of Grand Canyon began with a series of three river trips from Diamond Creek to Pearce Ferry in 1994-95. Cultural Resources staff, accompanied by Arthur M. Phillips III and Phyllis Hogan, interviewed elders at a number of sites, providing information on the traditional uses of plants encountered during the trips (Hogan 1993, 1995; Phillips 1994a, 1994b, 1994c, 1995). In total, 46 plant species were recognized as having cultural significance to the Hualapai people during these river trips. The Hualapai Cultural Resources Division evaluated the effects of the 1996 experimental flood on ethnobotanically significant resources and the overall environment by monitoring five sites in the lower Grand Canyon deemed by the Hualapai people to have particular cultural significance: National Canyon delta (River Mile [RM] 166.5L), Granite Park (RM 209L), Diamond Creek (RM 225.5L), Bridge Canyon delta (RM 235L), and Spencer Canyon delta (RM 246L) (Hualapai Tribe 1995; Jackson and Phillips 1996; Phillips and Jackson 1996). All of these sites were visited, and one or more of the Hualapai ethnobotanical trips included interviews with elders. Three permanent line intercept plant study transects were installed at each of the sites prior to the experimental flood in March 1996, and transects were re-read immediately following the flood, six months later in late 1996 (Phillips and Jackson 1996), in the spring and fall of 1997 (Phillips and Jackson 1997), in 1998, and again in 1999 (Phillips and Jackson 1999). In addition, Hualapai Cultural Resources and the Southern Paiute Consortium carried out an assessment of the condition of the historic Goodding willow at Granite Park and stabilized the river bank to protect the tree prior to the 1996 experimental flood (Jackson 1999; Jackson, Mayo, and Phillips 1997; Thompson 1997).

Navajo

The Navajo Nation's participation is well summarized in Roberts, Begay, and Kelley (1995). Prior to 1995, the Navajo made three river trips with three goals in mind: (1) to visit 33 places, (2) to identify traditional cultural properties, and (3) to familiarize themselves with the project area. Their final report consists of an introduction, a methodology chapter, an ethnohistorical study of Navajo use of the Grand Canyon, a chapter on identified Navajo cultural resources, a chapter on natural resources in the Grand Canyon that have been used by Navajos, a chapter on the effects of Glen Canyon Dam on the resources, and an Epilogue (Alfred W. Yazzie's account of one of the river trips). The Navajo were accompanied by a GRCA RCMP staff member on these river trips.

Among the Navajo cultural resources identified were rivers, trails, subsistence areas, clan migration places, places associated with Holy People (Navajo supernaturals), and other locations. In all, Roberts, Begay, and Kelley identified some 93 locations as culturally significant to the Navajo, but, as mentioned above, most of these were in the greater Grand Canyon region, and only about 24 were within the river corridor (Table 3.1). In addition, eight sites on the South Rim of the Grand Canyon recorded by Vanette (1988) were mentioned, although these are not within the river corridor. Finally, Roberts, Begay, and Kelley listed 47 sites in the region that were identified by Navajo Land Claims researchers, although only two of these sites were identified by their consultants, and only Indian Gardens is within the canyon (but it is not within the river corridor). Natural resources of the Grand Canyon that are used by Navajos include 57 types of plants, three minerals (salt, red ochre, and white clay), fish, and wildlife.

Table 3.1. Navajo Cultural Resources Within and Outside of the River Corridor

Site Type	Within	Outside	Total
River	3	0	3
Trail	6	18	24
Subsistence Area	4	3	7
Clan Migration Place	1	1	2
Place Associated with Holy People	2	7	9
Other	8	40	48
Total	24	69	93

Southern Paiute Consortium

The Paiute Indian Tribe of Utah (PITU) is composed of five bands, the Shivwits being one of them. The Kaibab Band of Paiute Indians is a separate government. PITU and the Kaibab agreed to join together during the EIS process and formed the Southern Paiute Consortium. The San Juan Southern Paiute Tribe is a separate entity (Stoffle, Austin, et al. 1995:4), but since they have dropped out of the process, SWCA has no activities to report for them. BOR requested that the Shivwits Paiute (who have the strongest ties to the Grand Canyon region) have the greatest input during the EIS process, so Shivwits cultural experts provided most of the information (Stoffle, Austin, et al. 1995:4). The San Juan Southern Paiute were able to participate in the process for only two years and had to withdraw due to other pressing tribal business (Stoffle, Austin, et al. 1995:4). As Stoffle, Austin, et al. (1995:4) emphasized, "The San Juan Southern Paiutes [did] reserve the right to re-enter these cultural resource discussions after pressing governmental business is resolved and government officials are once again available."

Three publications came out of the Southern Paiute Consortium's research. Stoffle et al. (1994) is the overview and is in the GCMRC library and at the Cline Library at Northern Arizona University. Stoffle, Loendorf, et al. (1995) is devoted entirely to rock art. Stoffle, Austin, et al. (1995) presents management recommendations.

The Southern Paiute Consortium made four river trips to gather information from 1992 to1995, and GRCA RCMP staff members attended at least three of these trips. Trips from July 16 to 25, 1992, on October 12, 1992, and from May 1 to 16, 1993, were devoted primarily to archaeological sites (Stoffle et al. 1994:144). The research team visited 23 locations with a total of 34 archaeological sites and one location with no archaeological sites. At each stop, the team recorded any plants, archaeological sites, or rock art that were present. Paiute members of the research team were also asked about how each site might have been used by Paiutes. As often as not, site use was described as what would typically occur at a site like the one being visited; only rarely could people say that a particular site had been used in a specific way by specific individuals or families. Paiute members of the research team reported that sites in the river corridor were used in at least six general ways: (1) farming, (2) hunting/camping, (3) ritual/ceremony, (4) food gathering, (5) trade, and (6) other. Gathering food was the most common use of sites, occurring at all 24 locations visited (Table 3.2).

Stoffle, Austin, et al. (1995:71) list 23 rock art sites and five TCPs. The TCPs are *Ompi* (Hematite) Cave, Salt Cave, Deer Creek Valley and Falls, Vulcan's Anvil, and Pumpkin Spring. Few of these rock art sites or TCPs are located within the corridor's APE, however.

An April 5-17, 1995, river trip was designed to gather ethnofaunal data (Stoffle, Austin, et al. 1995:16). The Paiutes identified 34 mammals, 12 reptiles, 4 amphibians, 34 birds, 11 fish, and 12 invertebrates as culturally significant (Stoffle, Austin, et al. 1995:Table 2.2). Thirty-three mammals, 11 reptiles, 4 amphibians, 29 birds, 10 fish, and 10 invertebrates were identified according to biological classification; the others were more generally identified (e.g., "lizard").

Table 3.2. Paiute Uses of 24 Locations

Use	Number of Locations (Out of 24)
Farming	18
Hunting/Gathering	23
Ritual/Ceremony	22
Gathering Foods	24
Trade	19
Other	15

The Southern Paiute Consortium recorded information on plants during a river trip from May 1 to 16, 1993, identifying 205 plant species at 24 stops along the Colorado River (Stoffle et al. 1994:Table 7.1). This report listed the English common name and scientific name of 68 different types of plants considered culturally significant (Stoffle et al. 1994:Table 7.3). (The Southern Paiute Consortium did not specifically identify native versus non-native ethnofaunal or enthnobotanical species.)

The Southern Paiute Consortium (Stoffle, Austin, et al. 1995:Figure 1.3) devised a preliminary model showing how operation of Glen Canyon Dam affects cultural properties significant to the Paiute (Figure 3.1). Although rudimentary, this model is the only one devised for understanding how operation of Glen Canyon Dam affects cultural properties significant to Native Americans.

A final component of the Southern Paiute Consortium research program was an environmental education program for Southern Paiute students. The students made a river trip in July of 1995 and studied the hydrology, geology, biology, and anthropology of the river corridor (Stoffle, Austin, et al. 1995).

Zuni

Hart (1995) represents the final Pueblo of Zuni report for public distribution. The report includes an introduction and fairly general discussions of the traditional origin story, the trail to Grand Canyon, historical use of Grand Canyon, plant use, minerals and water, animal resources, shrines, archaeological sites, and recommendations. The introduction contains a discussion of methods, although it does not discuss specifics, such as number of trips (which may be discussed in the quarterly reports). We do know, however, that an GRCA RCMP staff member has accompanied all of the Zuni river trips since 1992. No specific plants were mentioned in the section on plant use. Twenty mineral deposits were mentioned, and the report also states that rain priests collect water

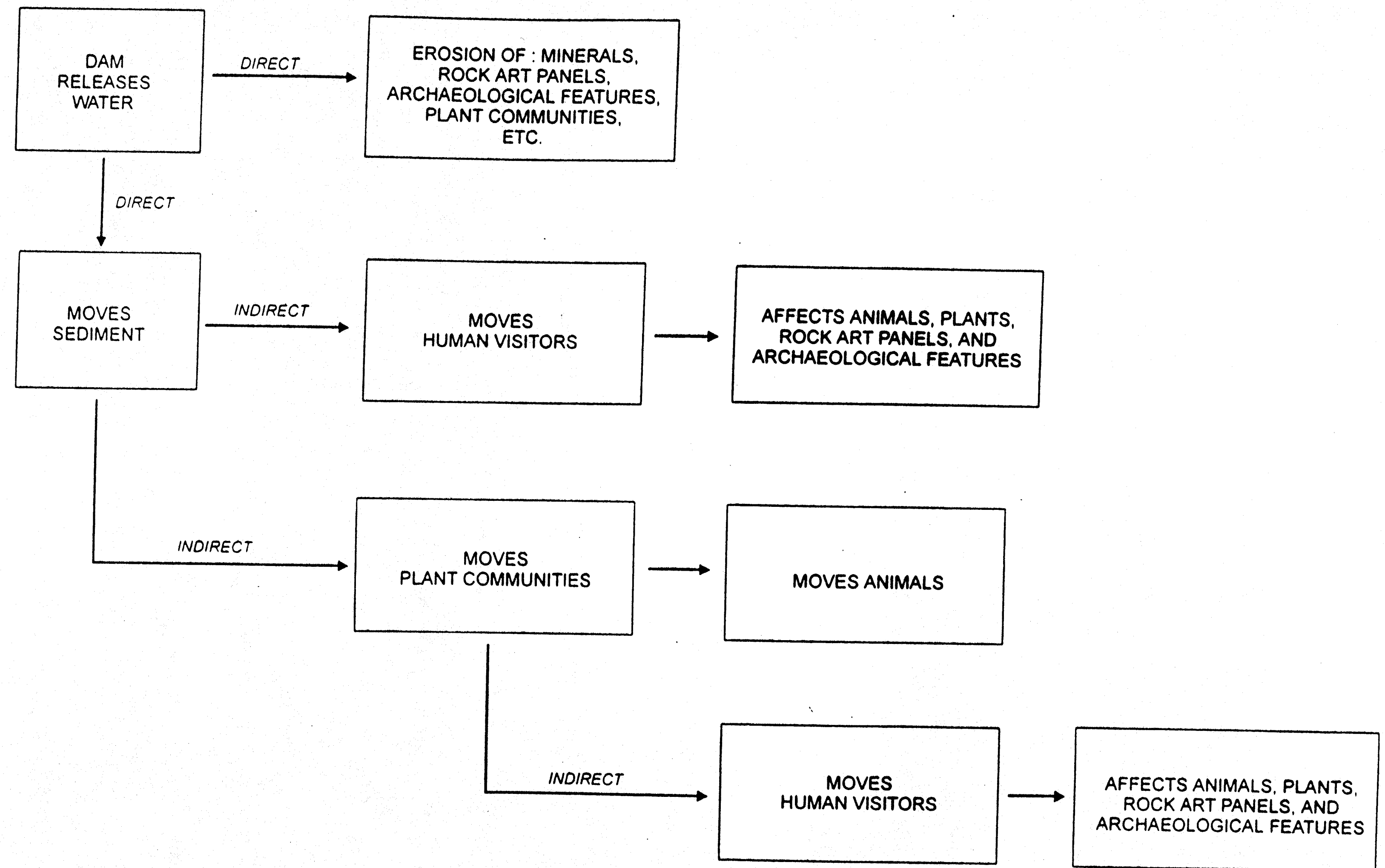

Figure 3.1. Example of direct and indirect impacts to cultural resources caused by the operation of Glen Canyon Dam (from Stoffle, Austin, et al. 1995:Figure 1.3).

from streams. Nearly 50 Puebloan sites (room blocks, refuse mounds, petroglyphs, pictographs) were examined, but the most numerous and most significant sites, being considered TCPs by the Zuni, extend from river mile 50 near the confluence of the Little Colorado River to the confluence of Bright Angel Creek on the Colorado River. The recommendations comprise the longest section.

Tribal Records

One of the basic methodological conditions of tribal research during the GCES program, and later working with the BOR/PA and GCMRC—and a key to the successful participation of the tribes—was that the tribes would control all of the records they generated during their research. The tribes now have varying amounts of data in various formats (including written notes, audiotapes, videotapes, and photographs) that are in need of archival curation. Most of the tribes contacted apparently do not have inventories of the records they control, or data managers, archivists, or librarians to care for these records. Given the tribes' uncertainty about the information in their possession, the following summary provides only an approximation of the data and archives controlled by the tribes.

Havasupai

None.

Hopi

In a telephone conversation with Lynn Neal on June 2, 1998, Mr. Kurt Dongoske of the Hopi Cultural Preservation Office said that audiotapes and transcriptions of tapes of conversations with Hopi individuals were produced during Ferguson's research archived at HCPO. Video tapes, including those shot during river trips, were also made and are archived at HCPO (Kurt Dongoske, personal communication 17 May 1999). The HCPO is in the process of cataloging all of Ferguson's data and all GCES- , BOR/PA- , and GCMRC-related data from 1990 to the present. They plan to give GCMRC a list of the types of data for different categories of information that they have in their possession. In the future, this list and maybe some samples of documents will be accessible on CD-ROM.

Hualapai

Gilpin discussed Hualapai archives with Mr. Monza Honga of Hualapai Cultural Resources on September 18, 1998. Mr. Honga said that the Hualapai Tribe did have some video and audio tapes, as well as notes, and that it would be good to computerize these (creating a computerized database).

Navajo

Gilpin discussed Navajo Nation Historic Preservation Department (NNHPD) archives with Mr. Richard Begay in a telephone conversation on September 18, 1998. Non-report archives relating to corridor research include a box of photographs, a couple of audio recordings, and notes. Mr. Begay said he does not know precisely where the notes are. He wants to inventory and organize the material.

Southern Paiute Consortium

The Southern Paiute Consortium has most extensively discussed how to archive and use the data collected during corridor research (Stoffle, Austin, et al. 1995:87-89). They have proposed the creation of a multimedia database in which audio, video, and written records could be stored on a personal computer.

Zuni

The Zuni Heritage and Historic Preservation Office's records include videotapes, photographs, and TCP field forms. For some time now, the department has experienced changes in personnel and has been understaffed, but they hope to put these on a computerized database once they are fully staffed. On their work for the EIS, Zuni visited more than 20 plant sites in the Colorado River corridor. An employee from Zuni Fish and Wildlife collected plant specimens that are now curated in the plant collections of the Zuni Fish and Wildlife Department. The report on the ethnobotany, which was submitted as part of the original EIS, is currently restricted.

Trip Reports

Each tribe was supposed to submit reports on each river trip, both as a contract deliverable with the BOR and to comply with Grand Canyon National Park requirements for research trips. In fact, most tribes did not submit trip reports. Trip reports submitted by the Hualapai Tribe include Bender (1994); Hogan (1994); Hualapai Tribe (1994a); Jackson (1994, 1996); Jackson and Stevens (1994); and Phillips (1994a, 1994b, 1994c). All of these can be found at the GCMRC library; Jackson (1994) is restricted, however. The Hopi Tribe prepared a summary of their four river trips conducted from 1991 through 1994 (Yeatts 1994). The report, which can be found in the GCMRC library, lists participants (summarizing their villages, clans, and societies), sites visited, resources identified, general recommendations, and site specific recommendations.

SYNTHESIS OF TRIBAL RESEARCH RESULTS

As discussed in previous sections, each tribe (and their consultants) classified cultural resources somewhat differently. A summary of tribal traditional cultural properties is also included in the recent project synthesis by GRCA RCMP, NPS, and NAU staff (Leap et al. 2000:52-66).

Havasupai

No data.

Hopi

The Hopi Tribe claims ancestral affiliation for over 250 archaeological sites within the Colorado River corridor. These sites are listed in a letter from the Hopi Tribe to the Bureau of Reclamation concerning the identification of traditional cultural properties and their eligibility to the National Register (Secakuku 1997). On river trips with Dr. T. J. Ferguson, the Hopi cultural advisers provided more extensive information on nine sacred sites, 38 ancestral cultural properties, nine minerals, 77 plants, and 54 animals (eagles being singled out as especially important). The Hopi also emphasized the general significance of water and springs. Ferguson (1998:283-340) summarized 52 locations mentioned by the Hopi CRATT. Two (Rainbow Bridge and Shinumo Altar) were outside the river corridor. Thirty-eight were ancestral (or potentially ancestral) sites, mostly archaeological, petroglyph, and rock-painting sites. (Thirty-one of these sites have been assigned archaeological site numbers.) Nine (Lees Ferry, Vasey's Paradise, Ochre Cave, two salt seeps, Sipapu, Salt Mine, Salt Trail, and Hematite Mine) were TCPs, with Ochre Cave, the Sipapu, Salt Trail, and Hematite Mine being outside the corridor APE. The Marble Canyon Dam Site, Saddle Canyon, and Shinumo Creek were stops where the CRATT made observations.

Hualapai

Eighteen cultural resource sites, including Hualapai habitations (4), a place associated with well-known Hualapai people (1), rock writing sites (3), a burial site (1), a Puebloan site (1), the salt mine, the hematite mine, boundary lines and markers (3), a natural landmark of cultural significance to the Hualapai (1), and springs (2), have been assessed as traditional cultural properties. The Hualapai also identified 46 culturally sensitive plants within the river corridor.

Navajo

Navajos were concerned with the whole Grand Canyon region, not just the Colorado River corridor, documenting 69 resources in the region as a whole and 24 within the corridor. Three rivers, 24 trails, 7 subsistence areas, 2 clan migration places, 9 places associated with Holy People (Navajo supernaturals), and 48 other places, as well as 8 sites on the South Rim and 47 sites in the general Grand Canyon region (but not in the Colorado River corridor), were identified by Navajo Land Claims researchers. Natural resources of the Grand Canyon that are used by Navajos include 57 types of plants, three minerals (salt, red ochre, and white clay), and fish and wildlife.

Southern Paiute Consortium

The Southern Paiute Consortium identified archaeological sites, rock art sites, traditional cultural properties, plants, and animals, with specific numbers of each provided in the Tribal Activities section of this chapter.

Zuni

Hart (1995) summarized the general significance of plants, minerals, water, animal resources, shrines, and archaeological sites without discussing specific examples, but generally 20 mineral deposits were mentioned and nearly 50 Puebloan sites were examined. These National Register–eligible sites are considered to be TCPs by the Zuni.

General Synthesis

Because each tribe had its own classification system, we do not have consistent data for comparing the information reported by each tribe. Furthermore, we do not have specific data for the Pueblo of Zuni. Thus, the following list is intended to give an idea of the range of resource types that the various tribes identified:

- Rivers (Navajo)

- Water and springs (Hopi, Hualapai, Zuni)

- Minerals (Hopi, Hualapai, Navajo, Zuni). The salt mine and the hematite mine were listed by the Hopi and the Hualapai. The Hopi listed nine minerals and pigments, including salt, two types of hematite, blue-green copper, yellow ochre, a crystal, colored sands, and two unidentified pigments. The Navajo listed salt, red ochre, and white clay.

- Plants (Hopi, Hualapai, Navajo, Southern Paiute Consortium, Zuni)

- Animals (Hopi [including eagles], Navajo [fish and wildlife], Southern Paiute Consortium, Zuni)

- Archaeological habitation sites (Hopi, Hualapai, Navajo, Southern Paiute Consortium, Zuni)

- Subsistence areas (Navajo)
- Clan migration places (Hopi, Navajo)
- Places associated with Holy People (Navajo supernaturals)
- Places associated with well-known people (Hualapai)
- Rock-writing sites (Hopi, Hualapai, Southern Paiute Consortium)
- Burial sites (Hopi, Hualapai)
- Shrines (Zuni)
- Trails (Navajo)
- Boundary lines and markers (Hualapai)
- Natural landmarks of cultural significance (Hopi, Hualapai, Navajo)
- Other (Navajo; mostly places about which Navajos have stories)

During their research, the Hopi Tribe stopped at 50 locations along the Colorado River corridor; the Hualapai Tribe identified 18 sites; the Navajo Nation identified 93 significant sites, of which 24 were within the river corridor; the Southern Paiute Consortium stopped at 24 locations, which were considered to be just a sample of what is there; and the Pueblo of Zuni stopped at approximately 50 sites. Given that some sites or locations were identified by more than one tribe, somewhere in the neighborhood of 106 sites were identified along the Colorado River corridor by the tribes (Table 3.3). In general, however, the tribes consider these sites to be only a sample of the types of sites present in a highly significant cultural landscape, not a comprehensive list of TCPs.

EFFECTS OF OPERATION OF GLEN CANYON DAM ON CULTURAL RESOURCES SIGNIFICANT TO NATIVE AMERICANS

The tribes succeeded in identifying a number of cultural resources significant to Native Americans. The next step in the research would seem to have been identifying the effects of the operation of Glen Canyon Dam on these resources. Resources impact evaluations, including resources of tribal concern, were completed for the EIS. Tribes had representation on the EIS writing team and participated in evaluating the impacts to cultural resources for the EIS. Although archaeological sites were the focus, the tribes did look at the impact evaluations for sites of concern to them. Nevertheless, cultural resources monitoring has focused on archaeological sites (Stoffle, Austin, et al. 1995:Figure 1-3; Figure 3.1 in this Chapter), and the one model of how cultural

Table 3.3. Sites Listed by Tribes as Visited

Site Number/Name	Hualapai	Hopi	Navajo	Southern Paiute
Glen Canyon Dam			✓	
Navajo Bridge			✓	
Pueblo site	✓			
Petroglyphs (not recorded, possibly not cultural)	✓			
B:2:012		✓	✓	
C:2:011			✓	
C:2:034		✓		
C:2:038		✓		✓
C:2:057			✓	
C:2:060			✓	
C:2:071				✓
C:2:073				✓
C:2:075				✓
C:2:077				✓
C:2:079				✓
C:2:081				✓
C:2:101		✓		
C:2:103				✓
C:5:001		✓		✓
C:5:037				✓
C:6:003		✓		
C:6:005		✓		
Boulder Narrows		✓		
B:9:094		✓		
Vasey's Paradise		✓		
Marble Canyon Dam		✓		
B:10:004			✓	

Table 3.3. Sites Listed by Tribes as Visited, continued

Site Number/Name	Hualapai	Hopi	Navajo	Southern Paiute
C:9:001		✓		✓
C:9:021		✓		
C:9:032		✓		
Saddle Canyon		✓		
Little Nankoweap Canyon		✓		
C:9:049		✓		
C:9:069				✓
C:9:151		✓		
Little Colorado River/Colorado River Confluence	✓		✓	
Tatatsiwqtömuy Öönga'am		✓		
Tatatsiwqtömuy Öönga'am		✓		
Hawiönga		✓		
Sipapuni		✓		
C:13:001		✓		✓
Salt Trail		✓	✓	
Salt Cave (C:13:3)	✓	✓	✓	✓
C:13:003			✓	✓
C:13:004		✓		
C:13:007				✓
C:13:010		✓		
C:13:066		✓		
C:13:099		✓	✓	
C:13:132		✓		
C:13:271		✓		
C:13:272				✓
C:13:273		✓		
C:13:070, 348, 387		✓		

Table 3.3. Sites Listed by Tribes as Visited, continued

Site Number/Name	Hualapai	Hopi	Navajo	Southern Paiute
C:13:355				✓
Cardenas Creek		✓		
River Reach 5 petroglyph		✓		
Bright Angel Pueblo		✓		
Phantom Ranch	✓			
B:16:003		✓	✓	
GCES-7 (Numbering system used by Navajo [Roberts, Begay, and Kelly 1995])			✓	
GCES-12			✓	
GCES-17			✓	
GCES-18			✓	
GCES-19			✓	
GCES-23			✓	
GCES-24			✓	
GCES-26			✓	
GCES-29			✓	
GCES-47			✓	
GCES-87			✓	
GCES-88			✓	
Shinumo Creek		✓		
Deer Creek		✓		
B:11:282				✓
B:10:001		✓		
B:10:223				✓
B:10:230				✓
B:10:251				✓
B:10:264				✓

Table 3.3. Sites Listed by Tribes as Visited, continued

Site Number/Name	Hualapai	Hopi	Navajo	Southern Paiute
Hotauta Canyon	✓			
Wickiup Site	✓			
Clay Dirt Canyon	✓			
Hualapai Reservation Boundary	✓			
Rock Shelters	✓			
Vulcan's Anvil	✓			
A:16:001	✓	✓		✓
A:16:153		✓		
A:16:154				✓
A:16:160		✓		✓
A:16:168				✓
Burial	✓			
Hematite Mine	✓	✓		
A:15:003				✓
A:15:018				✓
A:15:025				✓
A:15:042				✓
A:15:055		✓		
Granite Park (G:3:3.:26.:27.:28)	✓			✓
G:3:004		✓		✓
G:3:020		✓		
G:3:024		✓		
G:3:077		✓		
Pumpkin Springs	✓			
Three Springs	✓			
Rock-writing site	✓			
Total	18	50	24	24

Note: Sites are listed from northeast to southwest, downriver.

resources in the Grand Canyon might be affected by the operation of Glen Canyon Dam seems best fitted to archaeological sites. The effects of the operation of the dam on traditional cultural properties or sacred places has also been addressed primarily in terms that would be most appropriate for archaeological sites. Significantly, though, the tribes also identified as *cultural* resources plants, animals, minerals, water, and other resources that are generally considered *natural* resources by Americans of European descent. Therefore, one measure that needs to be taken in identifying the effects of the dam on cultural resources significant to tribes is to views that these are cultural resources.

The tribes seem to see visitation as the primary impact to cultural resources along the river (even though this has been confirmed not to be the case through the NPS RCMP's monitoring efforts, which show only 25% of monitored sites to have active visitor-related impacts [Leap et al. 2000:xiii]). The Southern Paiute Consortium model (Figure 3.1) illustrates how operation of Glen Canyon Dam and the erosion of beaches appears to concentrate visitation and camping at the locations of the most important archaeological and cultural sites. Effects of operation on particular sacred sites, plants, animals, and other cultural resources are less clear or undefined.

TRIBAL RECOMMENDATIONS

All of the public reports prepared by the tribes included recommendations, although some related more to the policies of Grand Canyon National Park than to the operation of Glen Canyon Dam. As mentioned above, most tribes seemed to feel that visitation was causing the greatest impacts to cultural resources along the river, and their recommendations focused rather heavily on managing the impacts of visitation. (This is, however, as mentioned above, in direct conflict with the findings of the NPS monitoring program. In fact, the great majority of archaeological sites and TCPs are not even visited. Any impacts to these sites are therefore erosional in nature, and this seems to be disregarded by tribal opinions. The NPS's RCMP, GRCA, and GLCA, are working to control or mitigate impacts to those sites that are significantly or increasingly impacted by visitation.) The Southern Paiute Consortium model (Stoffle, Austin, et al. 1995:Figure 1.3; Figure 3.1 in this chapter) illustrates the effect of the operation of Glen Canyon Dam on visitor impacts to cultural resources. Other than controlling visitor impacts to sites, the next most common concern of the tribes was the deterioration of the natural environment (which—as residents and long-time users of the Grand Canyon—they view as a cultural landscape). Because changes in the natural environment and the causes of these changes have not been presented to the tribes as effects on the cultural landscape nor integrated into monitoring procedures, tribal recommendations about preserving the cultural landscape are still rather provisional. Specific tribal recommendations are summarized below.

Havasupai

No recommendations.

Hopi

Ferguson (1998:354, 357-360) summarizes two basic positions of the Hopi Tribe: (1) that Glen Canyon Dam should be operated to protect the cultural environment of the Grand Canyon and (2) that the involvement of the Hopi Tribe in the decision-making process needs to continue. Summarizing the Hopi Tribe's recommendations about the operation of the dam, Ferguson (1998) states:

> In general, Hopi cultural advisors recommend that the Glen Canyon Dam be operated to (1) protect beaches, (2) protect ancestral sites and religious shrines from damage due to water releases from the dam, (3) protect cattails, willows, and other riparian growth, and (4) protect all wildlife. The dam should be operated under the principle that all living things have a right to exist [Ferguson 1998:354].

The Hopi Tribe also recognized that additional data are needed to make decisions about how to accomplish the above goals. Ferguson (1998:357-360) emphasizes the Hopi Tribe's desire to participate in both data gathering and decision making. In conversations with SWCA personnel, personnel from the Hopi Cultural Preservation Office reiterated two general recommendations: (1) continued participation by the tribes and (2) consultation with Hopi about suggested changes in the monitoring program.

Hualapai

The highest priority for the Hualapai is the protection, preservation, and restoration of the Granite Park site, a major Hualapai habitation site. The Hualapai also identified a burial site in a sand dune where they wanted erosion to be stopped. (They also recommended against recording this locality as an archaeological site, because they do not want a record of the site in archaeological site files.) Rock-writing sites, particularly those painted with red hematite, which the Hualapai recognize as their own creations, are also of great importance. and one of the recommendations was for Hualapai recording, study. and interpretation of these sites. The Hualapai believe that they have a sacred stewardship of the Hematite Mine. The Hualapai also believe that the term *Hopi* Salt Mine (author's emphasis) fails to acknowledge the use of this salt source by several tribes in the area, including the Hualapai. (The Hualapai's concern has already been heard. however, as evidenced by the Hopi descriptor *not* being used in the EIS and elsewhere.)

Navajo

The Navajo Nation recommends (1) monitoring site conditions, (2) conducting additional inspections for Navajo ceramics, (3) lessening visitor impacts at some sites, (4) incorporating Navajo history into interpretive programs at Grand Canyon National Park, and (5) recognizing that the archaeological or historic district concept is too arbitrary, because sites inside the district are related to sites outside the district. Recommendation (4) pertains to the operation of Grand Canyon National Park; the other four are pertinent to Colorado River corridor management.

Southern Paiute Consortium

The Southern Paiute Consortium (Stoffle, Austin, et al. 1995:155-156) recommends protecting sites by (1) maintaining low water levels; (2) not advertising locations of archaeological sites, rock art sites, or TCPs in displays or brochures; (3) restricting access to Salt Cave (closed), *Ompi* (Hematite) Cave, Vulcan's Anvil, Bedrock Canyon Site, and Granite Park (especially the Goodding Willow); (4) reducing trailing through sites; and (5) educating visitors. In terms of their continued involvement, the Southern Paiute Consortium recommends (1) monitoring, (2) access and youth environmental education, (3) visitor and agency education, and (4) research (particularly on ethnobotany and visitor impacts).

Zuni

The major recommendations of the Pueblo of Zuni include halting human-caused erosion but not attempting to control natural erosion, reducing visitor impacts to sites, protection of native fish, and preservation of beaches. The Pueblo of Zuni also made recommendations about presentation of Zuni history to the public by Grand Canyon National Park.

Most importantly, shrines are to remain undocumented in NPS records but be monitored by the Pueblo of Zuni. The Zuni would prefer that, if possible, archaeological sites not be disturbed; otherwise, the sites should be completely excavated. The Zuni believe that natural erosion of sites is acceptable but that human-caused erosion should be prevented or repaired.

The Zuni recommend that when workers are constructing erosion control features, they should start from the river and work up. The Zuni object to data recovery in conjunction with construction of erosion control features and object to collection of soil or pollen samples even from noncultural contexts. They urge the National Park Service (and other federal agencies) to avoid use of the word "Anasazi" in public education and interpretation of sites. They recommend reducing visitor impacts, both vandalism and erosion, and urge people not to walk in kivas or in areas that may have human remains. They believe that human remains and associated pots and funerary objects, whether exposed by human activities or erosion, should be reburied. The Pueblo of Zuni elders expressed concern that the cold water being released from Glen Canyon Dam was killing native fish and that water releases were contributing to erosion of beaches.

In a presentation at the 1998 Pecos Conference, Simplicio (1998) described his experience during a PA/BOR–sponsored trip through the Grand Canyon. He said that seeing first-hand the places mentioned in so many Zuni stories was a profoundly spiritual experience and one that he wished other Zuni people could share. Unfortunately, he noted, the cost of a commercial river trip was far beyond the means of many, maybe even most, of the Zuni people, and he expressed regret that the Colorado River through the Grand Canyon had become a playground for the wealthy. He concluded that the Pueblo of Zuni should explore ways to allow more of the Zuni people to experience the Zuni sacred places of the Grand Canyon.

DISSEMINATION OF RESULTS

All of the tribes have made efforts to disseminate the results of their studies. Methods include the preparation of public reports, publication of chapters in books and articles in professional newsletters, participation in professional symposiums, and the presentation of papers at management meetings. At least one interactive computerized program has also been produced (Hualapai Tribe 1999).

All of the tribes except the Hualapai have prepared reports, some of which are available to the public: Ferguson (1998) for the Hopi; Roberts, Begay, and Kelley (1995) for the Navajo; Stoffle et al. (1994), Stoffle, Austin, et al. (1995), and Stoffle, Loendorf, et al. (1995) for the Southern Paiute Consortium; and Hart (1995) for the Zuni. All of these reports are available in regional libraries such as the Cline Library at Northern Arizona University.

In a chapter in a book on Native Americans and anthropologists, Jackson and Stevens (1997) mention Hualapai participation in the GCES and PA research. In an article in the newsletter of the Society for American Archaeology, Anyon et al. (1996) discuss GCES research in the context of Native American oral traditions and archaeology. Mercer (1992) summarizes Native American participation in the GCES process and their views on the Grand Canyon. Begay and Roberts (1992a, 1992b) summarize the Navajo perspective, and Yeatts (1992) summarizes the Hopi perspective. Ferguson et al. (1993, 1995a, 1995b) use the GCES research as an example of how consultation with the tribes should be done. Two chapters in a recently published book concerning American Indians and national parks (Keller and Turek 1998) are dedicated to Grand Canyon National Park, with a section on the Hopi Tribe that references the Glen Canyon Dam–related research.

A significant contribution to disseminating results of all cultural resources efforts along the corridor came at the 61st annual meeting of the Society for American Archaeology (SAA) in 1996 at New Orleans. The Hopi (Ferguson et al. 1996), Hualapai (Honga and Jackson 1996), Navajo (Begay 1996), Southern Paiute Consortium (Bullets 1996), and Zuni (Dishta 1996) presented papers in the symposium sponsored by NPS and BOR entitled "Below the Dam: Cultural Resources and the Colorado River below Glen Canyon Dam."

In March of 1997, presentations similar to those given at the SAA symposium were made at the George Wright Symposium on research and resource management in parks and on public lands in Albuquerque. Representatives of the Hopi Tribe (Ferguson et al. 1997), the Southern Paiute Consortium (Osife, Bulletts, and Austin 1997), and the Pueblo of Zuni (Dishta 1997) presented papers that were published in the proceedings of the conference (Harmon 1997). Jenkins and Ferguson (1994) described the Hopi Tribe's participation in GCES/EIS research in a paper presented at the Annual Meeting of the Western History Association in Albuquerque.

Begay (1992a) described the Navajo Nation's cultural resources research for GCES at a conference on tribal cultural resource management held at Arizona State University. Begay and Roberts (1993a) presented a similar paper at a meeting of the National Research Council in Flagstaff in 1993. Begay and Roberts (1993b, 1998) presented papers at the 58th and 63rd Annual Meetings of the Society for American Archaeology. Their 1993 paper was published in a volume on Navajo archaeology (Begay and Roberts 1996).

In a paper presented at the annual meeting of the American Anthropological Association, Dongoske (1992) described Hopi research for GCES as an example of how to incorporate Native American perspectives in archaeological research. In papers presented at the meetings of the American Anthropological Association and at a conference on cultural resources and the Hopi Tribe, Ferguson (1991, 1995b) used GCES research in discussing the use of proprietary and privileged information collected during research for a Native American tribe (in this specific case, the Hopi). Yeatts and Dongoske (1999a) described the Hopi Tribe's ethnobotanical research program at the Colorado River Ecosystem Science Symposium held at Grand Canyon National Park in February of 1999.

Dan Simplicio of the Zuni Heritage and Cultural Preservation Office gave a presentation at the 1998 Pecos Conference (Simplicio 1998).

All of the tribes except the Navajo made presentations to the Technical Work Group at a meeting in Phoenix in March of 1999. Cheama (1999) discussed how a group of employees of the Pueblo of Zuni called the Zuni Conservation Projects have participated in stabilizing Colorado River corridor sites by constructing checkdams. Yeatts and Dongoske (1999b) described the general perspective of the Hopi with regard to the Grand Canyon, then went on to discuss the Hopi Tribe's current ethnobotanical research. Drye (1999) summarized the Southern Paiute research on the Colorado River corridor, and Jackson (1999) did the same for the Hualapai, presenting portions of the interactive computer program developed by the Hualapai. This computer program, *Hwalbcy Madwi: Winiyigach Guyay'I Hak Ama*, has six components: introduction, student experiences, elders and educators, plant studies and cultural sites, Granite Park songs, and acknowledgments. The Southern Paiute Consortium has developed an extensive educational program described in Stoffle, Austin, et al. (1995:136-153) and Austin et al. (1996).

Undoubtedly, all of the tribes have made less formal presentations that have not been documented in correspondence with BOR, PA signatories, GCES, or GCMRC, but a group of presentations made by Begay and Roberts, researchers for the Navajo Nation, and reported in the Navajo Nation's June 1993 progress report (Begay 1993a), may be representative. In 1992, Begay and Roberts (1992c) gave a talk to river guides on Navajo use of the Grand Canyon; Begay (1993b) gave a similar talk in 1993. Begay (1992b) gave two talks to Elder Hostel groups in 1992. Begay and Roberts (1992d) created a poster exhibit on Navajo use of the Grand Canyon and plants in the Grand Canyon for display at the Flagstaff Festival of Science in 1992. A similar poster was exhibited at the Crystal Chapter House (Begay and Roberts 1992e). Begay (1992c) gave a talk to staff members of the Northern Arizona University Branch of the Navajo Nation Archaeology Department on Navajo history and sacred sites in the Grand Canyon. In June 1993 Begay was also scheduled to be interviewed about the GCES work on the television show "Voice of the Navajo," broadcast by KOBF, Farmington, New Mexico.

RECOMMENDATIONS

The cooperative efforts among GCES researchers, BOR, GCMRC, NPS, and the tribes have succeeded in identifying cultural resources in the Grand Canyon that are significant to Native Americans. Several of the tribes emphasized the cultural landscape approach to cultural resources and specifically identified only a sample of the types of resources they consider significant rather than a comprehensive list. Preliminary assessments about the effects of Glen Canyon Dam on these resources have been suggested, and measures to mitigate the adverse effects of Glen Canyon Dam on resources significant to Native Americans have been proposed. Although some additional documentation of cultural resources and curation of records and archives are in order, future work should focus on upgrading documentation of dam-related effects and improving mitigation measures dealing with impacts to affected resources.

Dongoske and Yeatts (1998) have raised the issue of lack of coordination and integration between PA and AMP activities and have suggested an organizational plan and schedule to address this problem. Their proposal has been accepted by the PA signatories and the AMP.

Kurt Dongoske (personal communication 5 March 1998) feels that some of the tribes have more or less dropped out of the consultation process. Mr. Dongoske says that the tribes need to stay involved for several reasons: (1) they had to fight too hard for recognition to not stay involved; (2) the agencies are likely to say that the tribes insisted that the Grand Canyon was really important to them but now will not show up at meetings; (3) BOR and GCMRC are important sources of funding; (4) the tribes do have important concerns; and (5) the tribes can provide oversight on the activities of the BOR/PA and GCMRC.

For example, Mr. Dongoske is concerned that the Park Service has been minimally reactive to the need to protect archaeological sites (personal communication 5 March 1998); has neglected data analysis, publication of results, and dissemination of results to the public; and lacks a comprehensive research design for conserving cultural resources in the river corridor.

In a telephone conversation with Lynn Neal on June 2, 1998, Mr. Dongoske cited artifact control units as an example of his concerns about the RCMP. Based on suggestions by PA signatories, RCMP monitored the plant and artifact distributions in 10 1 × 1-m units at five sites from 1994 to 1996 (Coder, Leap, Andrews, and Hubbard 1995:4-5; Coder, Leap, Andrews, Hubbard, and Kunde 1995:3-7; Leap, Andrews, Kunde, Coder, and Hubbard 1996:83-84). The objective of the monitoring was to track artifact movement at sites with substantial visitor impacts, physical impacts, or both (Coder, Leap, Andrews, Hubbard, and Kunde 1995:3). Leap, Andrews, Kunde, Coder, and Hubbard (1996:83-84) criticized the study because, while it resulted in data on changes in artifact distributions, it failed to illuminate the processes causing these changes, and they therefore recommended that the study be discontinued. A position paper was provided to all attending PA signatories at a PA meeting, and after discussion of the issue the PA decided to discontinue the study (Jan Balsom, personal communication 1998; Lisa Leap, personal communication 1998). Mr. Dongoske felt that the study should not have been discontinued without reframing the research questions, reassessing the methodology, or analyzing the data more thoroughly. Mr. Dongoske's comments on drafts of this report and those of other researchers indicate that this issue may remain unresolved.

Documenting Cultural Resources

Research conducted to date has focused on identifying and recording cultural resources within the Colorado River corridor. This research has largely succeeded in recording most of the cultural resources within the corridor, but some additional work is still warranted. For example:

- The Hopi Tribe is currently conducting ethnobotanical research and has proposed that more be undertaken. Furthermore, a number of petroglyph sites listed in Ferguson (1998) have apparently not been recorded as archaeological sites.

- The Hualapai recommend additional research by the tribe on rock-writing sites.

- Navajo research was conducted in the summer, when Navajos are not supposed to tell traditional stories and therefore could not share all relevant information. A research project conducted in other seasons might provide new data. Navajo Nation personnel (Roberts, Begay, and Kelley 1995:14) were critical of the archaeological assumption that pottery equates with ethnic group. For example, sites with Hopi Yellow Ware were considered to be Hopi sites, but Roberts, Begay, and Kelley (1995:14) point out that such sites could have been occupied by Navajos using Hopi pottery acquired through trade. (GRCA archaeologists note that Hopi pottery is extremely rare in the corridor, occurring at only a few locations. They felt that it was unlikely that the recording of Hopi pottery affected the quality of archaeological documentation in any significant way.) Furthermore, Roberts, Begay, and Kelley (1995:14) note that plain graywares and brownwares of the Pai, Paiute, and Navajo are difficult to distinguish from each other. The National Research Council (1996:149) also mentioned this problem, pointing out that the archaeologists conducting the survey of the river corridor were unable to distinguish between Tizon Brown Ware (Pai pottery) and Southern Paiute Brown Ware (Paiute) pottery and therefore classified many sites as Pai/Paiute. Field identification was at times difficult, and since it was a non-collection survey, laboratory analysis of these ceramic types was not possible. Fifty sites were identified as Paiute or Pai/Paiute during the survey. Thus, more detailed analysis of pottery, flaked stone, and site organization may be warranted.

- The Southern Paiute Consortium treated the sites they visited during their river trips as *a sample* of the Southern Paiute cultural landscape. Further research may be warranted to document all cultural resources within the Colorado River corridor that are significant to the Paiute.

Archives and Data Management

Current management of tribal data ranges from adequate to poor. GCMRC needs a full time librarian with database management skills. (Archive and database recommendations were prepared by the Museum of Northern Arizona [MNA] after a workshop hosted by GCES prior to 1996. These recommendations and information on the conference should be available through MNA, which was functioning as a contractor for GCES at the time.) As mentioned above, the Southern Paiute Consortium provided the most extensive discussion of how to archive and use the data collected during GCES research (Stoffle, Austin, et al. 1995:87-89). They propose to create a multimedia database in which audio, video, and written records could be stored on a personal computer. In general, copies of public reports should be placed in more libraries or other agreed upon repositories (for example, the Hopi Tribe's public report is not yet in public libraries, and Navajo Nation researchers mentioned the need to publish another run of their public report.)

Evaluating Significance

Under the National Historic Preservation Act, BOR (in cooperation with the NPS, SHPO, and other interested parties) is responsible for evaluating which sites may be eligible for the National Register of Historic Places (NRHP). Most archaeologists emphasize the research potential of sites and nominate them to the NRHP under Criterion D. Although it may seem imperative that the research potential of a site would be evaluated according to how the site might contribute to answering important current research questions, no research design has been developed for the archaeological sites along the Colorado River corridor. Sites were evaluated according to whether or not they appeared to have intact subsurface cultural deposits or might be expected to provide information about such standard archaeological questions as site date, subsistence practices, architecture, and technology. Although there is little disagreement about which archaeological sites are eligible, the Hopi Tribe has attempted to broaden the range of criteria under which sites are considered significant. Given the fundamental importance in traditional Hopi history of the migration of Hopi clans to the Hopi Mesas, the Hopi Tribe has argued that ancestral Hopi sites should be considered eligible under all four criteria. Ancestral Hopi sites would meet Criterion A (the location of a historically significant event) because they mark stops along the migration routes of different clans. Ancestral Hopi sites would meet Criterion B (a place associated with a historically significant individual) because all Hopi ancestors are historically significant. Although Criterion C is usually invoked for historic properties of great artistic merit, 36 CFR 60.4 includes a clause that allows nomination of properties that "represent a significant and distinguishable entity whose components may lack individual distinction." In Bulletin 38, Parker and King (1990) argue that, for example, sedge fields that are not individually distinctive are important in Pomo basket making and therefore may meet Criterion C. In similar fashion, the Hopi Tribe has asserted that ancestral Hopi sites would meet Criterion C because of their importance in Hopi migration stories. The Hopi Tribe asserted this position in a letter to BOR; BOR is currently preparing a response. BOR also questions whether some properties identified as TCPs by the tribes really meet the criteria set forth in Bulletin 38.

In their recent synthesis report, Leap et al. (2000:53-54) propose that enough specific information is now available to create a successful National Register nomination for river corridor archaeological sites and TCPs in GRCA, within the format of a Multiple Property submission. They would like to see such a submission prepared in 2000. The GRCA RCMP team offer an outline of how the submission might be structured in terms of boundaries, historic context, property types, research topics, information categories, and integrity considerations. Their proposal relates mostly to considering historic and prehistoric sites under NHPA Criterion D, but they believe that other criteria undoubtedly apply to many of the sites monitored by RCMP and that many of the sites are considered as TCPs by the PA tribes. The proposed context boundary would follow the definition of the Grand Canyon river corridor provided by Fairley et al. (1994:2) in the survey report, encompassing the entire area considered to be the floodplain or riverine zone of the Colorado River within the boundaries of Grand Canyon National Park.

(*Note*: This could all become somewhat of a non-issue for the Grand Canyon, since recent strides have been made in the way of a Memorandum of Understanding [MOU] that Thomas King has drafted for the PA signatories making the entire Grand Canyon, from rim to rim, a Register-eligible TCP [Jan Balsom, personal communication 2000]). Acceptance of this MOU by GRCA's Superintendent would nullify the need to identify individual TCPs or resource areas within the Canyon.)

In any case, GCMRC may be in a position to mediate some of these issues. Under the Grand Canyon Protection Act, the GCMRC may study cultural resources that may not be eligible to the NRHP, such as culturally significant natural resources, culturally significant features and landmarks that are not eligible to the NRHP, and isolated occurrences. Furthermore, GCMRC may be able to sponsor studies on: (1) cultural landscapes of the Grand Canyon, and (2) research values of Grand Canyon sites. The former study would explore how groups of sites and their environments might be considered and managed as cultural landscapes as described by Bulletin 30. The latter study would result in an explicit research design describing what research questions will be addressed by data recovery at sites being disturbed, what methods will be used to recover these data, how data will be analyzed and how results will be disseminated. The research design could be broken down into an overall plan supported by separate historic context studies.

Determination of Effects of Glen Canyon Dam on Cultural Resources

Research by the various agencies and tribes involved in cultural resource studies along the Colorado River corridor has thus far succeeded in identifying and recording most of the cultural resources significant to Native Americans that are within the corridor. As has been mentioned, representative examples, rather than comprehensive lists, have been recorded for some types of cultural resources, particularly culturally significant natural resources. BOR is responsible for determining the effects of the operation of Glen Canyon Dam on National Register–eligible historic properties under Section 106 of the National Historic Preservation Act. GCMRC, through the AMP, is responsible for conducting studies related to research and monitoring to be used in evaluating impacts to the natural, cultural, and recreational resources of the Colorado River corridor through GLCA and GRCA that are affected by dam operations.

Ongoing monitoring by both the NPS RCMP and the tribes seeks to: (1) document how operation of Glen Canyon Dam affects cultural resources along the Colorado River corridor, (2) mitigate damages, and (3) develop plans and recommendations for preserving sites or mitigating damages. As definite linkages between dam operations and adverse effects to eligible historic properties are solidified, monitoring efforts should continue to subside and be replaced by the implementation of management recommendations to mitigate the effects. As has been discussed, RCMP (an NPS program funded by BOR) regularly monitors National Register–eligible archaeological sites and those register-eligible TCPs that are recorded as discrete sites. RCMP does not monitor TCPs that are not recorded as archaeological sites nor culturally significant natural resources. Furthermore, as is discussed in more detail elsewhere, the RCMP field forms provide information on what types of impacts are occurring at sites but are not well designed to quantify the severity of impacts at specific sites or loci within sites. Under the PA, the tribes also monitor archaeological sites and TCPs. In addition, under ongoing research, some of the tribes monitor the general condition of the Colorado River corridor, including plants, springs, minerals, and other resources that non–Native Americans typically classify as natural resources. Contrasting with some overlapping responsibilities is the situation in which the tribes typically see the Grand Canyon as a cultural landscape, while BOR is more focused on individual properties and questions whether natural resources meet the definition of TCP as described in Bulletin 38 (Parker and King 1990). It is up the PA signatories, and ultimately the NPS and BOR as the responsible agencies, to explore a more comprehensive cultural landscape approach—advocated by several of the tribes—that integrates landforms, vegetation, archaeological sites, isolated occurrences, and traditional cultural properties and impacts to this system.

Other Issues

- The Havasupai Tribe has not signed the PA. The Havasupai position has not changed, and the San Juan Southern Paiute Tribe withdrew from the process after only two years because of internal tribal management pressures. Are the San Juan Southern Paiutes ready to re-enter the process and do they want to?

- Almost all tribal participants in the Colorado River corridor research have commented on how well the process worked. An overall history of tribal involvement would therefore be a welcome addition as a GCMRC-sponsored research project. The Glen Canyon Dam project may provide an excellent overall case study of the identification and management of traditional cultural properties and cultural resources.

- Despite the continued involvement of the tribes in the overall monitoring process, tribal databases as they are, in various formats and many unaccessible to researchers or the public, cannot be balanced with the monitoring and inventory databases of NPS. Without a more effective means existing to better integrate tribal data into the overall monitoring and mitigation format, cultural resource management decisions will continue to focus on the NPS RCMP data and results of NPS efforts as a whole rather than those of the tribes. The tribes will continue to have input into the decisions made, however, as their ideas are incorporated into the NPS RCMP's system.

CHAPTER 4

ANCILLARY STUDIES: ETHNOBOTANY

Dennis Gilpin

INTRODUCTION

As mentioned in the previous chapter, the Bureau of Reclamation (BOR) was extremely open to the concerns of the tribes and set few restrictions on what the tribes were allowed to investigate. It is therefore noteworthy that ethnobotany was a significant focus of the cultural studies conducted by the tribes, comprising a major component of the Hopi, Hualapai, Navajo, Southern Paiute Consortium, and Zuni research.

The National Research Council volume summarizes the history of biological research in the Grand Canyon and provides a useful introductory bibliography of the most significant previous research (NRC 1996:84-117), including several botanical studies (Anderson and Ruffner 1987; Johnson 1991; Pucherelli 1988; Stevens and Ayers 1993a, 1993b, 1994; Stevens et al. 1994; Stevens and Waring 1985). A more comprehensive synthesis of botanical research along the Colorado River corridor has been funded by GCMRC and is currently being prepared by Michael Kearsley. According to the NRC evaluation,

> GCES provided much new information on the biotic resources of the Colorado River below Glen Canyon Dam. The abundances and distributions of many kinds of organisms were quantified satisfactorily for the first time....Many functional relationships, however, were not explored satisfactorily or were not explored at all. Some of these relationships are critically connected to management options, but studies of them were not initiated or did not come to completion in a way that would be useful to management. Finally, the integration of biotic components with each other, and joint consideration of biological and physical aspects of the environment, particularly involving sediment dynamics, remained largely undeveloped as of the end of GCES [NRC 1996:110-111].

Thus, as a result of previous and ongoing botanical studies, the tribes have comprehensive lists of plants that grow in the Grand Canyon as well as studies of how plant communities are affected by the operation of Glen Canyon Dam. As indicated by NRC, however,

> While this information is essential in support of ecosystem analysis, GCES failed to progress to a comprehensive view of connections between biotic components, physical or chemical habitat features, and operations. Synthesis was notably absent, and predictive capability was weak [NRC 1996:5].

It therefore remained for the tribes to identify the plants that were significant to them and to evaluate specifically how operation of Glen Canyon Dam affects the plants and attributes of the plants that are important to the tribes.

Phillips, Phillips, and Bernzott (1987) have identified some 1400 plant species in the Grand Canyon. The Hopi Tribe has identified 97 plants with Hopi names (Ferguson 1998; Yeatts and Dongoske 1999a); the Hualapai Tribe identified 46 (Hogan 1994; Phillips 1994a, 1999); the Navajo Nation identified 57 (Roberts, Begay, and Kelley 1995); and the Southern Paiute Consortium identified 205, 68 of which were culturally significant (Stoffle et al. 1994:Table 7.3). The Pueblo of Zuni did not list specific plants in its public report (Hart 1995). Individual species are listed in Table 4.1 by their scientific and English common names, along with the tribes that consider them to be significant. It should be noted that the Hopi and Navajo listed plants by their Hopi or Navajo names, and many plants with a single scientific name have more than one name in Hopi or Navajo. Sometimes different parts of the plant have different names; other cases in which a plant species has more than one Hopi or Navajo name are currently unexplained. Also, the Navajo listed plants from throughout the Grand Canyon region, many of which do not grow within the Colorado River corridor.

INDIVIDUAL TRIBAL DATA

Hopi

The Hopi Tribe identified 77 plant species with Hopi names during the EIS process (Ferguson 1998:Table 15). In their survey of 12 miles of the Little Colorado River above its confluence with the Colorado, Hopi researchers also recorded 27 plant species, 19 of which had Hopi names and uses (Yeatts 1995a:Table 1); the 19 culturally significant plant species in this list also appear in Ferguson (1998:Table 15). The Hopi Tribe completed a river trip in September 1998 and another in the spring of 1999 to continue more detailed research on ethnobotany, including collection of samples for identification at Hopi. After the September 1998 trip, 17 plant species were added to the list, with 14 more identified in spring 1999, bringing the total to 97 identified species that are culturally significant to the Hopi. These recent trips used knowledgeable informants who re-identified some plants to better identify them taxonomically (Yeatts and Dongoske 1999a). Plant locations were also better documented, with specific zones being targeted along the river's length and at its various elevations. Michael Kearsley's vegetation zones were used; Kearsley, a botanist with NAU who works in the Canyon, has five main study sites along the corridor where these zones have been clearly defined. During the September 1998 trip, 32 different locations were evaluated, and 50 specimens representing 52 species (17 of them new) were collected from 20 of the locations. The Hopi have their own classification system for identifying plants, which was used during this project. Mostly ceremonial plants were represented in the original 77, so some focus in later trips was on identifying plants with medicinal uses (Yeatts and Dongoske 1999a). What remains to be worked out for the Hopi ethnobotanical studies is which plants are specific to the Grand Canyon and which plant-gathering areas are significant in the canyon. The researchers hope that the Hopi Tribe will make the plant collections available at Hopi with Hopi names and general categories of use identified. A report of these ethnobotanical efforts was expected by the end of 1999 (Yeatts and Dongoske 1999a).

Table 4.1. Plant Species Identified by Four Tribal Groups

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Abronia villosa	sand verbena			✓	
A. elliptica	sand verbena	✓			
Abutilon incanum	Indian mallow				✓
Acacia greggii	catclaw acacia		✓		
Acanthochiton wrightii	(no common name given)	✓			
Acourtia wrightii	Arizona cotton		✓		
Adiantum capillus-veneris	maidenhair fern	✓			
Agave utahensis var. *kaibabensis*	Kaibab agave	✓			✓
A. utahensis var. *utahensis*	Utah agave	✓	✓		✓
Agropyron sp.	wheatgrass	✓			
Alhagi camelorum	camelthorn		✓		
Ambrosia dumosa	white bursage				✓
Anogra (Oenothera) sp.	evening primrose	✓			
Aristida sp.	three-awn grass	✓			
Artemisia bigelovii	black sagebrush				✓
A. filifolia	sand sagebrush	✓		✓	✓
A. frigida	mountain sagebrush	✓			
A. ludoviciana	wormwood, water sage	✓	✓		✓
Aster sp.	white aster	✓		✓	
Astragalus praelongus	poison vetch	✓			✓
A. tephrodes	milk vetch				✓
Atriplex canescens	four-wing saltbush	✓		✓	✓
A. confertifolia	shadscale	✓			
Asclepias involucrata	milkweed	✓			

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Baccharis emoryi	Emory baccharis	✓			
B. salicifolia	seep-willow		✓		✓
B. sarathroides	desert broom	✓	✓		
Battarrea stevenii	mushroom				✓
Berberus fremontii	holly grape, Fremont barberry	✓			
Bouteloua sp.	grama grasses			✓	
B. barbata	six-weeks grama	✓			
Brickellia sp.	(no common name given)	✓			
Bromus rubens	red brome	✓	✓		
Calamovilfa gigantea	sandreed	✓			
Canotia holacantha	false paloverde		✓		
Cassia covesii	desert senna	✓			
Castilleja sp.	paintbrush	✓			
Celtis reticulata	netleaf hackberry	✓	✓	✓	
Ceratoides lanata	winterfat	✓			
Cercis occidentalis var. *orbiculata*	California redbud				✓
Cercocarpus sp.	mountain mahogany			✓	
Chrysothamnus nauseosus	rabbitbrush	✓		✓	✓
Cirsium sp.	pink thistle	✓			✓
Cleome serrulata	Rocky Mountain beeweed	✓			
Cowania mexicana	cliffrose	✓		✓	
Datura meteloides	sacred datura, jimsonweed	✓	✓	✓	✓
Descurainia pinnata	yellow tansy mustard	✓			✓
Dyssodia acerosa	dogweed	✓			
D. pentachaeta	fetid marigold				✓

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Echinocereus triglochidiatus	claret cup cactus	✓	✓		✓
Encelia farinosa	white brittlebush				✓
E. frutescens var. *resinosa*	rayless encelia	✓			✓
Ephedra nevadensis	Nevada Indian tea/Mormon tea	✓	✓	✓	✓
E. torreyana	Torrey Indian tea/Mormon tea		✓		✓
Equisetum hiemale	scouring rush	✓			
E. laevigatum	smooth scouring rush				✓
Erigeron sp.	fleabane	✓			
Eriogonum inflatum	desert trumpet	✓	✓		
Erodium cicutarium	filaree		✓	✓	
Euphorbia polycarpa	small-seeded sand-mat		✓		
Fallugia paradoxa	Apache plume, owl's eye	✓			✓
Ferocactus acanthodes	California barrel cactus		✓		✓
Forestiera neomexicana	wild privet			✓	
Fouquieria splendens	ocotillo		✓		
Fraxinus pennsylvanica	velvet ash				✓
Gilia sp.	gilia			✓	
Gutierrezia microcephala	three-leaf snakeweed	✓	✓	✓	✓
Helianthus sp.	sunflower	✓			
Hilaria jamesii	galleta grass	✓			
Juncus acutus var. *sphaerocarpus*	spiny rush				✓
Juniperus sp.	juniper	✓		✓	
Krameria parvifolia	range ratany	✓			
Larrea tridentata	creosotebush	✓	✓	✓	✓
Lupinus sp.	lupine	✓			

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Lycium andersonii	Anderson wolfberry	✓			✓
L. fremontii	Fremont wolfberry		✓	✓	✓
L. pallidum	pale wolfberry		✓		
Machaeranthera canescens	purple aster	✓			
Mammillaria microcarpa	fishhook cactus	✓	✓		
Martynia louisana	devil's claw	✓			
Mentha arvensis	field mint				✓
M. spicata	spearmint	✓			
Mentzelia sp.	stickleaf		✓		
Mimulus cardinalis	crimson monkey flower	✓			
Mirabilis multiflora	Colorado four-o'clock	✓			✓
Muhlenbergia sp.	muhly	✓			
M. asperifolia	scratch grass	✓			✓
M. pungens	purple hair grass. sandhill muhly	✓			
Nasturtium officinale	watercress				✓
Nicotiana trigonophylla	desert tobacco	✓	✓		✓
Nolina microcarpa	beargrass. sacahuista			✓	✓
Oenothera (Anogra) pallida	pale evening primrose				✓
Opuntia basilaris	beavertail cactus	✓	✓		✓
O. erinacea	grizzly bear cactus	✓			✓
O. fulgida	chainfruit cholla			✓	
O. phaeacantha	Engelmann prickly pear	✓	✓	✓	✓
O. whipplei	Whipple cholla	✓			
Oryzopsis hymenoides	Indian ricegrass	✓	✓	✓	✓

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Parryella filifolia	dune broom	✓			
Parthenocissus vitacea	Virginia creeper				✓
Penstemon sp.	beardtongue			✓	
Phacelia sp.	(no common name given)	✓			
Phragmites australis	giant common reed		✓	✓	✓
P. communis	reed, scouring horsetail	✓			
Physalis crassifolia	wild tomato		✓		
Pinus edulis	piñon pine			✓	
P. ponderosa	ponderosa pine			✓	
Populus fremontii	Fremont cottonwood	✓	✓		✓
Prosopis glandulosa var. *torreyana*	Torrey mesquite	✓	✓	✓	✓
Pseudotsuga menziesii	Douglas fir			✓	
Quamoclidion multiflorum	four-o'clock	✓			
Quercus sp.	oak	✓		✓	
Rhus sp.	sumac			✓	
R. trilobata var. *simplicifolia*	squawbush				✓
R. trilobata var. *trilobata*	squawbush	✓	✓		✓
Ribes sp.	gooseberry			✓	
Rumex hymenosepalus	wild rhubarb		✓		✓
Salicornia utahenis	(no common name given)	✓			
Salix exigua	coyote willow	✓	✓		✓
S. gooddingii	Goodding willow	✓	✓		✓
Salsola iberica	Russian thistle, tumbleweed				✓
S. kali	Russian thistle	✓			

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Salvia davidsonii	Davidson sage				✓
S. dorrii	purple sage, desert sage				✓
Sarcobatus sp.	greasewood	✓		✓	
Sclerocactus parviflorus	pineapple cactus				✓
Scirpus acutus	hardstem bullrush, tule		✓		
S. lacustris	sedge rush	✓		✓	
Senecio sp.	groundsel			✓	
Sitanion hytrix	squirrel-tail grass	✓			
Sonchus oleraceus	common sow-thistle				✓
Sphaeralcea ambigua	desert globemallow	✓	✓	✓	✓
S. grossulariaefolia	globemallow		✓		
Sporobolus airoides	alkalai sacaton	✓			
S. contractus	spike dropseed	✓			
S. cryptandrus	sand dropseed	✓			
S. giganteus	giant dropseed	✓			
Stanleya pinnata	prince's plume, Indian spinach	✓			✓
Stephanomeria tenuifolia	wire lettuce				✓
Stipa comata	needle-and-thread grass	✓			
Suaeda torreyana	desert seepweed	✓			
Tamarix chinensis	tamarisk, salt cedar		✓		✓
T. pentandra	salt cedar	✓			
Tessaria sericea	arrowweed	✓	✓		✓
Thamnosma montana	turpentine broom				✓
Thelesperma gracile	greenthread, Hopi tea	✓			
Trifolium repens	white clover	✓			
Trixis californica	trixis		✓		
Typha latifolia	broad-leaved cattail	✓	✓		✓

Table 4.1. Plant Species Identified by Four Tribal Groups, continued

Botanical Name	Common Name	Hopi	Hualapai	Navajo	Southern Paiute
Verbascum sp.	mullein			✓	
Vitis arizonica	canyon grape	✓			✓
Xanthium saccharatum	cocklebur	✓			
Yucca angustissima	narrowleaf yucca	✓		✓	✓
Y. baccata	banana yucca, broadleaf yucca	✓		✓	✓
Y. elata	soaptree yucca	✓			
Y. whipplei	Whipple yucca		✓		✓
Ziziphus obtusifolia	graythorn		✓		

Plants in the Grand Canyon are significant to Hopi for several reasons. First, the Hopi believe that all plants and animals have the right to exist and should not be forced to extinction. Second, some plants are used by the Hopi. Third, plants that may not be used figure in Hopi stories and therefore have significance for the Hopi. Fourth, plants can serve as indicators of environmental changes along the Colorado River and therefore should be monitored in order to understand the effects of the operation of Glen Canyon Dam on other cultural resources.

In a telephone conversation with Dennis Gilpin on March 5, 1998, Mr. Kurt Dongoske of the Hopi Cultural Preservation Office said that the initial Hopi research—and the activities that are described in the Hopi Tribe's "final" reports (Ferguson 1995a, 1998)—had two goals: (1) to back up claims in the EIS and (2) to document traditional cultural properties. In Dongoske's opinion, the initial Hopi research probably succeeded in identifying all of the plant-gathering areas that qualify as TCPs. Hopi research on ethnobotany also gathered some anecdotal data about plants in the Grand Canyon. Still, the Hopi Tribe has some concerns about plants important to the Hopi that may be in the Grand Canyon. For example, Dongoske would like to know more about whether Hopi use of plants in the Grand Canyon was sustained or opportunistic. He noted that female practitioners of Hopi medicine cannot go into the Grand Canyon, so one whole set of Grand Canyon plants that are important to the Hopi may not be represented in the data previously collected. And even though these plants may not have to be collected in the Grand Canyon (i.e., they may be available at Hopi), the Hopi may still have concerns about these significant plants within the Grand Canyon. One way of documenting these plants was to collect samples in plant presses and take them back to Hopi for identification.

Hualapai

As mentioned in Chapter 3, Hualapai Cultural Resources staff began formal studies focusing on the ethnobotanical resources of the Canyon with a series of three river trips from Diamond Creek to Pearce Ferry in 1994-95. Cultural Resources staff, accompanied by Arthur M. Phillips III and Phyllis Hogan, interviewed elders at a number of sites, providing information on the traditional uses of plants encountered (Hogan 1993, 1995; Phillips 1994a, 1994b, 1994c, 1995). In total, 46 plant species were recognized as having cultural significance to the Hualapai people during these river trips (Table 4.1). Phillips (1999) lists each of these plants by scientific name, common name, Hualapai name, and the trip number or numbers on which the plant was identified.

The Hualapai Cultural Resources Division evaluated the effects of the 1996 experimental flood on ethnobotanically significant resources and the overall environment (Hualapai Tribe 1995; Jackson and Phillips 1996; Phillips and Jackson 1996). Five sites in the lower Grand Canyon deemed by the Hualapai people to have particular cultural significance were selected for study: National Canyon delta (River Mile [RM] 166.5L), Granite Park (RM 209L), Diamond Creek (RM 225.5L), Bridge Canyon delta (RM 235L), and Spencer Canyon delta (RM 246L). All of these sites were visited, and elders were interviewed during one or more of the Hualapai ethnobotanical trips. Three permanent line intercept plant study transects were installed at each of the sites prior to the experimental flood in March 1996, and transects were re-read immediately following the flood, and six months later in late 1996 (Phillips and Jackson 1996), in the spring and fall of 1997 (Phillips and Jackson 1997), in 1998, and again in 1999 (Phillips and Jackson 1999). All of the transects were re-read once each year during this period to determine the effects of 20,000 to 27,000 cfs releases during most of 1997, and to assess the progress of vegetation recovery following the 1996 flood. Each site was visited once in 1998, and in 1999 all of the sites were visited during the April Hualapai Cultural Resources river trip (Phillips and Jackson 1999). Some transects at Granite Park, Diamond Creek, and Bridge Canyon received significant amounts of sediment deposition during the 1996 experimental flood. Most of this material was eroded by high flows during 1997. Two transects at National Canyon were affected by flooding in National. One site at Diamond Creek that was eroded by the experimental flood has since been augmented twice by Diamond Creek flooding. High levels of Lake Mead gradually encroached on all sites there, eventually flooding all transects. Lower lake levels allowed two of the three transects to be read in 1999. In general, there was a gradual increase of marsh and riparian vegetation along the Colorado River shoreline in 1998 and 1999 as plants invaded and recovered after the high releases of 1997 (Phillips and Jackson 1997, 1999).

In addition, Hualapai Cultural Resources and the Southern Paiute Consortium carried out an assessment of the condition of the historic Goodding willow at Granite Park, reported in Jackson, Mayo, and Phillips (1997) and Thompson (1997).

Navajo

The Navajo Nation (Roberts, Begay, and Kelley 1995) identified 57 types of plants significant to the Navajo that can be found in Grand Canyon National Park. Some of these plants (e.g., Douglas-fir, ponderosa pine) do not grow within the corridor. The Navajo Nation's public report presents the Navajo name for all of the plants, the English translation of the Navajo name for 50 of them, and the English common name for 44 of them. It should be noted that some plants have more than one Navajo name, and that different parts of some plants have different Navajo names and that these plants are therefore listed twice.

Southern Paiute Consortium

The Southern Paiute Consortium recorded information on plants during a river trip from May 1 to 16, 1993 (Stoffle et al. 1994:Table 7.1), identifying 205 plant species at 24 stops along the Colorado River. The Southern Paiute Consortium (Stoffle et al. 1994:Table 7.3) reported the English common name and scientific name of 68 different types of plants considered culturally significant; they could not remember the Paiute name for 11 of these plants. An ancient Goodding willow at Granite Park was singled out as being individually significant. The Southern Paiute Consortium divided the river corridor into five ecozones: (1) canyon wall, (2) desert, (3) old riparian, (4) new riparian, and (5) side canyon riparian (Figure 4.1). The side canyon riparian ecozone contains the largest number of plants (103), followed by the desert ecozone (92 plants), the old riparian ecozone (90 plants), the new riparian ecozone (85 plants), and the canyon wall ecozone (17 plants) (Table 4.2). Paiutes identified as significant 23.5% of the plants in the canyon wall ecozone, 40.2% of the plants in the desert ecozone, 46.7% of the plants in the old riparian ecozone, 36.5% of the plants in the new riparian ecozone, and 43.7% of the plants in the side canyon riparian zone. The old riparian ecozone was once flooded on a regular basis but has not been regularly flooded since construction of Glen Canyon Dam. The new riparian ecozone is currently most affected by releases from the dam; the desert and canyon wall ecozones are not affected by dam operations. Southern Paiute cultural experts recommended preservation of the Goodding Willow at Granite Park (which has since occurred—see Hualapai under the Tribal Activities subsection in Chapter 3). Otherwise the Southern Paiute Consortium argued for preservation of vegetation on a general level.

Zuni

The public report prepared by the Pueblo of Zuni (Hart 1995) did not list specific plants and the report that does discuss plants is still restricted. Plant collections from approximately 20 locations or more are curated by the Zuni Fish and Wildlife Department.

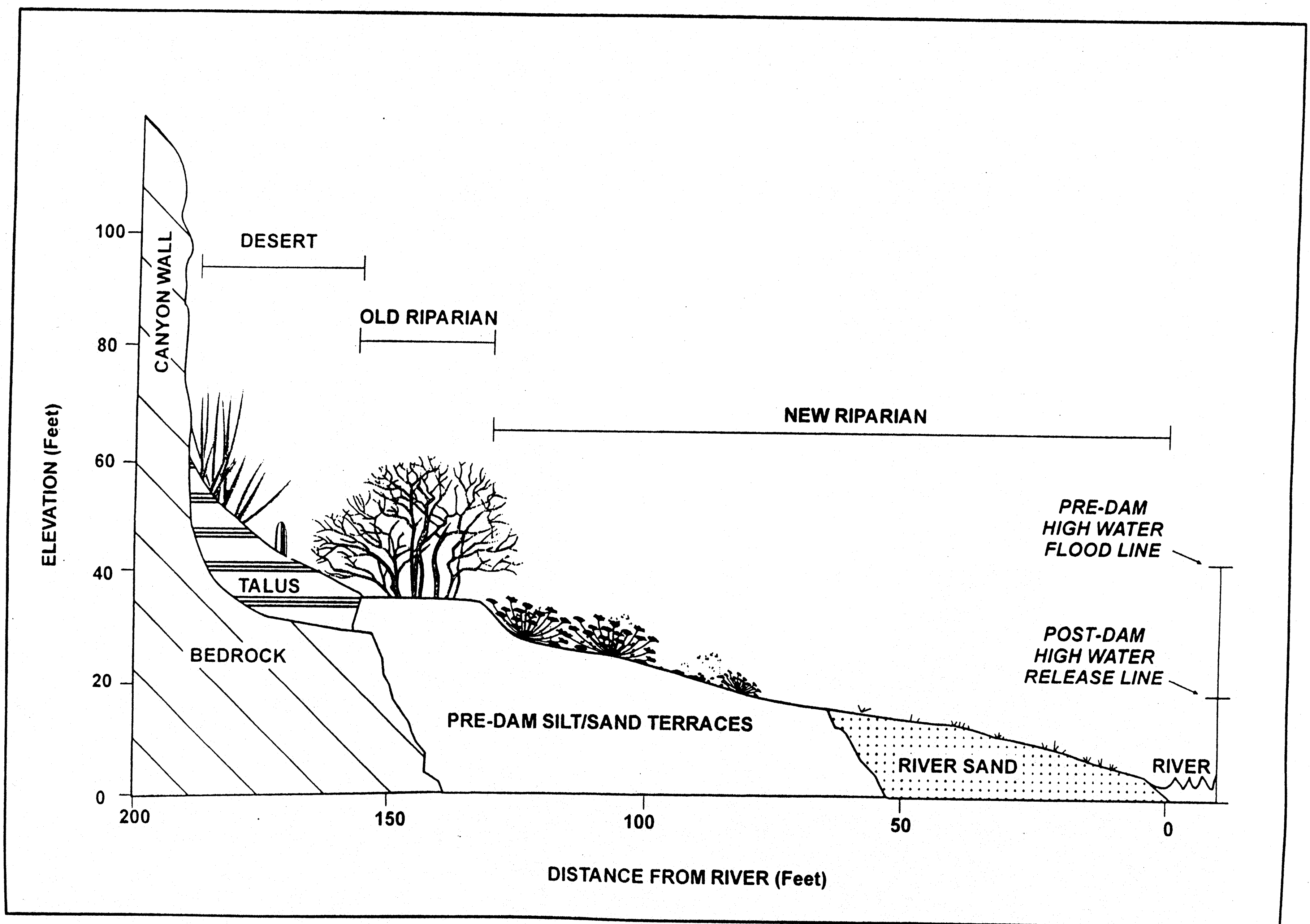

Figure 4.1. The Southern Paiute Consortium's five vegetation ecozones (Stoffle et al. 1994, adapted from Carothers, Aitchison, and Johnson 1979:Figures 2 and 3). (*Note*: The side canyon riparian zone is not illustrated here.)

Table 4.2. Number of Plant Species Identified by the Southern Paiute Consortium within Each Ecozone

Ecozone	All Plants			Southern Paiute Plants		
	Number of Species Exclusive to Ecozone	Total Number of Species within Ecozone	Percent of All 205 Species Identified on Trip	Number of Species Exclusive to Ecozone	Total Number of Species within Ecozone	Percent of All Species within Ecozone
Canyon Wall	2	17	8 %	0	4	24 %
Desert	22	92	45 %	6	37	40 %
Old Riparian	16	90	44 %	6	42	47 %
New Riparian	21	85	41 %	1	31	36 %
Side Canyon Riparian	36	103	50 %	9	45	44 %

Note: after Stoffle et al. 1994:Table 7.13

RECOMMENDATIONS

The tribes carried out tribal ethnobotanical studies for several reasons: (1) the tribes consider plants to be cultural resources in that (a) Native Americans use different plants and (b) even plants that are not used figure in traditional stories; (2) most, if not all, of the tribes believe that all plants are significant in and of themselves as part of creation and should not be forced into extinction; and (3) plant cover and distribution can serve as indicators of environmental change caused by the operation of Glen Canyon Dam. Furthermore, at least one tribal group (the Southern Paiute Consortium) desires to see plant cover increased, even though studies show that the pre-dam corridor environment would have been far less vegetated overall. The tribes have already identified the plants they consider significant, and the Hualapai, Hopi, Navajo, and Southern Paiute Consortium have submitted lists to BOR/GCES, NPS, and GCMRC. The Pueblo of Zuni's public report did not name specific plants; the lists of plants considered significant by the Hopi, Hualapai, Navajo, and Southern Paiute Consortium are combined in Table 4.1. The list of plants considered significant to the Navajo includes species that do not grow along the river corridor, and a botanist would need to document which ones do grow within the corridor. In fact, it would be useful to park managers to know whether each of the plants listed in Table 4.1 is within or outside the river corridor (APE) and whether each of the plants is native or introduced. The Hopi and Hualapai tribes are currently carrying out additional ethnobotanical research.

Of all the ethnobotanical studies undertaken by the tribes, the Hualapai studies (Hualapai Tribe 1995; Phillips and Jackson 1996, 1997, 1999) and the Southern Paiute Consortium study (Stoffle et al. 1994) seem most capable of documenting the effects of the operation of Glen Canyon Dam on plants considered significant by Native Americans. The next phase of research should entail monitoring the distribution and density of plants within the corridor, evaluating effects of the dam on the culturally significant vegetation, and making recommendations, perhaps following the model presented by the Southern Paiute Consortium (Stoffle et al. 1994). Plants are cultural resources as well as natural resources, and the tribes need to be provided with data on stability and change in plant distributions and density at sites within the river corridor, along with interpretations about how the operation of Glen Canyon Dam may be affecting these distributions and densities. In addition, a GCMRC database manager should continue to update the data provided in this chapter as new studies are conducted.

CHAPTER 5

ANCILLARY STUDIES: GEOMORPHIC MODELING TO PREDICT EROSION OF PRE-DAM COLORADO RIVER TERRACES CONTAINING ARCHAEOLOGICAL RESOURCES

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PROJECT JUSTIFICATION AND ORIENTATION

The GCMRC has funded a geomorphic study to address concerns about gully erosion and arroyo cutting associated with archaeological sites in the Colorado River corridor below Glen Canyon Dam and the need to further test the current geomorphic hypothesis proposed by Hereford et al. (1993). This hypothesis, referred to as the base-level hypothesis, suggests a causal link between Glen Canyon Dam operations and accelerated erosion of certain archaeological sites. The geomorphic study completed by principal investigators Kate Thompson and Andre Potochnik with SWCA (Thompson et al. 2000) also describes the utility of a predictive model concerning physical erosion of archaeological sites designed to streamline monitoring and prioritize remedial efforts at archaeological sites along the Colorado River in Grand Canyon.

The primary concern of the BOR, NPS, GCMRC, and others is establishing how the operation of Glen Canyon Dam is directly or indirectly impacting cultural resources on the river corridor. It has been the responsibility of the NPS to identify and evaluate the significance of eligible cultural properties, and affected Native American tribes are encouraged to identify their ancestral connection to these resources. In turn, both NPS and tribal groups are concerned with protecting significant cultural resources. The NPS mandate requires preservation of the integrity of these resources for the tribes and the public. The Grand Canyon Protection Act (1992) specifies that Glen Canyon Dam "shall be operated in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use." It was the concern of the geomorphic researchers, therefore, to rate archaeological sites and/or areas containing cultural resources as to their susceptibility or vulnerability to degradation from geomorphic processes.

Research conducted under GCES Phase II documented erosional degradation of numerous sites within the old high-water zone of the pre-dam period (Carothers and Brown 1991; Hereford et al. 1991). This finding prompted Hereford et al. (1993) to formulate the hypothesis that site degradation was fundamentally caused by rainfall-induced erosion of the pre-dam terraces due to the disappearance of sand bars fronting these terraces. These bars, located at the "toes" of the culturally rich pre-dam terraces, served as buttresses in the pre-dam period, preventing downcutting by small tributary streams that drain onto the higher terraces. Before the dam, annual floods renewed these buttress deposits each year. With the onset of post-dam erosion of pre-dam terraces, heavy local rainfall has initiated downcutting into terraces by creating headward erosion, which has damaged cultural sites. Furthermore, several streams that once drained onto a higher terrace level as terrace-based streams have since breached the buttress deposits and currently drain directly into the Colorado River as river-based streams.

In sum, the Hereford et al. (1993) hypothesis proposes that post-dam operations indirectly impact archaeological sites because sediment is no longer being replenished at the bases of pre-dam terraces by annual flood events. This hypothesis has been refined by the current study to improve its predictive utility in determining how, when, and where terrace-based erosion is likely to impact previously identified archaeological resources within the study areas. The predictive model can then be applied to cultural properties outside the study areas by evaluating a site's physical characteristics and environment and matching them with a studied environment.

The draft HPP (BOR et al. 1997) targets the need for a refined understanding of erosional processes and in particular calls for "a predictive model of geomorphic processes related to archaeological site erosion." As stated in the draft HPP, this effort will help close gaps in the database by integrating archaeological findings and efforts with the geomorphic model, thereby ultimately assisting in preserving cultural sites along the river corridor.

The objectives for the geomorphic study conducted by Thompson et al. (2000:1) were threefold: (1) to test hypotheses of accelerated gully erosion in the post-dam period that may explain the apparent increased erosion rates at cultural sites on pre-dam Colorado River terraces; (2) to develop a predictive geomorphic model to identify site vulnerability to gully erosion related to selected archaeological sites, providing a useful tool for long-term monitoring, preservation, and mitigation of these resources; and (3) to identify the most threatened sites so that GRCA cultural resource managers can prioritize remedial action needs. Thompson et al. (2000) were able to compare model predictions with on-site field evaluations to test the validity of their model. They also discuss how monitors/archaeologists can use this model as a practical predictive tool for anticipating the vulnerability of sites to incipient degradation.

Using a variety of variables, the resulting vulnerability ratings were then applied to create a priority ranking of the studied catchments in cultural areas. This system provides cultural resource managers with a better understanding of erosional processes affecting cultural sites so that they can streamline the decision-making process for remediation. This study also provides cultural resource managers with a practical predictive tool for anticipating the vulnerability of sites to incipient degradation, and the best possible erosion control measures can then be used to protect the priceless cultural resources and associated natural habitat. Finally, the study also identifies cultural areas that will benefit from a sediment-laden flood and those that may be negatively impacted by a flood, since the geomorphic investigations have given researchers the ability to better assess loss of site fabric and therefore integrity in particular geomorphic settings.

PREVIOUS STUDIES AND BACKGROUND INFORMATION

The geomorphology associated with archaeological sites along the Colorado River corridor (317 of which have been actively monitored, are recommended as eligible to the National Register of Historic Places, and are on pre-dam Colorado River alluvium [considered to be within the Area of Potential Effect]) was investigated by Hereford et al. (1991, 1993), Hereford et al. (1995), Lucchitta (1991), and Lucchitta et al. (1995). These researchers identified periods of deposition and erosion from Quaternary times until the present by mapping the great variety of these depositional sequences present along the river corridor. Detailed mapping of specific sites (Hereford 1996a; Hereford, Burke, and Thompson 1996; Hereford, Thompson, and Burke 1994a, 1994b; Thompson, Burke, and Hereford 1996) has provided an understanding of geomorphic processes affecting these deposits, which has, in turn, allowed the formulation of the hypothesis set forth by Hereford et al. (1993), that erosion of pre-dam alluvial terraces is at least indirectly the result of dam operations. However, Hereford et al. (1993) were criticized for not establishing a control site for comparison outside the Grand Canyon where the river is largely uncontrolled by dams, although the BOR would not allow or fund it.

Hereford et al. (1993) and Hereford et al. (1995) described and synthesized the late Holocene alluvial terrace stratigraphy in four discrete study areas of the Furnace Flats reach (Schmidt and Graf 1990) on the Colorado River. In this reach, these pre-dam alluvial terraces comprise an extensive geomorphic system that interfaces with two adjacent geomorphic systems: the tributary plain system (Hereford et al. 1995; Webb, Pringle, and Rink 1989; Thompson et al. 2000) and the river channel system (Rubin, Schmidt, and Moore 1990; Schmidt 1990; Schmidt and Graf 1990). Hereford et al. (1995) developed methods for dating late Holocene debris fans by integrating archaeological and radiocarbon techniques from adjacent fluvial terraces. In addition, they produced and published detailed geologic maps of two major tributary fan complexes, Nankoweap Creek (Hereford, Burke, and Thompson 1996) and Palisades Creek (Hereford 1996a), that illustrate the late Holocene stratigraphy.

Hereford et al. (1993) also described various geomorphic processes affecting the pre-dam alluvial terraces, particularly the effects of local ephemeral stream networks that cross the terraces. They distinguished terrace-based streams from river-based streams, based on whether the stream terminates on a pre-dam alluvial terrace or is integrated with the river or a major tributary to the river (side canyon–based). They noted that river-based streams had cut deep arroyos in the sandy pre-dam terraces, exposing and eroding numerous archaeological sites. Hereford et al. (1993) further suggested the possible effects of local climatic variations that were eroding the pre-dam terraces that contain most of the cultural sites.

Hereford et al. (1993) pointed out the need to understand cause and effect relations between the pre-dam alluvial terrace system and post-dam water flows and associated deposits. They hypothesized that the presence of Glen Canyon Dam, with its regulated flows and reduction in sediment supply, had increased natural erosive processes on pre-dam terraces. Before regulation of the Colorado River, small ephemeral streams probably drained to a higher local base level, represented by the pre-dam terraces. Under pre-dam conditions, sand and silt deposited in the mouths of small tributary channels during annual floods would infill previously eroded headcuts, thus preventing them from migrating up-channel. With local intense rainfall as the driving force, channels are presently extending headward and widening, as they adjust to the new post-dam base level. Once streams reach this configuration, erosion of upper terraces is greatly accelerated, rendering remedial efforts difficult, if not, in some cases, fruitless.

If this hypothesis is correct, the size and characteristics of channel-margin sand bars along the river are of critical importance in determining rate and extent of erosion of cultural sites. A model for sediment transport and deposition by the post-dam river was produced by Schmidt (1990), Schmidt and Graf (1990), and Rubin, Schmidt, and Moore (1990). The continuing work of Kaplinski et al. (1993) evaluates changing conditions on channel-margin sand bars along the river under different flow regimes; their work is also relevant to the modeling of mainstream flow and sediment dynamics in selected locations containing cultural resources, a current GCMRC-funded project under the Cultural Resources Program by Stephen Wiele of the USGS. Wiele's multi-dimensional model of flow, sand transport, and riverbed evolution has been developed and is being applied to four areas between river miles 65 and 72 to study depositional rates and processes for varying channel morphologies and sand supplies (Wiele 1997; Wiele, Andrews, and Griffin 1999; Wiele, Graf, and Smith 1996; Wiele and Griffin 1997; Wiele and Smith 1996). The purpose of Wiele's GCMRC project is to assess the effect of the operation of Glen Canyon Dam on sand bars located near the water's edge. Erosion of archaeological sites by the formation and propagation of arroyos has been linked to the erosion of the Colorado River sand bars since the opening of Glen Canyon Dam (Hereford et al. 1991, 1993). Data derived from this project will assist cultural resource managers in evaluating possible impacts to cultural resources from flood inundations and related fine-sediment deposits at varying flow regimes. The study will also assist in testing the geomorphic hypotheses. Together, these studies may be extremely important in predicting the longevity of the pre-dam terraces.

METHODOLOGICAL APPROACH

Under the Hereford et al. (1993) hypothesis, with local intense rainfall as the driving force, channels are presently extending headward and widening as they adjust to the new post-dam base level (the lowered level at which river sand bars are currently deposited due to regulated flows). Small ephemeral streams are generally re-establishing grades to a lower effective base level. Although this hypothesis is quite viable, it has been criticized for two reasons: (1) an analogous setting on a wild river has not been examined to determine whether some external factor (e.g., climate change) is causing the erosion; and (2) base-level efforts may not be the only geomorphic mechanism for inducing accelerated erosion by small streams.

Thompson et al.'s (2000) first step was therefore to review related literature on alternate hypotheses, such as intensified monsoonal rainfall, natural base-level change, and increased animal and human impacts. An annotated bibliography was provided to GCMRC in an interim report by

Thompson, Potochnik, and O'Brien (1998:Appendix A, Part 3). The repeat photography collection of Robert Webb, a USGS hydrologist conducting work in the Upper Colorado River Basin, was also investigated to record changes at any of the study sites. The researchers supplemented this collection with Belknap's 1963 photos and rephotographing of related sites. Much of the numerical data had already been collected or was generated from detailed topographic base maps and low-altitude aerial photography. Field studies consisted of methodical observations and quantitative measurement of selected catchments (n=119) associated with archaeological sites in the Grand Canyon. Catchment site variables were recorded on a data sheet that is included as Appendix C in this report. Catchment sites were identified in coordination with Lisa Leap, GRCA RCMP lead project archaeologist, so that they could closely relate local catchment parameters to the nearby archaeological resources. A discrete number of catchments, as listed in Table 5.1, provided the areas used for the predictive model. Archaeological sites and their associated catchment areas were chosen according to their cultural significance and associated physical properties, such as location relative to the river, parent material of the deposit, and type of tributary stream associated with the site.

To establish a control outside of Grand Canyon, the geomorphic team conducted studies in Cataract Canyon. Based on initial field observations and consultations with Robert Webb, they determined that Cataract Canyon provides the setting most analogous to the pre-dam environment in Grand Canyon. Not only is Cataract Canyon in a similar climatic zone, it carries a similar pre-dam sediment load and has an annual hydrograph approximating that of the Grand Canyon (Van Steeter and Pitlick 1998). One difference is that many river recirculation zones in Cataract Canyon are formed by constrictions caused by landslides and rockfalls rather than by tributary side canyon fans. Nonetheless, similar geomorphic settings and terrace sequences, flow history, and hydrologic features occur between Grand and Cataract canyons. Specifically, the researchers attempted to correlate the alluvial history in Cataract Canyon with that in Grand Canyon. Once the terrace sequence was complete, detailed topographic maps of three selected small areas were generated, chosen because they have two components: (1) complete terrace sequences and (2) juxtaposed river- and terrace-based streams within a small area.

Another means of testing the base-level hypothesis in Grand Canyon was characterizing the process of channel integration with the river at each of the selected catchment sites. Thompson et al. (2000) did this by identifying all of the alluvial terraces present and recording whether gullies drain toward a recirculation zone (upper pool, separation, or reattachment bar), point bar, or cutbank (channel margin bar). By doing so, they were able to record the presence of pre-dam alluvium (pda), 1983 flood sand. and any active eolian sand derived from these deposits. This information provided a basis for evaluating the base-level hypothesis as a general process operating throughout the river corridor. The researchers' data indicated that channelization occurs as a result of some combination of six processes. documented at each of the study sites: (1) alluvial fan progradation, (2) ponding and overflow, (3) piping, (4) nickpoint migration, (5) scarp retreat from the river, and (6) trailing that forms channels for runoff. The researchers also recorded any evidence of sediment renewal, including the presence of the 1983 and 1996 post-dam flood sands at each catchment site compared to the presence of pda sand. The base-level hypothesis was then refined at each of the 119 sites according to the processes at work.

Table 5.1. Cultural Areas in Grand Canyon Containing Study Catchments

Reach	Area	River Mile/Side	Number of Catchments
Marble Canyon	Paria Cove	1.0/R	2
	Axehandle Cove	2.0/L	3
	Ten Mile Rock	10.0/R	1
	Soap Creek	11.2/R	3
	Willy's Grave	44.8/L	1
	Little Nankoweap	51.7-52.0/L	5
	Main Nankoweap	52.5-53.3/R	12
	Kwagunt Canyon	56.1/R	1
	60 Mile Canyon	59.7/R	2
Furnace Flats	Lava Canyon	65.3/L	2
	Palisades Creek	65.4-65.6/L	10
	Espejo Creek	66.9-67.0/L	3
	Comanche Creek	67.1-67.8/L	4
	Tanner Canyon	68.9-69.0/L	2
	Basalt Canyon	69.3/R	5
	Lower Tanner	69.6-70.3/L	6
	Upper Unkar	71.5-71.6/R	8
	Old Unkar Camp	72.2/R	1
	Lower Unkar	73.2/L	3
Aisles	122 Mile Canyon	121.9-122.0/R	4
	Owl Eyes	134.5-134.6/L	4
	Fishtail Canyon	139.0/R	1
	140 Mile	139.7/L	1
Western Grand Canyon	Saddle Horse Canyon	176.3/R	2
	Old Heli Pad	182.7/R	1
	186 mile	186.2/R	1

Table 5.1. Cultural Areas in Grand Canyon Containing Study Catchments, continued

Reach	Area	River Mile/Side	Number of Catchments
	190 mile	189.7/L	1
	194 mile	194.4/L	1
	196 mile	196.2/R	1
	201 mile	201.2/R	5
	202 mile	201.9/R	2
	Indian Canyon	206.5/R	2
	Arroyo Grande	207.7-207.8/L	6
	Granite Park	208.5-209.1/L	9
	Below Granite Park	209.5/R	3
	Fall Canyon	211.5/R	1
Total	**36**		**119**

Finally, a conceptual model, developed with assistance from statistical modeler Ron Ryel, was created using precipitation, watershed, soils, and vegetation as the critical variables. Five type-catchment study sites were selected from the catchment sites listed in Table 5.1. The type sites represent five unique geomorphic settings that coupled with type catchments are represented in study areas with significant archaeological resources and are as follows:

(1) Alluvial fan—Nankoweap
(2) Tributary plain—Palisades
(3) Talus slope—Upper Unkar/Furnace Flats
(4) Debris lobe—122 Mile Canyon
(5) Dune field—Lower Tanner

The researchers chose to represent these geomorphic settings by modifying a series of base maps produced by GCMRC and Horizons, Inc. These topographic base maps, produced from 1998 aerial photography, are a product of new photogrammetric technology. The researchers had planned to use existing base maps available from the USGS (Hereford 1996a; Hereford, Burke, and Thompson 1996), GRCA RCMP, and GCMRC (GIS maps) for this part of the study. However, in scrutinizing these maps, they encountered problems with scale, coverage, and legibility that would ultimately preclude effective one-dimensional flow modeling (S. Wiele and S. Lamphear, personal communication 1998). The geomorphic researchers were hoping to work with Wiele to model different streamflow events through selected catchments on these maps to better predict the type of rainfall event that would downcut the drainages. The new maps show excellent detail of drainage geometry and topography at 0.25-m contour intervals. The researchers sought base maps with a large enough scale to precisely plot details within each channel for use in flow modeling, such as areas of channel roughness, nickpoint locations, and stream cross sections. Other data collected from the type sites included soil infiltration rates, grain-size distributions, surface geology, and location of archaeological sites.

Resulting from the modeling process was the indication that slope and drainage basin area are principal components driving erosion, while vegetation seems to be the principal component resisting erosion. Active eolian deposition seems to be the predominant process for restoring or preventing gully erosion; yet this process is dependent on fresh sediment supply, which has been provided recently only by the 1996 flood sand. Furthermore, eolian infilling is mostly beneficial if the source is fresh flood sand rather than pre-existing terraces.

RESULTS AND CONCLUSIONS

The following excerpt is taken from the introductory paragraph in the Conclusions section of the Thompson et al. (2000) report:

> Results of this study indicate that the balance between catchment erosion and flood-sand deposition in Grand Canyon has been disrupted since emplacement of Glen Canyon Dam. The geomorphic response to this condition is gully rejuvenation, where down-cutting is initiated and accelerated. Also, terraces lying below cultural sites are no longer being sustained at their higher pre-dam level. The reduction of fine sediment supply (sand, silt, and clay) has propagated headward erosion at terrace risers, providing a link for gullies draining onto higher terraces to be integrated with the river. The result is increased rates of erosion on the cultural terrace through channel deepening and widening. In arriving at these conclusions, we investigated two hypotheses that might account for these changes and developed a mathematical model for predicting erosion of pre-dam terraces (2000:113).

The first of the two hypotheses is the climate-variation hypothesis, which states that increasing intensity of rainfall has accelerated erosion processes. From an examination of previous work, it appears that warm-season precipitation was more intense than average during the decades before 1932, was less intense from 1932 to 1980, and has been more intense than average again since 1980 (Thompson et al. 2000:113). Previous work on winter-season rainfall shows a similar pattern of high precipitation in the first decade and last two decades of the twentieth century. Their overall conclusion, however, from examining weather stations throughout the Colorado River corridor is that warm-season rainfall intensity did not significantly change in the 32 years before and after emplacement of the dam. Although Thompson et al. (2000) cannot reject the hypothesis that increases in precipitation have caused increased gullying in the 1980s and 1990s, these pulses of wet and dry periods also occurred in pre-dam time, and the restorative effects of annual floods probably outweigh any subtle differences in precipitation patterns.

Actual erosion of a particular gully probably occurs during a major rainstorm and flood, but the condition conducive to accelerated erosion—flood sands that are not replenished in sediment on an annual basis—is already present. After evaluating each site for processes that seem to be driving erosion, the researchers support the second of the two hypotheses that they evaluated, the current base-level hypothesis (Hereford et al. 1993). Thompson et al. (2000) agree with previous researchers (Hereford et al. 1993; Lucchitta et al. 1995; Schmidt and Graf 1990) that pre-dam terraces are in a stage of net erosion, accelerated by the lack of renewed river sediment. A few catchment sites that did not support the base-level hypothesis are identified below. Thompson et al. (2000) suggest that the current hypothesis be clarified to include the instrumental effects of wind. Therefore, the new operating base-level hypothesis suggests that recurrent floods with a fresh source of sand are instrumental for healing gullies and replaning or maintaining lower terraces, while providing a supply of material for eolian deposition onto the upper terraces.

The geomorphologists have documented evidence of cut-and-fill in pre-dam terraces at a few sites. Cut-and-fill structures in terraces provide evidence that gully erosion and subsequent infilling by river sand has been an ongoing process until recently. The researchers propose that this dynamic process has been upset by the lack of fresh river sand renewal. Only where they could find good exposures within an arroyo or side canyon were any cut-and-fill structures obvious in the stratigraphy, and only three areas outside of the Hereford et al. (1993) study areas showed cut-and-fill structures: Espejo Creek, Soap Creek, and Arroyo Grande (see Table 5.1). This type of cut-and-fill was also noted at two sites in Cataract Canyon where the geomorphic researchers profiled two exposures, one at Rapid 12 and one at Range Canyon. Any evidence of these specific sedimentologic structures lends support to the base-level hypothesis: that gullies eroding pre-dam terraces were periodically infilled by sediment from restorative pre-dam floods.

One of the most critical aspects of this study was the documentation of any renewal of river sand and windblown sand at each site. The process of regrading terraces and infilling channels or swales can effectively interrupt the channelization process, best illustrated by the presence of the 1983 and 1996 flood sands, which were identified by their sedimentology, overall positioning, vegetation community and maturity, and associated driftwood piles and diagnostic artifacts included within these piles. In their interim report to GCMRC, Thompson, Potochnik, and O'Brien (1998) presented preliminary results showing that 69% of all sample catchments studied have 1983 flood sands deposited at their base. The work of Jack Schmidt and Paul Grams (unpublished data), who mapped the 1983 and 1996 flood sands for five GIS reaches in the Grand Canyon, show similar results.

Eolian infilling of gullies is one of the strongest restorative forces operating at archaeological sites. Eolian deposits are important because they can overlie archaeological terraces by several meters (Hereford et al. 1993). Dunes can protect archaeological sites from gully erosion by forcing runoff to pond temporarily before reaching the river. In agreement with observations by Thompson and her colleagues, Hereford et al. (1993) originally explained that river terraces are often the immediate source of eolian sand. In places of high eolian activity, where fresh river sand is still available, Thompson and her fellow researchers noted many gullies that had been infilled recently.

GRCA RCMP's personnel and their monitoring data were consulted in assessing the average vulnerability ratings of sites to determine if the results of Thompson et al. (2000) generally correlated with those of the monitors, which overall they did. To calculate a sites's average vulnerability, Thompson et al. (2000) calculated vulnerability for each terrace at each catchment. This calculation takes into account the vulnerability of the terrace immediately upslope, with the assumption that no degradation has occurred. In this way, they were able to evaluate the effectiveness of the terrace "sponge" across the whole suite of terraces. These weighted average ratings for the terraces per catchment site are provided in Appendix B of Thompson et al. (2000).

To detect trends in vulnerability throughout the Canyon, Thompson et al. (2000) grouped values for upper terrace vulnerability to geomorphic reach and geomorphic setting. Do reaches closer to the dam show a higher average vulnerability? This is not the case; all reaches except the Aisles (see Table 5.1), which has substantially lower average vulnerability, show similar average vulnerability. Evidence of eolian activity is abundant at many of the sites in the Aisles reach, and terrace areas therefore generally tend to be larger than those in other reaches. Thompson et al. (2000) observed numerous drainages that travel through or end at dunes and noted those that have been temporarily stabilized by active eolian sand accumulating in the drainage. However, inactive dunes that have been vegetated often show recently rejuvenated streams that are forcing their way to the river. In many cases, they documented 1983 flood sand that had been blown upslope, infilling the mouths of these streams. However, they felt that without renewed fresh sand (from a sediment-laden flood flow), it is only a matter of time until these streams breach the 1983 deposit and become integrated with the river.

The alluvial history of Cataract Canyon, like that of Grand Canyon, comprises several distinct sandy alluvial terraces that can be identified by diagnostic features. Through various radiometric techniques, such as dendrochronology, radiocarbon dating, and identification of diagnostic artifacts, the geomorphologists attempted to correlate Cataract Canyon terraces with those in the Grand Canyon. This chronological association set the stage for comparing erosional processes in Cataract Canyon, the pre-dam analog, to those in the Grand Canyon.

Several sites with excellent terrace sequences and geomorphic settings similar to those in Grand Canyon were identified. The most prominent clues to terrace level were distinctly different driftwood lines, sedimentology, vegetation community and maturity, and relative topographical position above a given datum. Data that further define the age of terraces came from dendrochronological and charcoal samples, percent silt and clay, and diagnostic artifacts found in the soil or in driftwood piles. A more detailed analysis of terrace correlations is provided in the final geomorphology report. Although terraces in Cataract Canyon are not extensive, they display a sequence that overall correlates roughly with that in the Grand Canyon. The exception is a terrace equivalent to the striped alluvium, an upper terrace containing cultural resources, in the Grand Canyon. It is likely that this flood deposit has been buried by talus slope debris or rockfall, which are frequent in Cataract Canyon.

The base-level hypothesis is founded on the fact that the dam has interrupted 87% of the flow of sediment through the river corridor in Grand Canyon (Andrews 1991). Thompson, Potochnik, and O'Brien (1998) maintained that ongoing "natural" erosional processes at the cultural sites have taken precedence over the "natural" restorative processes that would have otherwise kept these sites intact through the millennia. To assess what might cause a small tributary catchment to integrate with the river, they documented the six processes that can contribute to this integration. Each of these processes leads to the formation of a channel across a previously flat terrace surface, which leads, in turn, to the development of a gully. In their interim report (Thompson, Potochnik, and O'Brien 1998) and the current final report (Thompson et al. 2000), the geomorphologists summarized these processes for each of the 36 study areas examined (see Table 5.1). For each area, catchment and river processes are discussed; the condition of what has been termed the pre-dam alluvium (pda) terrace, the terrace containing cultural deposits/sites, is assessed, the potential for a restorative flood flow is rated, and the most current impact assessments by GRCA RCMP staff for existing sites in these areas are compared.

Overall, 60% of the catchments supports or strongly supports the base-level hypothesis, while 13% weakly support the hypothesis, and only 7% do not support it. This translates to only five study areas and eight actual catchments that did not support the restorative base-level hypothesis, meaning that erosion of these sites has little relation to the presence and/or operation of Glen Canyon Dam. (Restorative refers to incorporating into the hypothesis the importance of periodic sand renewal to the bases of gullies and terraces [Thompson et al. 2000:114].) These five study areas generally show pre-dam arroyo cutting and bank retreat with little to no pre-dam annual flood deposits (pda) or 1983 sand deposits. The sites are Axehandle Cove (Catchments A, B, C), Little Nankoweap (Catchment A), Basalt Canyon (Catchment B), Arroyo Grande (Catchment A), and Granite Park (Catchments E and F). Studies of repeat aerial and oblique photography in Grand Canyon further illustrate that before closure of Glen Canyon Dam few gullies were incised to the degree found during field investigations in 1998 and 1999. Only the largest arroyos such as those at Axehandle Cove, Tanner Canyon, Lower Unkar, and Arroyo Grande, were present in pre-dam time (Thompson et al. 2000:114).

RECOMMENDATIONS RELATING TO THE CULTURAL RESOURCES MONITORING PROGRAM

Based on the geomorphic research conducted to date, the current base-level hypothesis (Hereford et al. 1993) is supported as the main concept under which the NPS RCMP should be basing decisions for preservation versus data recovery in the form of excavations. The current geomorphic studies have generally indicated that the river- , terrace- , and side canyon–based stream erosion affecting over 100 of the archaeological sites in the corridor is exacerbated by the operation of Glen Canyon Dam. The revised geomorphic hypothesis and conceptual model should be used as the basis for making decisions concerning when to conduct preservation efforts at sites and when data recovery is the necessary action to mitigate dam-related impacts to cultural resources.

The NPS RCMP is an exemplary program that should be a prototype for other national parks. Yes, it has some problems, but they can be remedied by refining methodology and data management. During their site evaluations, RCMP staff should track where and when terrace-based streams become integrated with the river. A refined protocol for distinguishing terrace-based from river-based streams is of utmost importance in tracking the history of these streams. Thompson, Potochnik, and O'Brien (1998) recommended identifying the 1996 and 1983 flood sands where possible; if a stream incises these deposits, it should be considered river based. RCMP personnel should be trained to recognize these key deposits at all monitored sites. Furthermore, their attention should be drawn to heads of small streams where they can easily monitor, measure, and map headward migration or streambank widening over time. These observations are important, as several of these streams may soon capture and integrate with an adjacent larger catchment. While this situation is addressed in the geomorphic model, monitoring of heads of streams should continue, using the current geomorphic data, coupled with the existing RCMP data, as the starting point.

Any future monitoring activities can benefit from applying the basic geomorphic methods employed in the study by Thompson et al. (2000). With some training and orientation, future monitors can easily measure changes in gully depth at their pre-established points of measurement, track how points shift on a scatter plot, and evaluate the rates at which a terrace is degrading or aggrading. The NPS RCMP should also immediately employ the priority ranking of 22 catchment areas summarized in Table 4.2 in Thompson et al. (2000:117). These rankings are based on a vulnerability rating of the top terrace greater than 50 on a scale of 1 to 100, in conjunction with gully-depth ratios. High vulnerability ratings greater than 50 and gully-depth ratios greater than 0.5 indicate that a catchment has already incised most of its terrace depth and that mitigation efforts should therefore focus on data recovery. This was the case for four cultural areas in four catchments: Axehandle Cove (Catchment A), Palisades (Catchment B), Comanche Creek (Catchment H), and Arroyo Grande (Catchment A), and archaeological sites in the vicinity of Catchment B at Palisades have in fact already been recommended as having a high priority for excavation by Leap et al. (2000). Individual catchment site vulnerability ratings and summary descriptions are given in Appendix B, and air photos of the catchment locations are provided in Appendix D, of Thompson et al. (2000). These appendixes should be used during fieldwork to guide NPS RCMP monitors and managers in assessing and prioritizing sites recommended for remedial action

Thompson, Potochnik, and O'Brien (1998) generally agreed with GRCA RCMP's emergency priority rankings for FY1999. They observed that gully erosion was much more of a threat to the resources than visitation. Thus, they believe that the best mitigative efforts would be in the form of replenished sediment from a controlled flood. Almost all the catchment sites that they recorded had deposits of 1996 flood sand, and about 70% contained extensive 1983 sand deposits. This information suggests that a controlled flood between the 45,000 and 96,000 cfs stages would effectively restore much sediment to the bases of higher terraces with archaeological sites and would provide the supply from which wind could deliver sediment to upper terraces.

The high steady flows of 1996 and 1997 seemed to have had the most devastating impact to lower terraces, as bank retreat exacerbated gully erosion by shortening the distance and steepening the slope of streams (Thompson, Burke, and Potochnik 1997). Therefore, any high steady flows following recently deposited river sand will tend to negate the benefits of terrace building.

The use of good base maps and repeat photography is critical for effectively monitoring erosional processes on archaeological sites. New photogrammetric technology that uses aerial photography to create detailed topographic maps (accurate to 0.25-m contour intervals) is a cost-effective method that should reduce the amount of on-site monitoring and resurveying.

The conceptual geomorphic model provides the best means for first predicting the susceptibility or vulnerability of recorded archaeological sites and other significant cultural resources to degradation from geomorphic processes. This model has illuminated which sites or cultural areas are affected by dam operations, which should continue to be monitored (including mapping and photography), which ones should undergo preservation efforts and subsequent monitoring of these efforts, and which may require data recovery.

In lieu of the use of aerial photography, scaled photography and total station mapping should be continued and refined. This methodology should be further investigated with GCMRC surveyors. Maps and photographs can be used to measure the severity of disturbance at sites, and they are also the best source of data on the location of erosional impacts and how location relates to disturbances caused by the dam's operation. For example, maps can illustrate in a measurable way whether erosion of beaches has increased stream gradients, turned terrace-based drainages into river-based drainages, and forced visitors further into archaeological sites.

Archaeological monitoring of sites in sandy deposits should be based on a geomorphic monitoring program. Such a program would include quantitative monitoring of river terraces and dunes that could contain surface and likely buried cultural deposits and features. Thompson et al. (2000) propose a modification to the current RCMP to include simple repeat measurements at each catchment and/or photogrammetric-style repeat mapping to avoid extensive fieldwork and the resulting impacts of this work to the sites. The geomorphic research conducted thus far on the large sample set of archaeological sites should be expanded to include the remaining sites located in sandy deposits. An actual list of those archaeological sites included within the 119 catchments and 36 study areas should also be generated and expanded as additional catchments are recorded in relation to archaeological resources.

CHAPTER 6

ISOLATED OCCURRENCES

Dennis Gilpin and Lynn A. Neal

INTRODUCTION

During the archaeological survey of the Colorado River corridor, 489 isolated occurrences (IOs) were reported to have been documented (Fairley et al. 1994:151), but records were available for only 436 IOs. (Since that survey at least one more IO has been added by GRCA RCMP staff, raising the total number to 437.) Fairley et al. (1994:8) provided only brief definitions of sites and IOs, and the distinction between them was apparently based on a field decision about whether recording a cultural manifestation was worth the effort. Isolated occurrence data were not analyzed or discussed in the survey report, leaving unanswered the question of whether IOs might be types of cultural resources that need further attention. Why are isolated occurrences important? Isolated occurrences may represent periods of prehistory or history that are not otherwise represented in an area. For example, it is quite common to publish reports on individual Paleoindian projectile point finds, because Paleoindian sites are so rare that even isolated points can offer important information on (1) the range and intensity of Paleoindian occupation, (2) point typology and Paleoindian lithic technology, and (3) movement of and relationships between Paleoindian populations based on distribution of lithic raw materials from known sources. Second, isolated occurrences may represent portions of a settlement system. For example, large numbers of isolated Late Archaic projectile points in a highland area may indicate use of the area for hunting, in contrast to a lowland area that contains base camps of the same period, indicating a collecting (versus foraging) strategy for the Late Archaic period. Or, a survey area may contain large numbers of pot drops because the area was repeatedly used for harvesting saguaro fruit by residents of a village outside the survey area. Third, isolated occurrences may be parts of sites; for instance, what initially appears to be an isolated cairn may turn out to be part of a system of cairns marking a trail or boundary.

Given the concern of GCMRC, BOR, the PA participants, and others involved parties with documenting and mitigating the effects of the operation of Glen Canyon Dam on cultural resources along the Colorado River corridor, it should not be surprising that the RFP for this project specifically raised the question of whether isolated occurrences are more likely to be the last remnants of sites that have largely eroded away or the first evidence of sites that are just beginning to be exposed by erosion. More specifically, the definition of IOs, the procedures for recording them, and the lack of analysis of related data raised three questions: (1) were isolated occurrences recorded consistently? (2) do some isolated occurrences represent types of human behavior not represented by sites? and (3) are any isolated occurrences the earliest evidence of sites that are being exposed by erosion or the last remnants of natural anomalies, modern-day fire pits, or sites that are being eroded away? These issues are treated in order below.

EVALUATION OF RECORDING FORMAT

The key issues in evaluating the methods for recording IOs were (1) the definition of IOs and (2) the consistency of the recording of IOs. Fairley et al. (1994) defined sites and isolated occurrences as follows:

> Sites are broadly defined as one or more human-made features or a cluster of artifacts representing a former locus of human activity. No minimum number of artifacts or areal extents were delimited, since the survey aimed to record evidence of past human activity in the canyon, and many activities do not result in the deposition of numerous or extensive remains. The cut-off date for recording a site was approximately 1960.
>
> Isolated artifacts and other remains that could be indicative of past human activity but did not warrant the time investment of a full recording (e.g., isolated charcoal stains without associated artifacts, possible wall alignments, or cleared areas under an overhang) were plotted on aerial photos and designated as isolated occurrences or "IOs" [Fairley et al. 1994:8].

This distinction between sites and IOs contrasts with other definitions of these types of cultural remains. The Arizona State Museum (ASM), for example, does not provide a formal definition of isolated occurrence but does define sites in detail. Summarizing a 10-page discussion, ASM defines a site as a bounded area that "contains one or more archaeological features that are at least 50 years old, including artifact concentrations, purposeful constructions, excavations, or deposits, or the remains thereof " (ASM 1993:A-10). Among 116 defined feature types, ASM includes ash stain (ASM 1993:B-2), cairn (ASM 1993:B-3), charcoal stain (ASM (1993:B-3), clearing in desert pavement (ASM 1993:B-3), undefined rock alignment (ASM 1993:B-13), and undefined rock feature (ASM 1993:B-13), all of which are represented in the isolated occurrences from the river corridor survey. Of course, ASM also defines archaeological sites as being at least 50 years old. Many of the isolated occurrences recorded during the survey were probably created by river runners in the past 50 years and correctly evaluated in the field by the survey archaeologists, but because the archaeologists did not record the reasons for their evaluations, managers have no way of knowing whether specific isolated occurrences might bear further study. We should also note that in additional guidelines for defining sites, Fish (1994) specified that sites: should consist of 30 or more artifacts in an area 15 m in diameter, except when all pieces appear to be derived from a single artifact; should consist of 20 or more artifacts in an area 15 m in diameter if two types of artifact are present; should be recorded if one or more features are associated with any artifacts; and should be recorded if two or more features are present. Fish (1994) leaves the recording of isolated, nonlinear features without associated artifacts (including rock piles, mine shafts, prospecting pits, and unidentified depressions) up to the discretion of the archaeologist.

The Navajo Nation Historic Preservation Department (NNHPD) has succinct definitions for both sites and IOs:

> The definition for "site" on the Navajo Reservation is: "The location of an event, belief, or activity, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined or vanished, where the location itself maintains historic, archaeological, or traditional cultural value regardless of the value of any existing structure." A site is anything that falls within the preceding definition and is more than an isolated occurrence.
>
> The definition for "isolated occurrence" is: "Any non-structural remains of a single event; alternatively, any non-structural assemblage of approximately 10 or fewer artifacts within an area of 10 sq m or less, especially if it is of questionable human origin or if it appears to be the result of fortuitous causes." The number and/or composition of observed artifact classes is a useful rule of thumb for distinguishing between a site and an isolate. It seems unlikely, for example, that the presence of three artifact classes (e.g., lithic debitage, ground stone or sandstone fragments, and pottery) represents the remains of a single event. Similarly, it seems unlikely that two sherds from different vessels or two pieces of debitage from different parent materials, *together with a small number of items from a second artifact class*, represent a single event [emphasis in original] [NNHPD 1991].

The Colorado River corridor survey was intended to record all evidence of past human activity. However, in addition, the surveyors recognized that many activities leave only small numbers of artifacts, and the survey was also designed to document the condition of cultural resources in an eroding environment related to physical and human impacts caused by the operation of Glen Canyon Dam (both directly and indirectly). Given these circumstances, a narrower, more objective definition of isolated occurrences would have been more appropriate for the survey.

One reviewer recommended that we give the National Park Service definition of isolated occurrences; another expressed the belief that the survey crews used a definition of isolated occurrence that was more explicit than the one given in the final report. People who worked on the survey, however, stated that they were told not to worry about isolated occurrences and that when they found items or features that were not definitely of cultural origin or that were of questionable significance (such as probably less than 50 years old or in disturbed contexts), they should plot them on the aerial photographs along with a brief notation about what they were. After the survey was completed, the authors of the survey report were instructed to compile a list of the isolated occurrences, and the definition provided in the final report was formulated (Helen Fairley, personal communication 27 January 2000).

During the fieldwork, isolated occurrences were assigned an item number and an IO number in accordance with the GRCA Arizona quad numbering system used for sites. River mile, bank, and aerial photograph number were recorded. A map number, crew designation and session date at the time of recording, description, and physical setting were also given, as well as basic artifact class(es) and counts. Cultural affiliation, date, and function were not recorded, however. Most isolated occurrences were plotted on 1989 black-and-white aerial photographs, but, according to Christopher Coder (personal communication 1998), a crew chief for the survey, IOs were not always plotted on the aerial photographs, and the spatial database for the IOs is thus incomplete. Coder (personal communication 13 September 1999) further confirmed that during the first, and probably the second, field season, an IO list was kept, but by the third session the crews switched to just plotting and describing IOs on the aerials. A table of isolated finds was later created from information on the aerials, as confirmed by the field director for the survey, Helen Fairley (personal communication 13 September 1999). (This procedure may account for the discrepancy in the number of IOs reported [489] and the number officially recorded [436].)

The table of isolated finds documenting 436 IOs was prepared in May of 1994 by Jan Balsom and Christopher Coder (Appendix D of this report). The table was not included in the December 1994 survey report (Fairley et al. 1994) because of the confidentiality of site information but was included in the mailings of the report to the tribes. GRCA RCMP staff conducted a thorough search of their files but were not able to locate an electronic version of the IO table, or any additional lists or notes pertaining to IOs. Furthermore, the IOs were never plotted on topographic maps to obtain legal descriptions or UTM coordinates.

DISTRIBUTION OF ISOLATED OCCURRENCES BY DATE AND TYPE

In order to determine whether activities represented by the IOs are different from activities represented by the sites, SWCA went through the IO table and tried to classify the IOs by time period and function or type. SWCA counted all flaked stone and ground stone as lithic IOs (further study or fuller descriptions might show some to be Archaic, Formative, or historic Native American). Formative isolated occurrences were those that included prehistoric ceramics; a possible terrace site was also classified as Formative. SWCA classified cairns, rock alignments, and such as recent, modern, or historic if these temporal designations appeared without question marks, and as undated if question marks were appended.

Fairley et al. (1994) did not present summary statistics on the distribution of sites and components by chronological period, but SWCA's estimate is that the distribution was roughly 5% Archaic, 45% Formative, 20% historic Native American, 15% Euroamerican, and 15% undated. The distribution of IOs is approximately 12.1% Formative, 32.0% historic (only about three of the historic sites are Native American), and 55.8% undated (including 26.1% that are lithic IOs and 1.1% undated prehistoric). Thus, undated cultural resources and historic Euroamerican cultural resources were more likely to be recorded as isolated occurrences than as sites. Whether undated cultural resources were cultural or natural was often uncertain. The large number of historic IOs is in part the result of mass production (resulting in the creation of more trash) by Euroamerican society and in part the result of recent and ongoing deposition coupled with less time for deterioration.

In terms of IO function or type, cairns (31), stacked rocks (16), and dry-laid masonry walls and rock alignments (22) were routinely recorded as IOs. Charcoal stains (particularly if they were not associated with artifacts) and fragments of charcoal (especially in overhangs and protected areas) were also commonly (40 cases) recorded as IOs. A number of reasonable explanations for classifying some of these types of features as isolated occurrences can be posited. One reviewer stated that the goal of the survey was to record only National Register–eligible properties. Charcoal stains, for example, were often of questionable cultural origin and date and in many cases would not be eligible for the National Register. It was not until 1980 that river runners were required to bag and pack out their trash; prior to that time, they burned it on the beaches or above the camp areas. SWCA recognizes that the archaeologists who conducted the survey undoubtedly had good reasons for questioning whether the various items, materials, and features that were classified as isolated occurrences were significant, or even if they were cultural. However, these IOs could represent human activities that are not represented at the sites. Charcoal stains can be radiocarbon dated and analyzed to find out what plants were being used, which might indicate classes of human activities other than those identified at sites. Since cairns, stacked rocks, dry-laid masonry walls, and rock alignments could represent historically significant mining claims, trail markers, shelters, and so forth, they should be recorded in more detail. The materials and construction techniques used to build these features, as well as their location with respect to high-water marks, might indicate whether they are likely to be more than 50 years old. The problem facing SWCA (and resource managers) in assessing which of the isolated occurrences might be sites is that the rationale for in-field classification of each item, material, or deposit as being of doubtful cultural origin or significance was not written down. Therefore, if any of the various involved or interested parties have concerns about whether any isolated occurrences are the last remnants of sites that are eroding away or the first evidence of sites that are being exposed by erosion, then some of those isolated occurrences will need to be re-evaluated in the field.

FORMATION PROCESSES

In an effort to determine whether some of the isolated occurrences were the earliest evidence of sites that were being exposed by erosion or the last remnants of sites that were being eroded away, SWCA examined the IO table and identified types of IOs that might be archaeological sites under the definitions used by, for example, ASM and NNHPD. This analysis suggested that as many as 183 (41.9%) of the IOs could be archaeological sites, and a more conservative estimate of 147 (33.6%) is still high. (Since very brief descriptions were given, these estimates were made systematically, but there is significant room for interpretation.) The recorders themselves hypothesized that eight IOs (3, 66, 96, 181, 184, 247, 253, and 285) could be sites, and two were in fact called "unrecorded lithic sites." In 23 cases there were multiple historic artifacts, features, or both, that would have been recorded as sites under the ASM and NNHPD definitions. In similar fashion, 19 cases of multiple prehistoric artifacts, features, charcoal, or some combination of these suggest that sites may be present. Ten overhangs, alcoves, or rock shelters contained charcoal or an isolated artifact that suggested that they might be or may have been sites. As mentioned above, charcoal stains and fragments of charcoal were often recorded as IOs. Isolated charcoal stains are likely to be remnants of modern-day campfires dating before1980, prior to the era of fluctuating flows and NPS firepan requirements. On the other hand, charcoal stains represent the class of IOs most likely to be the first evidence of sites being exposed by erosion or the remnants of sites that have been almost completely destroyed by erosion. These stains could be tested and radiocarbon dated to determine whether they are evidence of prehistoric sites, historic sites, or natural occurrences. Given the absence of some specific locational data and data on depositional environment, it is difficult to make this evaluation. However, since the majority of the IOs are plotted on aerial photographs housed at the GRCA RCMP's Flagstaff office, some inferences could be derived from the locations of IOs in comparison to the locations of sites on aerial plots. The number of IO plots on the aerials would first have to be counted and compared with the IO table. (See Recommendations section for additional suggestions.)

DISTRIBUTION OF ISOLATED OCCURRENCES RELATIVE TO SITES

In the survey report, Fairley et al. (1994) discussed the distribution of sites and other patterns within the study area in terms of "reaches," which represent the division of the Colorado River into 13 segments (Table 6.1) and provide a convenient means for addressing such a large study area. The reach system employed in the survey report was originally devised by Schmidt and Graf (1990) based on geomorphic characteristics of the river channel. Although archaeological criteria were not considered in the formulation of this scheme, the reach system does have archaeological validity because geologic and topographic factors directly affect resource availability and accessibility.

Cross-tabulating the location of IOs to sites by reach/river mile shows that the spatial trends are very similar, with few exceptions (Table 6.2). For example, in Reach 3, three times more sites than IOs were recorded (16 and 5, respectively), with sites averaging 1.2 per mile and IOs 0.4 per mile (see Table 6.2). A single site complex at the mouth of South Canyon in Reach 3 may explain the deviation between the number of sites and IOs; otherwise, both the sites and IOs appear to reflect short-term transient use of the corridor. In Reach 3 there is also a complex of historic sites associated with exploratory activities for Marble Canyon Dam (Fairley et al. 1994:18). (Site types by reach are given in Table 6.3.) In Reach 12, the opposite scenario occurs—twice as many IOs are recorded as sites (11 and 6, respectively), with IOs averaging 2.2 per mile and sites 1.2 per mile. All of the IOs were historic, as were the six sites, all but one associated with engineering work at the proposed Bridge Canyon Dam site (Fairley et al. 1994:20). The sixth site is a historic memorial monument. As shown in Table 6.2, similar numbers of sites and IOs were found in the remaining 10 reaches. Sites and IOs were also evenly distributed between right and left river banks. The ratios do vary per reach, depending primarily on geological environment. On the whole, however, the river bank distributions average out, with 236 sites and 208 IOs on the left bank and 232 sites and 228 IOs on the right bank. Seven sites occur on both banks.

Some interesting trends resulted from comparing relative time periods and type for the sites and IOs. Out of 58 IOs in Reach 3, for instance, 37 represent historic or modern activity, while roughly 18 of the 45 sites represent historic or modern occupation. This is most likely indicative of more historically associated limited activities (i.e., inscriptions, cairns, trail or survey markers, isolated trash deposits) related to the overall historical use of this reach. Prehistoric sites and activities seem

Table 6.1. Designated Reaches for All GCES/GCMRC Studies

Reach	Name	Mileage
0	Glen Canyon	-15.5 to 0
1	Permian Section	> 0 to 11.3
2	Supai Gorge	> 11.3 to 22.6
3	Redwall Gorge	> 22.6 to 35.9
4	Lower Marble Canyon	> 35.9 to 61.5
5	Furnace Flats	> 61.5 to 77.4
6	Upper Granite Gorge	> 77.4 to 117.8
7	Aisles	> 117.8 to 125.5
8	Middle Granite Gorge	> 125.5 to 139.9
9	Muav Gorge	> 139.9 to 159.9
10	Lower Canyon	> 159.9 to 213.8
11	Lower Granite Gorge	> 213.8 to 235.0
12	Lake Mead	> 235.0 to 278.0

Note: after Fairley et al. 1994:Table 1)

to be more discrete. Fairley et al. (1994:15) note that the distribution of sites within Reach 0 is primarily tied to travel routes and secondarily linked to geologic resource areas, with historic sites widely scattered throughout this reach. The historic sites (inscriptions, trash, and structures) relate to a variety of activities, including mining, dam-site exploration, ferry travel, and USGS gaging work. Generally speaking, many of the historic isolates seem to represent discrete limited activity events (e.g., cairns, historic rock writings, survey markers).

The highest site density (5.3 per mile) occurs in Reach 5, a stretch of 15.9 miles from river mile 61.5 to river mile 77.4 (defined as the Furnace Flats reach). There are broad alluvial terraces and debris fans suitable for farming and settlement throughout the central portion of this reach. Thus, it is not surprising that 17.9% of all recorded sites and 36% of all structural sites (pueblos, small structures, and storage features) occur within this reach, which comprises only 6.2% of the project area. Historic structural sites were also common in this reach. Sixty-seven IOs (4.2 per mile) were recorded within this range of river miles, a high percentage of them prehistoric (n=42) and undefined charcoal fragments or stains (n=7), noteworthy when compared with the abundance of prehistoric IOs in other reaches. This increased prehistoric IO distribution was probably indicative of two

Table 6.2 Site and Isolated Occurrence Distributions by Reach

Reach	Miles	Total Sites	Total IOs	Left Bank Sites	Left Bank IOs	Right Bank Sites	Right Bank IOs	Sites on Both Banks	RB to LB Ratio: Sites	RB to LB Ratio: IOs	Average per Mile: Sites	Average per Mile: IOs
0	15.5	45	58	29	38	14	20	2	.5	.5	2.9	3.7
1	11.3	18	17	5	7	12	10	1	2.4	1.4	1.6	1.5
2	11.3	9	13	5	7	4	6	0	.8	.9	.8	1.2
3	13.3	16	5	7	2	8	3	1	1.1	1.5	1.2	.4
4	25.6	50	43	15	7	34	36	1	2.3	5.1	2.0	1.7
5	15.9	85	66	60	43	25	23	0	.4	.5	5.3	4.2
6	40.4	35	51	14	22	19	29	2	1.4	1.3	.9	1.3
7	7.7	17	10	12	6	5	4	0	.4	.7	2.2	1.3
8	14.4	29	22	15	16	14	6	0	.9	.38	2.0	1.5
9	20.0	13	15	2	5	11	10	0	5.5	2.0	.6	.8
10	53.9	128	108	61	42	67	66	0	1.1	1.6	2.4	2.0
11	21.2	24	17	8	4	16	13	0	2.0	3.2	1.1	.8
12	4.9	6	11	3	9	3	2	0	1.0	.2	1.2	2.2
Total	**255.4**	**475**	**436**	**236**	**208**	**232**	**228**	**7**	**1.0**	**1.1**	**1.9**	**1.7**

Note: after Fairley et al. 1994:Table 2

Table 6.3. Site Type by Reach

Site Type	Reach 0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Pueblo					1	3	1							**5**
Small Structure	6		2	4	17	28	5	3	10	1	9	1		**89**
Ephemeral Structure	3	3		3	6	7	4	2	4	5	14	2		**53**
Storage Structure		1		1	1	7			1					**11**
Enigmatic Feature					2				1			1		**4**
Sherd Scatter											1			**2**
Lithic Scatter	6			1	1		3				2	1		**14**
Artifact Scatter	2	4				3					3	2		**14**
Isolated Thermal Feature		2				3		2	1		6			**14**
Roaster Complex					1	4		4	1	1	45	6		**62**
"Camp"	8	5	1	1	6	16	7	5	8	3	38	1		**105**
Isolated Pot Cache				1	3		1			1	1			**7**
Burial			1		2		1				1			**5**
Ground Stone Cache								1	1		1			**3**
Other Tool Cache			1	1	1		1				1	1		**6**
Water/Soil Control					2	1			1					**4**
Bedrock Mortar										1	2	1		**4**
Trail	3	1			1									**5**
Rock Art	8		1			2					2			**13**
Inscription	3		3	1			2							**9**
Historic Trash	2				1				1		1	2		**7**
Historic Structure	2	1			1	7	3			1			5	**20**
Other	2	1		3	1	3	4				1		1	**16**
Delta Complex					2	1								**3**
Total	**48**	**18**	**9**	**16**	**50**	**85**	**35**	**17**	**29**	**13**	**128**	**24**	**6**	**475**

Note: after Fairley et al. 1994:Table 3 phenomena: (1) the overall preponderance of prehistoric resources in this reach; and (2) that many of these IOs likely represent exposed extensions of larger prehistoric sites recorded in Reach 5. In contrast, in Reach 10, which includes 53.9 river miles (from 159.9 to 213.3), 107 IOs (only 1.9 per mile) occurred, and over half of these IOs were historic, modern, or unknown in origin. There were 2.4 sites per mile within Reach 10, compared to 5.3 per mile in Reach 5.

Reach 9 (Muav Gorge) had the lowest site density (0.6 sites per mile over 20 miles), and a correspondingly low number of 15 IOs (0.75 per mile). Overall, these IOs represent discrete prehistoric (n=3) and historic or modern (n=12) remains. Both sites and IOs occur on ledges well above the mean high-water level, but one site occurred in close proximity to the river.

As noted in the survey report (Fairley et al. 1994:Figure 2, Table 2), the distribution of sites along the river corridor is highly variable. IOs appear to parallel this distribution, reflecting more limited use of areas but at densities similar to those of site distribution. The overall uneven distribution is largely a reflection of geomorphic factors, although elevation and exposure may also play a significant role in controlling site and IO distributions. Nevertheless, geomorphic variables—particularly the availability of alluviated debris fans, terraces, and fault-controlled access routes—appear to have been the primary factors influencing human settlement in the canyon.

Preliminary analysis of the site-type variables by Fairley et al. (1994:Table 3) revealed significant patterning in spatial and temporal distributions. For example, 6 of the 24 site types occurred only in the eastern half of the canyon (i.e., upstream from 140 mile), while one site type was confined to the western canyon below 140 mile. Site types found only in the eastern canyon included pueblos (n=7), storage sites (n=11), water/soil control features (n=8), developed trails (n=5), isolated historic inscriptions (n=9), and delta farming communities (n=3). Isolated bedrock mortar sites were the only type restricted to the western canyon. Since these features were recorded only as sites, they are not reflected in the IO distribution for comparison. Historic (and modern) inscriptions recorded as IOs are concentrated in the eastern canyon. Six historic or modern inscriptions were documented as IOs in the eastern canyon, with only one recorded in the western canyon. Historic or modern painted writing was also documented as IOs at six locations in Reach 0, with none recorded in the western canyon. Rock art, both isolated and in direct association with living areas, was found in both segments of the canyon, but the types of rock art were spatially discrete: all but one petroglyph site occurred upstream of Kanab Creek (mile 145), and all but one site with pictographs occurred below Kanab Creek. All examples of prehistoric rock art, even an isolated element on an isolated panel, were recorded as sites.

Other site types demonstrated a marked tendency to occur in one particular part of the canyon. For example, 87.6% of all small structural sites occurred upstream from river mile 140, while 83.9% of the roaster complexes occurred downstream from 140 mile (Fairley et al. 1994:20). When compared with the total number of sites recorded in each half of the canyon, small structural sites constitute 25.6% of all sites in the eastern area (n=304) but only 6.4% of the total sites recorded in the western area (n=171). Conversely, roaster complexes constitute 30% of all sites found in the western reaches of the canyon but only 3.3% of all sites recorded in the eastern reaches. Other site types with skewed distributions included ephemeral structures (n=5, 80% in east vs. 20% in west). lithic scatters (n=14, 78.6% east vs. 21.4% west), isolated thermal features (n=14, 92.9% east vs. 7.1% west), vessel caches (n=7, 83.3% east vs. 16.7% west), and isolated rock art (n=14, 78.6% east vs. 22.4% west).

Three small lithic scatters recorded as IOs above 140 mile were noted as possible sites, but no lithic IOs in the western canyon were so noted. Ephemeral structures (typically recorded as "modern"?) and thermal features with an unknown origin that are recorded as IOs do not seem to be divided so clearly between the eastern and western segments of the canyon. Four ceramic pot breaks were recorded as IOs in the eastern canyon, with none found in the western portion. In eight instances, association of an IO, particularly a historic IO (n=6), with a nearby site is noted. There were also 42 undefined, isolated charcoal lenses or deposits recorded as IOs (25 in the eastern canyon and 17 in the western canyon). If these IOs represent cultural features, they might represent buried deposits in proximity to recorded sites.

Since isolated occurrence date and density correlated with site date and density in most river reaches, isolated occurrences probably do reflect either shorter-term, more specialized, or marginal use of areas adjacent to sites. In Reach 12, for example, understanding the full range of activities associated with engineering the Bridge Canyon Dam site would require consideration of both isolated occurrences and sites.

CONCLUSIONS AND RECOMMENDATIONS FOR ISOLATED OCCURRENCES

Do isolated occurrences recorded during the survey constitute a resource meriting additional research and management? SWCA's analyses indicate that they do. Two isolated occurrences are clearly sites, recognized as such during the survey, and need to be recorded. Six isolated occurrences were recognized during the survey as possible sites. These IOs need to be revisited and recorded in such a way (paying particular attention to depositional environment) that they can be re-evaluated as to status and National Register eligibility. Between 147 (33.6%) and 183 (41.9%) of the isolated occurrences may be sites. To determine their status, they need to be revisited, and their depositional environment (especially charcoal stains) and construction (especially that of cairns, rock piles, and rock alignments) need to be more formally recorded for evaluation of their status and National Register eligibility. Finally, a number of isolated occurrences (primarily cairns, rock piles, and rock alignments) need to be re-evaluated, not only in terms of their depositional environment and construction, but also in terms of various definitions of isolated occurrences and both theories of and research into settlement systems that would suggest benefits of classifying some isolated occurrences as sites. SWCA found that most (58.1%) of the 437 isolated occurrences are probably not sites, but analysis of their distribution suggested that they might still constitute a resource worthy of further research.

It is very difficult to determine whether some IOs represent the last remains or first exposure of archaeological sites without evaluating their locations spatially, that is, visually comparing site and

IO distributions to see if IOs cluster around sites (in which case they might be considered parts of those sites) or do not cluster around sites (in which case they might be considered new sites or true isolated occurrences). Despite the general correlations between the distribution of sites and IOs that can be observed by examining both by reach, to properly determine whether IOs are the last remains of sites, the first signs of sites, or truly isolated occurrences, the aerial plots for the IOs would need to be transferred to USGS 7.5 minute topographic maps to generate UTM coordinates. A GIS database of these coordinates would then need to be created for spatial comparison of the IO locations with archaeological site locations. This more detailed spatial analysis would be necessary to definitively assess what part of a site's erosional history IOs represent and whether they represent discrete shorter-term loci for the same types of activities conducted at larger sites. From the Fairley et al. (1994) data, it is also difficult to determine whether the sites and IOs in a given area are contemporaneous, since very limited dating information was provided for the IOs. Generally the prehistoric and historic IOs do appear to date to the same periods as sites. A fair number of IOs (nearly 56%), however, are undated. SWCA concluded that undated cultural resources and historic Euroamerican cultural resources or isolated features were more likely to be recorded as isolated occurrences than as sites. In a number of cases, IOs did document probable modern activities—hearths, inscriptions, painting, trash, cairns, survey markers—that parallel historic uses.

To more accurately determine the degree to which IOs were under-recorded, certain areas along the corridor where IOs were concentrated could be re-evaluated to see if a new sample inventory of IOs would match the previous inventory, using the aerial plots to determine these concentrated areas. Have areas where IOs were recorded become more exposed over time to reveal buried sites? Some sample areas with alluvial deposits where no sites were found could also be checked through resurvey to observe whether IOs or sites are becoming exposed.

A database of the IO table should be created so that similar variables could be compared statistically. A last attempt should also be made to identify the approximately 53 IOs that were apparently not plotted. As IOs are found during subsequent archaeological investigations, they should be added to the list, but with expanded descriptions that include date, measurements, and association with nearby sites and/or IOs.

CHAPTER 7

CULTURAL RESOURCES MONITORING AND REMEDIAL ACTIONS: DATA SYNTHESIS, ANALYSIS, AND EVALUATION

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INTRODUCTION

Generally speaking, in resource management, monitoring is a methodological tool for answering specific questions designed to aid in making management decisions and in problem solving. Monitoring is a process, repeated at regular intervals, designed to provide a baseline for recording potential change in the future, and some forms of monitoring detect the occurrence of change, the direction of change, and the extent and intensity of identified changes. Monitoring is, however, more than the gathering of data; one of the principal goals of monitoring is to recognize the causes of change to a system so that negative changes can be avoided. Changes to any resource will likely fall into two distinct categories, physical change related to natural processes, and human change related directly to human interaction with the resource. As noted by Hellawell (1991), monitoring programs are designed to provide early warning of the harmful effects of excessive human, physical, or management pressure and to provide the information necessary for taking appropriate action to mitigate these effects.

Prior to the current National Park Service (NPS) River Corridor Monitoring Program (RCMP) under the Bureau of Reclamation (BOR), there were few attempts to monitor the condition of cultural resources in the river corridor below Glen Canyon Dam. As described in Fairley et al. (1994), early attempts at assessing the corridor's cultural resources were conducted by Taylor (1958), followed by Euler from the late 1950s into the 1960s (various surveys summarized in Euler and Chandler [1978]) and Schwartz (1965). Euler also conducted helicopter reconnaissance along the corridor in the 1960s (also summarized in Euler and Chandler [1978]). According to Fairley et al. (1994:4), "none of these surveys was intensive by current standards." In the 1980s NPS archaeologists intensively surveyed 15 miles of the corridor between Glen Canyon Dam and Lees Ferry, as reported in a comprehensive summary of cultural resources in this area by Geib (1990). Since the full-blown inventory survey of the corridor in 1990-1991, resulting in 357 newly recorded sites and the re-recording of 118 previously recorded sites, GRCA RCMP staff have worked to refine their understanding of which sites are potentially affected by the dam, and they have communicated their findings to the other Programmatic Agreement (PA) members to determine how best to identify and remedy negative impacts to cultural sites. The principal objective of the RCMP as part of the PA group has been to assist in the in situ preservation of cultural resources along the river corridor of Grand Canyon National Park (GRCA) and Glen Canyon National Recreation Area (GLCA). The responsibilities of the RCMP as outlined in the PA through the Monitoring and Remedial Action Plan (MRAP) are to generate data regarding the effects of dam operations on historic properties, identify ongoing impacts to historic properties in the APE, and develop and implement remedial measures for treating historic properties subject to damage. All monitoring and remedial efforts pursued under the PA are subject to approval by the PA signatories.

Of the 338 sites initially considered to be within the APE, 288 are within Grand Canyon and 50 are in Glen Canyon. GRCA RCMP staff have actively monitored 264 sites since 1992; 53 sites have been actively monitored by the GLCA RCMP and regular cultural resources staff. The main question that we asked in synthesizing, analyzing, and evaluating the monitoring data was, "How well has the program met its responsibilities to the PA? In particular, are the types of observations being made during the monitoring episodes providing the necessary information to meet the management and compliance goals set out in the MRAP?" More specifically, we asked:

- What is the severity of the erosion problem caused by dam operations to sites along the corridor?
- What are the causes of erosion?
- Are some site types more susceptible than others to erosion, and how does susceptibility relate to a site's physical location and site type?
- What can be done to prevent, curtail, or mitigate the effects of erosion on dam-affected cultural resources?

We found that the monitoring program had done a significant amount of work pertaining to all of these questions, particularly the last three, but had not quite succeeded in completely answering them. It was a general measure of program success that the existing data have been rigorously and continuously evaluated and that changes have been made in the program as necessary. The utmost care needs to be taken, however, to make collected data compatible over time.

When SWCA first started analyzing the data collected to date, two conclusions were most striking: (1) it was not really possible to tell what percentage of the sites are disturbed and to what degree or what percentage of the sites are more intact and to what degree; and (2) it was difficult to distinguish whether the major erosional impacts are caused by the operation of Glen Canyon Dam or by natural causes tied to the regular climatic cycle (rainfall resulting in runoff, sheetwash, etc.), and the severity of visitor-related impacts was not calculated. It is possible to establish a relative percentage of disturbance to a particular site by closely examining site records, maps, and photographs. Leap et al. (2000) have also addressed the number of sites being impacted and the types of impacts, as well as which sites are not being impacted. The recently completed geomorphic research has shed significant light on whether impacts to sites are indirectly or directly linked to dam operations.

What we did find out by analyzing the actual data was that about 30% of Grand Canyon sites and 28% of those in Glen Canyon have exhibited very few impacts and are considered to be inactive. On the other hand, 25% of sites in the Grand Canyon and 22% in Glen Canyon were extensively impacted and were considered to be the most disturbed or eroded sites (see Leap et al. 2000 for a site-by-site discussion of impact categories and impact severity). Physical impacts are causing greater impacts to archaeological sites than visitation in terms of number and severity. Gully and arroyo downcutting and slumpage are the leading physical impacts in terms of severity, and those sites with visitor trailing often show signs of the trails forming gullies if left untreated. These observations were mostly determined by analyzing the qualitative data from the monitoring forms and repeat photography.

Basically, we found that we could at least qualitatively identify the inactive and the eroded sites and the causes of disturbance. By combining the monitoring data with the geomorphic data, it is also possible to determine which site types and locations are most susceptible to erosion. The biggest problem that we found, however, is that the monitoring forms are not designed to quantify or measure physical or visitor impact severity or extent. The attributes used to record impacts indicate the general frequency of the impacts, or how widespread or common the impacts are, but they do not indicate how severe the impacts are at any given site or in the corridor as a whole. Furthermore, having different attributes for describing physical and visitor impacts impairs the ability to make direct comparisons between the two types of impacts. In order to document the severity of impacts, the monitoring form would have to record extent of disturbance expressed as volume (ideally) or area (less useful) and as a percent of total site volume or area. The NPS RCMP staff have made recent attempts to measure physical impact extent and severity by producing detailed (25-cm contour interval) total station maps for 78 sites and conducting medium-format scaled photography. These practices should continue, and both will be addressed at more length later in this chapter.

Second, SWCA found that a range of inconsistencies or discrepancies in the actual monitoring forms, databases, and recording procedures from year to year hindered data synthesis and analysis. We therefore started the synthesis and analysis process by evaluating the monitoring program's methodologies and management activities, and then turned our attention to summarizing and evaluating the actual monitoring data and remedial actions. We also offer recommendations for modifying certain aspects of the program to obtain the necessary information for meeting the PA's goals. We did find that the RCMP staff were usually already headed in the right direction. The most obvious evidence of this is expressed in the recently completed site-by-site draft synthesis of the Grand Canyon RCMP's monitoring data and actions for 1992-1999 (Leap et al. 2000). In fact, in several chapters they address many of our 1998 draft report recommendations for correcting their monitoring schedule, forms, and database.

MONITORING DATABASE COLLECTION, EVALUATION, AND RECOMMENDATIONS

This section addresses the synthesis and subsequent analysis of data compiled by the NPS RCMP from fiscal year (FY) 1992 to FY1998. Baseline monitoring data were also collected during the Grand Canyon River Corridor Survey in 1990-1991. An immediate problem was the observed changes in the recording of data, presentation of findings, and the monitoring and preservation/recovery recommendation process over the years. Such inconsistencies were exacerbated by a lack of written explanations for making specific changes in how and what monitoring data were collected. These problems made the goal of synthesis and analysis difficult.

Consequently, much of this section involves an analysis of the monitoring program's methodology and management activities related to Objectives 1, 3, and 6 (see Chapters 1 and 2) and provides recommendations for improving the process and the data generated.

Some of the problems with the monitoring data that are identified in this chapter reflect merely a lack of clarification of procedures (the monitors not explaining in a comment field why a change was made), not actual problems with the data and/or field efforts. In these cases, such problems can easily be remedied through detailed descriptions of procedures. However, other problems may be the result of faulty or inconsistent data management practices and/or a lack of concise and consistent methodological procedures for data collection and analysis, and should be dealt with accordingly.

Methodology

Initially, we had planned to quantitatively assess the NPS RCMP data. However, after close examination of the data, we discovered that running the most basic form of statistical analysis, including descriptive statistics, would require an extensive amount of work to restructure the computerized site databases, enter excluded types of data sets, and cross check the databases with annual (fiscal year) reports and RCMP field monitoring forms. This preliminary work would be essential for analyzing the actual data when asking such questions as which sites are more susceptible to certain types of impacts, either visitor-related or physical. Since the data were not in suitable condition to conduct such tests, the initial analysis conducted for this report was primarily qualitative in nature, with a focus on the appropriateness of the monitoring schedules, the remedial (preservation and/or data recovery) recommendations and actions, and the degree to which the schedules and recommendations were followed. For the final report, however, we did restructure the database to the point that we could conduct a descriptive analysis identifying the number of monitoring sessions and sites visited per year, the frequency of site visits, the number of monitoring sessions and sites visited per monitoring schedule, the most inactive and most disturbed sites, and the sites with river-based and terrace-based streams. These results were calculated separately for Grand Canyon and Glen Canyon and are discussed later in this chapter.

Some assumptions were made concerning what subsets of data were expressed within the overall data sets. For instance, we examined the monitoring schedules as a "sum" of the severity of impacts occurring at the monitored sites. (We also noted, however, that the monitoring schedule for a particular site is a reflection of changes at the site through time, including evolution of the project methods. The monitoring schedule through time may therefore be more of a reflection of tightening up the monitoring program and better understanding and predicting change than an indicator of site stability. This possibility is what we wanted to test, since ultimately a site's monitoring schedule is based on the impact activities observed there.) The remedial recommendations and actions (category on the monitoring forms) were assumed to be indicators of the types of impacts affecting the sites. The "post" field-generated priority listings for preservation and data recovery options were evaluated to determine what actions were taken and when. We then asked ourselves, "Do the actions taken reflect the recommendations for action given on the monitoring forms, and does the monitoring schedule reflect the priority ranking for action?"

To answer the above questions, the monitoring forms were first collected from each annual report, starting in FY1992 and ending in FY1998 (Appendix E), and evaluated for structure and consistency. Following this step, the monitoring schedules throughout the study for both the Grand Canyon (GRCA) and Glen Canyon (GLCA) were compared to the field notes recorded in the computerized site databases (Appendixes F and G), the site summaries in the annual reports, and a current monitoring schedules table provided by GRCA RCMP (Appendix H); observations made from this comparison were noted (Appendixes I and J). Remedial recommendations were assessed by examining preservation options and recovery options tables provided by RCMP personnel for GRCA (Appendixes K and L) and comparing them with the recommendations made in the annual reports.

RCMP personnel provided GRCA monitoring data for FY1992 through FY1998 (fiscal year was defined as beginning October 1 and ending the following September 30). These data, however, existed in various forms of computerized databases, as shown in Table 7.1.

Table 7.1. Monitoring Database Formats from Monitoring Forms

Monitoring Database	Format
FY1992-1993	dBase III
FY1994-1996	Paradox
FY1997	Microsoft Access
FY1998	Microsoft Word table

To conduct the analysis, all the data were restructured and imported into Microsoft Access. The dBase III and Excel files were readily imported; the Paradox files needed to be opened in Paradox, exported as dBase III files, and then imported into Microsoft Access. The Microsoft Word table was not provided in an electronic format and was thus re-entered directly into a Microsoft Access file.

Once all the files were converted into Microsoft Access, they were reconfigured and appended into one master monitoring schedule table containing four fields: Site Number, Monitoring Session, Monitoring Schedule, and Comments (see Appendix F). Although the fields used in the master table existed in each database, reconfiguration was necessary because the fields did not match in terms of title, data type, size, and description. For instance, the field "Site Number" was named "SITENO" in the 1992-1993 data; "SITE_NUMBE" in the 1994-1996 data; and "SITE" in the 1998 data. In addition, the monitoring schedules for the 1992-1993 data needed to be converted from a field labeled "Total_Rank." This ranking schedule was also adjusted because it differed from the monitoring schedules used for 1994-1998, although by only one number. For example, a rank of one in the 1992-1993 data was equivalent to a rank of two in the 1994-1998 data; a rank of two was equivalent to three, and so on.

After a master table for GRCA monitoring schedules was created, we reviewed the data for consistencies between the recommended monitoring schedules (recorded in the databases), the actual monitoring schedules (i.e., how often the sites were monitored, which was also recorded in the databases), the current monitoring schedules table provided by GRCA RCMP (see Appendix H), and the field notes contained in the comments field of the monitoring forms (recorded in the databases). Clear discrepancies in the data and/or between the data and the annual reports were recorded in a new field labeled "Notes." A report generated from these notes can be found in Appendix I. Observations made in the Monitoring Schedules section of this chapter were partially based on this report.

Similar reconfigurations were completed for the monitoring data provided by GLCA's RCMP archaeologist. However, since all the data obtained for GLCA were recorded in the same format (dBase III), less work was required to combine the data and make a master table for monitoring schedules (see Appendix G). GLCA RCMP staff did not provide a current monitoring schedules table. The report created from our review of the available GLCA monitoring data can be found in Appendix J. Observations made in the Monitoring Schedules section of this chapter were also partially based on this report.

Site Monitoring Forms

The monitoring forms used during FY1992-1998 are included as Appendix E. The monitoring forms used during the 1992 and 1993 monitoring trips for both GRCA and GLCA RCMP were five pages long and contain various "subjective" data. The forms consist of: (1) a page of management information (site number, date, location, environmental setting, etc.); (2) natural (later physical) impacts; (3) human (later visitor) impacts; and (4) recommendations. Impacts to sites were tabulated in a matrix format that lists causes in the left-hand column and assessments (presence/absence or rank-order) to the right. There was some reference to data collected on these 1992 and 1993 forms in subsequent GLCA RCMP annual reports, and the GRCA RCMP data gathered on these forms was not discussed beyond the compilation of the 1992 and 1993 annual reports. The recommendations for remedial work in the GRCA RCMP annual reports were never implemented, nor were they referred to in later reports. Because of problems experienced by RCMP personnel with using the 1992-1993 monitoring forms (e.g., too much subjectivity in data collection), they were nearly completely restructured for subsequent years. Thus, comparing the 1992-1993 data to 1994-1998 data is difficult at best.

The GRCA/GLCA RCMP monitoring forms for 1994-1996 were essentially the same. One significant change was made to the form in 1996, however. The "inactive" monitoring schedule was added as a sixth category, so some sites that were moved to this category were previously listed as "discounted and stable but within the APE" (category 1 under monitoring schedule). Several minor changes were made to the 1997 monitoring form. For instance, the field "PA Signatories" was added in the Management section of the form, altering the numbering of "Site Type" and "Monitor(s)," which also affected the numbering in the database. Other changes to the 1997 monitoring form included replacing the term "Human Impacts" with "Visitor-Related Impacts" in questions 18-26. In addition, question 27 concerning monitoring with a stationary camera was omitted, changing the numbering of the subsequent fields. The term "stabilize" was replaced with "other" on question 28 (originally question 29 on the 1994-1996 monitoring forms), and the term "excavate entire site" was replaced with the term "data recovery" in question 29 (originally question 30 on the 1994-1996 monitoring forms). While adequate reasoning was provided for these changes, and they were discussed in annual reports and often at PA meetings, such adjustments to the monitoring forms between 1994-1996 and 1997 needed to be further addressed if the data were to be combined into a master database and statistically analyzed.

On the 1998 monitoring form, the variables in the matrix of both the physical and visitor-related impacts sections were changed from: 0=Absent, 1=Present, 2=Increase, 3=Decrease, 4=NA to 0=Absent, 1=Active, 2=Inactive. While the purpose of increasing the objectivity of monitoring observations adequately justifies these modifications, they make comparing the 1998 and subsequent data to previous years almost impossible, unless the earlier data are restructured to fit into the new categories. Other changes in the 1998 monitoring form included the elimination of the physical impact variable "animal-caused" erosion and assignment of such data to the "other" category. In the Management section, the variable "close site to visitors" was eliminated, and the associated data were assigned to the "other" category; the variables "surface collect" and "map" were also replaced by the "other" category. These changes were adequately justified. However, as is the case with other alterations on the monitoring form, the data need to be reformatted in order to make comparisons with data from previous years.

The primary problem is that the recording form being used was not designed to address the severity of the erosion problem. The attribute choices for recording different types of physical impacts are "absent," "active," "inactive," or "not applicable," and the only attribute choices for different types of visitor impacts are "absent," "present," or "not applicable." These attributes indicate the extent of the impacts, or how widespread or common the impacts are, but they do not indicate how severe the impacts are at any given site or in the corridor as a whole. Furthermore, having different attributes for physical impacts and visitor impacts impairs the ability of the monitors and others referring to these data to make direct comparisons between the two types of impacts on specific sites and across the corridor. We do realize, however, that it would be very difficult to apply the same quantitative variables to both physical and visitor impacts.

Monitoring Schedules

Monitoring schedules were assigned to each site that was monitored during a particular session, as shown in Table 7.2. The specific problems found in the data collection/monitoring process are listed below, followed by a list of sites that demonstrate such problems. This list is not exhaustive,

Table 7.2. Monitoring Schedules and Codes

Code	Schedule
1	Discontinue
2	Semiannual
3	Annual
4	Biennial
5	Every 3-5 years
6	Inactive

as some sites demonstrating the described problems may not be listed. The observations were based on comparisons of the recommended monitoring schedules with the actual monitoring trips (see Appendixes I and J), the field notes on the data sheets, and site summaries in the annual reports for 1992 through 1998 (see Table 1.1). A current monitoring schedules table provided by GRCA RCMP personnel, which lists monitoring schedules and impact categories, was also referred to (see Appendix H).

- In reviewing the GRCA monitoring data, several instances were noted where monitoring schedules recommended for a site were different from year to year, with no explanation for the different schedules. In fact, the report site descriptions were often identical for two or more years, while the recommended monitoring schedules were different. For instance, for GRCA Site A:15:021, identical descriptions were provided in the 1994 and 1995 annual reports (e.g., "feature is deteriorating due to exposure"), but the suggested monitoring schedule was changed from annual monitoring in 1994 to every three to five years in 1995. No reason for or reference to this change was provided in the annual reports. Although they are annual reports (i.e., describing that year's monitoring efforts), providing a history of monitoring schedules throughout the years for the sites discussed would help to identify discrepancies between years and force an explanation for them. Other GRCA sites that demonstrated this problem included A:15:027, A:15:039, A:16:159, B:10:224, B:11:272, and B:11:282. This problem was not noted for GLCA sites.

- In some instances, monitoring schedules were consistent except for one or two years that seem out of place. For example, GRCA Site C:13:349 received recommendations for annual monitoring for six years (1993-1998), except in 1994 when it received a monitoring recommendation of every three to five years. Unless some major changes occurred at the site, which need to be explained in detail, monitoring schedule recommendations should be relatively consistent. Other GRCA sites that demonstrated this problem included B:13:002, C:09:050, C:13:098, C:13:099, C:13:100, C:13:272, C:13:354, C:13:359, and G:03:024. This problem was not found in monitoring schedule recommendations made for the smaller number of GLCA sites.

- Recommended monitoring schedules for some sites at both GRCA and GLCA were essentially not followed. For instance, it was recommended for three years that GRCA Site B:09:316 be monitored every three to five years. However, this site was monitored annually for two of those years, without any explanation offered. Other GRCA sites that demonstrated this problem included A:15:004, A:15:005, A:15:017, A:15:042, A:16:151, A:16:162, A:16:175, B:13:002, B:14:108, B:15:096, B:15:120, B:15:124, B:15:135, B:15:143, C:02:097, C:02:098, C:02:101, C:06:005, C:06:006, C:06:008, C:09:050, C:09:051, C:09:053, C:13:006, C:13:009, C:13:069, C:13:098, C:13:099, C:13:100, C:13:101, C:13:272, C:13:272, C:13:291, C:13:321, C:13:347, C:13:349, C:13:354, C:13:359, C:13:365, C:13:371, G:03:020, G:03:024, G:03:061, and G:03:080. GLCA sites that demonstrated this problem included C:2:011 Feature 4, C:2:011 Feature 12, C:02:060 Feature 2, C:02:060 Feature 8, C:2:081, and C:3:010.

- For some sites, the monitoring suggestions made in the annual reports did not correspond with the monitoring schedules entered into the database. Such discrepancies often occurred because upon further evaluation the GRCA RCMP Director and Program Manager changed the monitoring schedules after the report was written, then had the monitoring schedule in the database converted to reflect that change, leaving the original monitoring schedule in the report. For instance. the site description for Site A:15:035 in the 1993 GRCA RCMP annual report recommended an annual monitoring schedule. However, the GRCA RCMP Director changed that schedule to every three to five years some time after the 1993 annual report was written. In the description for that same site in the 1997 GRCA RCMP annual report, a monitoring schedule of every three to five years was recommended, but this was later changed back to annual monitoring. Such changes were made in the databases, but not in the annual reports. These inconsistencies made it difficult to determine the originally recommended monitoring schedules. Why the RCMP Director or Manager changed the schedules was also unclear and was not explicitly explained. To avoid such inconsistencies. RCMP staff should write an addendum to the annual reports explaining any changes made after report production. RCMP staff also should not type over or update the original monitoring schedules in the database. Instead, a new field should be added to the database that records monitoring changes and the justifications for the changes. Other GRCA sites that demonstrated this problem included A:15:021, A:15:039, A:15:042, A:16:175, B:15:131, B:16:262, C:02:101, C:09:068, C:09:082, C:13:008, C:13:131, C:13:274, C:13:326, C:13:344, C:13:357, C:13:359, C:13:365, C:13:384, G:03:054, and G:03:059. GLCA sites with discrepancies between report site descriptions and the database (not as a result of changes made by the GRCA RCMP Director. however) included C:2:011, C:2:053, C:2:060, and C:2:077.

- The "Inactive" and "Discontinue" monitoring schedules seem to be interchangeable. Apparently, an inactive site is within the 300,000 cfs level and is in "stable" condition, while a discontinued site is above the 300,000 cfs level and thus outside the boundaries of the NPS RCMP responsibilities. However. several sites were marked for discontinuation (i.e., assigned a "1") but were described as "stable" and within the 300,000 cfs level in the report site descriptions. These sites should be changed to Inactive (i.e., assigned a "6") in the database. In fact, several of these sites were classified as Inactive in the current monitoring schedules table (Appendix H).

Why there was a difference between that table and the database is unclear. GRCA sites that demonstrated this problem included B:09:315, B:09:319, B:10:262, B:11:279, B:11:283, B:15:096, B:15:124, B:16:261, B:16:262, C:05:007, C:05:009, C:05:035, C:06:004, C:09:004, C:09:054, C:09:073, C:09:083, C:13:008, C:13:326, C:13:364, G:02:001, G:02:103, G:02:107, G:03:027, and G:03:082. The only GLCA site with this problem was C:2:059. Part of the explanation for this may be that the Inactive category was not implemented until FY1996, which is why some sites were previously categorized as discontinued and stable but within the APE. Nevertheless, before significantly changing monitoring forms or their attributes, the effects of these changes on the database must be thought out and tracked through all records (database and annual reports).

- Monitoring at several sites was discontinued because the sites were above the 300,000 cfs level, but only after they had been monitored one or more times during the previous years. For instance, from 1994 to 1997 GRCA Site C:06:003 consistently received recommendations for annual and semiannual monitoring and was monitored accordingly. In 1998, monitoring at that site was discontinued. We did find reference to this, however, in Leap et al. 1998. It is not always clearly stated, though, why consistent monitoring of a site for so many years would be abruptly discontinued. Other GRCA sites that demonstrated this problem included A:15:025, A:16:003, B:10:227, B:13:002, B:15:096, B:15:124, C:06:004, C:13:005, C:13:374, G:03:027, G:03:061, and G:03:082. No GLCA sites demonstrated this problem. (Since our draft of this report, the GRCA RCMP Director has explained that monitoring sometimes continues at a site that is close to the 300,000 cfs level but has not been determined to be outside until observed by a geomorphologist. The 300,000 cfs level is often difficult to detect, but once a site is determined to be outside of it, monitoring of the site is discontinued.)

- A few sites were recommended for discontinuation one year, then re-monitored during a subsequent monitoring session. We were not able to determine why discontinued sites were re-monitored. GRCA sites that demonstrated this problem included A:15:001, B:15:132, B:15:143, and C:13:364. No GLCA sites demonstrated this problem.

- According to the current monitoring schedules table (Appendix H), several sites that were discontinued were also considered in the impact category "SI" or "I," indicating that these sites were "either impacted or potentially impacted by river flows" (BOR et al.1997:72). These classifications place these sites below the 300,000 cfs level. We suspected that these sites were misidentified during the original survey (1990-1991) as being within the 300,000 cfs level and were later determined to be above it. If this is the case, and they are not impacted or potentially impacted by river flows, these sites should be assigned a different impact category. GRCA sites that demonstrate this problem included A:15:001, A:15:025, A:15:044, A:16:003, A:16:173, A:16:175, A:16:179, B:13:002, B:16:261, C:02:050, C:02:089, C:06:003, C:09:001, C:09:058, C:09:059, C:09:071, C:13:005, C:13:357, C:13:374, C:13:392, G:02:102, G:02:105, G:03:056, and G:03:061. No GLCA sites demonstrated this problem. (Lisa Leap [personal communication 1999] has further noted that the impact categories originated in the office based on IMACS site information and monitors' memories. The categories have been disregarded by current GRCA

RCMP staff, since many of their in-field evaluations of the assigned impact categories do not match those made in the office. As a result, many of the sites that were previously discontinued, as well as sites that were continued, have been re-evaluated in the field and possibly given a different monitoring schedule. The current GRCA RCMP staff do not use the impact category data for any analyses.)

- A few sites that were discontinued or considered inactive did not fit the criteria for either monitoring category. Instead, these were sites that did not qualify to be listed on the National Register of Historic Places and/or were not considered significant "cultural manifestations," such as GRCA sites B:10:229, B:10:248, and B:15:131. Other sites were completely eroded or excavated, such as GRCA sites A:15:030, B:10:262, C:13:131, and C:13:358. GRCA B:16:365 was discontinued because it is maintained by GRCA Phantom Ranch personnel, while GRCA G:02:160 was discontinued out of concerns for the safety of monitoring personnel. RCMP staff should consider different monitoring schedules for these sites. For instance, sites that are not significant cultural manifestations or have lost their integrity due to erosion/excavation could be considered "non-sites" and assigned a monitoring schedule of "0."

- The monitoring schedule for the control group is unclear. According to the Historic Preservation Plan (HPP) (BOR et al: 1997:72), control groups are sites "located along the river corridor but outside the area of potential effects (APE)," and are placed in the "N" impact category. A 10% random sample from the "N" impact group is supposed to be monitored every three years to provide a comparison to sites in the "I" and "SI" impact groups. In the database, several control group sites were assigned monitoring schedules other than every three years and/or were discontinued. The main reasons provided (in the database and/or reports) for discontinuation of control group sites was that they were above the 300,000 cfs level. However, by definition, control groups are supposed to be above the 300,000 cfs level. GRCA sites that demonstrated this problem included A:16:002, B:10:227, B:10:260, B:14:105, B:15:001, B:15:118, C:09:032, C:13:132, G:03:023, G:03:029, and G:03:069. There is no control group in Glen Canyon. In general, the confusion concerning control groups is being partially addressed with the formulation of monitoring schedule "7" indicating a control group site, although this schedule has only recently (FY98) been added to the monitoring forms (Leap et al. 1998).

- Some sites had several different features or "loci." Occasionally, different features from the same site received different monitoring and/or preservation/recovery recommendations. For example, in the 1994 GRCA annual report, Locus A of Site C:06:003 was described as having increased gully cutting, with a recommendation for remedial action because of exposed artifacts. Locus B for that same site was considered stable. If a site has different loci/features that are impacted dissimilarly, resulting in different recommendations/assessments, then such loci/features should be treated separately (i.e., recorded on separate monitoring forms). This was effectively done for two GLCA sites, C:2:011 and C:2:060, and should be considered for other sites with multiple loci/features (at both GLCA and GRCA).

Preservation/Recovery Recommendations and Assessments

The following observations concerning preservation/data recovery recommendations and assessments for GRCA are based on examination and comparison of the 1992-1998 monitoring data, annual reports, and preservation and recovery options tables (Appendixes K and L). The latter are tables constructed by GRCA RCMP personnel that contain priority rankings for various remedial work options[1] (Table 7.3), the dates such priorities were recommended or assessed, and the date the action was completed. Generally, fields should be added to these tables so that they better coincide.

Table 7.3. Priority Codes for Remedial Actions

Code	Description	Remedial Action Should be Completed
0	Done	NA
1	First/High Priority (extensive impacts)	Within the following fiscal year
2	Second/Moderate Priority (moderate impacts)	Within the following two years
3	Third/Low Priority (minor impacts)	Within the following three years
4	No work recommended after an assessment	NA

This section of the analysis presented a challenge to us because the recommended priorities for remedial work were provided in electronic format only for current recommendations. Data from 1992 and 1993 were limited, and the preservation/recovery recommendations were not prioritized at that time[2]. Remedial actions did not officially begin until September 1995 (Lisa Leap, personal communication 1998). All sites recorded in the 1990-91 inventory were monitored, but few recommendations for preservation or recovery efforts were recorded. Prior to FY1995, after all sites were monitored at least once, the second phase of the program (Remedial Actions) began under the MRAP.

Another problem in tracking the history of recommendations made was that the priority ranking in the table is replaced with a "0" once work is completed, making it difficult to determine the original ranking of the recommendation/assessment and the time it took to implement the work. It

[1]The priority codes in the 1994-1997 annual reports, unlike those in the preservation and recovery options tables, are similar only for priority ranks 1, 2, and 3. A rank of 4 is not used in the annual reports, and a rank of 0 "is suggested when no remedial action will occur until enough evidence is provided to justify the action, or when work has already been completed" (Leap et al. 1997:83).

[2]However, the monitoring schedules for 1992 and 1993 did relate to remedial action priorities (e.g., 1=biannual or quarterly monitoring [high priority], 2=annual monitoring [second highest priority], etc.). This makes sense, since monitoring schedules and preservation/recovery recommendations are interrelated, that is, sites that need preservation/recovery work should also be monitored more frequently.

was thus necessary to refer to the annual reports to determine the history of recommendations/assessments, assess how well they were followed, and determine the time it took to complete the remedial work.

Sites given the highest priority for remedial work should generally be the sites that are also recommended for intense monitoring, either semiannually or annually, based on the definition of high-priority sites as those requiring work within the next fiscal year. However, out of 56 GRCA sites that received Priority 1 recommendations for remedial work[3], 20 were recommended for monitoring biennially or every three to five years[4], as illustrated in Table 7.4. Priority ranking, however, is dependent on the time and extent of impacts to a site; therefore, the need for remedial action may be a high priority relative to the type of impact, but the impacted area may not need to be monitored regularly once the priority assessment is made and prior to completion of the remedial action.

Table 7.4. Comparison of Monitoring Schedules for Priority 1 Remediation Sites

Monitoring Schedule	Number of Priority 1 Sites
(1) discontinue	2
(2) semi-annual	7
(3) annual	27
(4) biennial	12
(5) every 3-5 years	8
(6) inactive	0

Furthermore, 19 GRCA sites that were recommended for semiannual (biannual) monitoring at least once during the study never received a priority ranking of 1 for remedial work. While some of these sites did receive lower rankings for remedial work, such as priority 2 or 3, other semiannually monitored sites never received any recommendation for remedial work.

The process by which sites receive priority rankings for remedial action is unclear but generally is explained in the annual reports. Recommendations for certain remedial actions were made in the field, but only in the form of answering a "yes" or "no"question (0=no, 1=yes) on the monitoring forms. When and how the priority rankings were determined is difficult to assess. According to the

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[3]Some of these sites received priority rankings of 1 more than once.

[4]Out of 12 GLCA sites that received priority 1 recommendations, only two received recommendations for biennial monitoring, and no sites received recommendations for less frequent monitoring.

preservation and recovery options tables, the majority of recommendations and assessments for remedial work were made "in-office" during the first day of a given year (1994-1997) and not in the field. A description of how and why such recommendations/assessments were made was not provided, making it impossible to evaluate the priority ranking process. (Since our draft of this report, the GRCA RCMP Director has noted that the impact matrices and comments on the monitoring forms are assessed in the office. Recommendation and assessment dates refer to the fiscal year in which the recommendations/assessments were made. However, a site assessment form to be completed in the field has now been created to better track the priority ranking process.)

We were, however, able to identify specific problems with the priority ranking system by reviewing the preservation/recovery options tables and comparing them to the monitoring database and annual reports. Since summary tables of remedial actions were not provided for GLCA sites, the majority of the assessments below are only for GRCA sites:

- The priority ranks in the annual reports for some sites did not match the priority ranks in the preservation and recovery options tables. For instance, GRCA Site A:15:033 received a priority 3 recommendation for stabilization in the 1996 annual report but a priority 1 recommendation in the preservation options table. This is most likely a result of the site being reassessed in 1997 and given a higher priority ranking. Unfortunately, no written description of this change was provided, making it difficult to determine the exact basis for the change. Other GRCA sites demonstrating this problem listed in the preservation options table included A:16:149, A:16:149, A:16:150, A:16:159: B:10:111: B:10:121, B:10:237, B:15:091, B:15:126, C:13:070, C:13:098, C:13:349, C:13:371, C:13:387, G:03:020, G:03:041, G:03:058, and G:03:076. Sites with this problem listed in the recovery options table included B:10:237, G:03:034, and G:03:040. (Following completion of our draft report, GRCA RCMP staff explained that the priority ranking for a site moves up as work at higher-priority sites is completed. This process needs to be tracked in the priority table or a supplemental table, however, so that it is clear that a site is being moved up because work at a higher-priority site is finished rather than because of accelerated disturbance.)

- Similarly, the priority rankings in the annual reports for another group of sites did not match those in the preservation and recovery options tables. However, these sites had not been assessed. For instance, GRCA Site C:09:058 received priority 1 recommendations for testing and stabilization in the 1996 annual report but a priority 2 recommendation in the preservation options table. According to the table, this site was not assessed; GRCA RCMP staff have explained that not all sites are assessed and that the annual reports provide a discussion of which remedial actions are assessed and which are not. It remains unclear, however, why there is a discrepancy between priority rankings in the annual report and the table when no written description of the change is provided. The GRCA RCMP has noted that the preservation/recovery tables are planning documents meant to identify what will be done and when, assuming accessibility and availability of appropriate personnel, which can change. Other GRCA sites demonstrating this problem and listed in the recovery options table included A:15:021, A:15:039, A:16:180, B:11:271, C:09:058, C:13:006, C:13:327, C:13:359, C:13:384, G:03:044, G:03:020, and G:03:072. No other sites listed on the preservation options table demonstrated this problem.

- Priority recommendations made in the annual reports were not necessarily recorded on the preservation options table, and vice versa. For instance, GRCA Site C:13:070 received priority 1 rankings for trail obliteration, stabilization, and checkdams in the 1996 report. However, this site received recommendations in 1995 and an assessment in 1997 (with lower priority rankings for such preservation actions) in the preservation options table, but there was no record in this table of the 1996 report recommendations, nor was there an indication of why the 1996 recommendations were not included. Instead, we have been informed that the 1996 report recommendations were reflected in the 1997 assessment. A history of recommendations and assessments is provided only on the actual monitoring forms, not in the tables and reports (Lisa Leap, personal communication 1998). Other GRCA sites demonstrating the problem of priority recommendations being recorded in the annual reports but not the preservation table included C:09:051, C:13:070, C:13:098, C:13:291, and G:03:064. GRCA sites that had priority recommendations recorded on the preservation and recovery options tables but not in the annual report included C:09:030, C:13:273, C:13:389, G:03:002, G:03:025 on the preservation options table, and A:15:030, C:06:008, and C:13:379 on the recovery options table.

- Some sites received recommendations/assessments on the preservation and recovery options tables that were fundamentally inconsistent. For instance, some sites received a priority of 4 ("no work recommended after an assessment"), although according to the tables, the sites were never assessed. Other sites received a priority of 0 ("done") (i.e., work completed), although according to the tables, work was not completed. Other inconsistencies included sites that did not receive recommendations and/or an assessment, although work was completed. GRCA sites demonstrating these problems included, on the preservation options table, A:16:160, C:13:010, C:13:099, C:13:371, C:13:389, G:03:024, G:03:041, and G:03:064, and on the recovery options table, A:15:021, A:15:031, A:15:039, A:16:180, B:10:230, B:11:271, B:13:002, B:15:143, C:02:098, C:06:008, C:13:006, C:13:010, C:13:273, C:13:321, C:13:327, C:13:333, C:13:335, C:13:338, C:13:339, C:13:343, C:13:359, C:13:365, C:13:371, C:13:379, C:13:384, G:03:020, G:03:030, G:03:044, and G:03:072.

- Several sites received a priority ranking of 1, but more than one year passed before these sites were assessed and/or the recommended work was completed; in some cases the work has yet to be completed. This is especially a problem for some GLCA sites that consistently received priority 1 recommendations for remedial work from 1994 through 1997 but, as of 1997, had not received such work[5]. These GLCA sites included C:2:011 Feature 14, C:2:038, C:2:072, C:2:075, C:2:076, C:2:077, and C:2:099. It took more than one year to complete remedial work on a number of GRCA sites that received priority 1 rankings, and such work has still not been done at some sites. GRCA sites that demonstrated this problem included, on the preservation

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[5]Since no remedial actions tables were provided for GLCA sites, this assessment was based solely on information provided in the GLCA annual reports.

options table, C:06:003, C:09:031, C:09:051, C:13:273, C:13:291, C:13:399, C:13:389, G:03:003, G:03:020, G:03:024, G:03:026, G:03:064, and G:03:067, and on the recovery options table, C:13:070, C:13:291, C:13:347, C:13:349, and C:13:356. (GRCA RCMP staff have explained that the main reason why these actions are not being undertaken within a year of being assessed or assessed within a year of being recommended is directly tied to a lack of funding and time on the river to complete these tasks.)

Summary of Data Collection and Evaluation Recommendations

We based our observations on the monitoring schedules and remedial actions by reviewing the databases, tables, and annual reports provided by RCMP personnel, and making cross comparisons when appropriate. Many of the problems we identified may represent isolated mistakes or data entry errors made in these sources rather than problems in the monitoring or remedial actions recommended and/or taken. However, it was difficult to discern where many of the observed problems originated because of inadequate recording of the process involved in making recommendations or taking actions. For instance, with regard to remedial recommendations/actions, the primary origin of the problems identified in this chapter was insufficient documentation of the recommendation/assessment process. This problem can easily be addressed by using separate forms (either in the field or in-office) for recording the recommendations and assessments made, the reasons for such decisions, any remedial work completed, and a follow-up investigating the success/failure of such work, as well as any changes in previous recommendations/assessments and the rationale for such changes. A table could then be generated from this information, clearly showing the history of remedial recommendations, assessments, and actions taken. Similar follow-up activities could be done with the monitoring data, addressing many of the problems identified in the review of the monitoring schedules. GRCA RCMP personnel have designed a recommendation assessment form and a remedial action form (Appendix M), which are fine starts.

In general, for data to be statistically relevant or comparable, NPS RCMP staff must strive to avoid inconsistencies among the data gathered in the field, tables generated from such data, and the annual reports. If RCMP personnel discover while writing a report or making in-office assessments that the recommendations/assessments made in the field need to be changed, they should record such changes in the database. However, they should not type over or eliminate the original data. Instead, new fields should be added that document the changes, as well as fields for comments/notes so that reasons/justifications for such changes can be recorded. In this manner, the history of recommendations and assessments can easily be generated from the database. GRCA RCMP staff do have extended reports that track the history of a site's monitoring schedule, so the same tracking system needs to be applied to recommendations/assessments and remedial actions.

The importance of having a history of recommendations and assessments is to allow researchers to upgrade and improve the recommendation/assessment process. For instance, if different monitoring schedules are assigned to the same site on a number of site visits, this might indicate that something needs to be done to the monitoring forms to avoid such discrepancies (which have occurred nearly annually). Providing detailed reasons for changing both monitoring schedules and remedial recommendations allows others, especially new employees, to better understand the criteria used to determine schedules or to make recommendations and assessments. Schedules and recommendations/assessments can thus be more consistent, especially among different individuals working on the same site. For example, as we noted earlier, remedial action priority rankings for sites may move up as work at higher priority sites is completed, but there needs to be a way to distinguish between this type of advancement and advancement due to accelerated deterioration.

A number of the problems addressed stem from not clearly defining terms and identifying assumptions. For example, RCMP staff should more clearly describe the fluctuating monitoring schedule for the control group sites, since the schedule is supposed to be consistently monitored every 3-5 years. Based on Leap et al.'s (2000) recent synthesis, monitoring of the control group sites by GRCA RCMP staff has ceased, since it was determined during an April 1999 river trip of PA representatives that the sites are not similar enough in physical characteristics (i.e., not located on pre-dam alluvium) to provide any valuable information on impacts to sites in the APE. A lack of such explanations probably stems from a larger problem, that is, that the annual reports are being written for a very specific audience: the Programmatic Agreement signatories and not the general archaeological community. Consequently, many assumptions are not explained and therefore may not be grasped by readers or researchers unfamiliar with the work that has been done.

Although the annual reports are intended to describe the monitoring work in specific fiscal years, more reference should be made to work from previous years' to provide a bigger picture of the running history of work recommended or completed to date. Although any previous work that was done at the sites is noted in site descriptions in the GRCA annual reports, no descriptions of previous evaluations are provided. The GLCA annual reports, however, do go into detail in regard to previous evaluations, providing a nice history of physical impacts to the sites, which allows the reader to identify changes throughout the years and to better understand the rationale behind any recommendations made. Much of this lack of history has been remedied by the recently completed site-by-site draft synthesis by GRCA RCMP and NAU project staff (Leap et al. 2000).

Finally, in order to document the severity of the impacts, the monitoring form would have to record extent of disturbance expressed as volume (ideal for physical impacts) or area (less useful but could then incorporate visitor impacts more readily) and as percent of total site volume or area. See Chapter 5 for additional recommendations offered to better quantify site impacts and determine a site's vulnerability to erosion related to dam operation. In similar fashion, although the likeliest causes of the erosion problem are identified in the forms, the currently used attributes also hinder determination of the relative severity of different impacts and whether some sites are more susceptible to damage than others based on physical location or site date and type/function. Given that the forms do not really indicate the severity of impacts, it becomes somewhat difficult to fully evaluate management recommendations and results of remediation.

CREATING A GIS DATABASE

Before actually analyzing the monitoring data, we felt that the best place to start was to synthesize the site location data from the survey and subsequent monitoring efforts. GRCA RCMP had previously provided NPS/GRCA Geographic Information System (GIS) specialist Dan Spotskey with the IMACS site form database (in dBase III) for all 475 sites identified during the survey, which contained UTM coordinates to be placed in a GIS format. (The three newly recorded sites had not yet been entered into the IMACS database. To make the GIS coverage complete, these records were added during the data-archiving portion of this synthesis project.) Spotskey converted the UTM northing and easting fields of the dBase III database into a point file in ArcInfo (Dan Spotskey, personnel communication March 1998) and in August of 1998 provided SWCA with an electronic copy. Meanwhile, SWCA's GIS specialist Mark Cederholm had also created an ArcInfo data file by the same procedure, using a copy of the IMACS database provided by GRCA RCMP database manager Nancy Andrews. Spotskey's and Cederholm's GIS databases were then related using the common IMACS database field of SITENO.

Cederholm generated a point spread of the GIS databases in ArcView. Of the total 494 records in the databases, 485 had UTM coordinates. The databases need to be closely edited to determine which sites may have more than one plot, since there are 485 points and only 475 sites. Lisa Leap (personal communication 1998) suggests that the additional points may represent individual structures or site loci at Lees Ferry. Cederholm plotted the 485 points from both databases on a gray-scale surface map of the Grand Canyon on 8½ × 11–inch sheets at 300-m contour intervals (Figure 7.1). It would take approximately four to six 11 × 17–inch sheets to show the entire point coverage.

Seven of the 475 sites had plots that did not overlap, meaning that one set of plots was incorrect, since the GIS files were created using the same IMACS database. These plot discrepancies are shown in Figures 7.2 and 7.3. As noted on the figures, the RCMP IMACS database points will be kept, and the NPS/GRCA plots, which for an undetermined reason were incorrect, will be deleted from the master ArcInfo file that will be generated.

In August of 1998, SWCA also acquired from Chris Brod, contracted surveyor for GCMRC, total station–generated UTM coordinates for four of the 10 GLCA sites and 49 of the 68 GRCA corridor sites. (GRCA RCMP staff now have UTM coordinates for all 68.) Five of the points from GCMRC were duplicates of data supplied by Michael Yeatts of the Hopi Cultural Preservation Office. Yeatts had used a Global Positioning System (GPS) unit to obtain UTM coordinates at 28 GRCA sites. He had obtained comparison coordinates from the center of sites from Brod, and was mostly testing the accuracy of the GPS unit by taking shots on site datums throughout the corridor. Points were also collected from some sites for which comparative data were not obtained. SWCA also acquired Yeatts's database, consisting of a Microsoft Access spreadsheet, in August 1998. Like the IMACS UTM coordinates, these databases (Brod's in Excel and Yeatts's in Access) were imported into ArcInfo to generate GIS files for each. The two data sets were then plotted on the gray-scale maps, along with the RCMP IMACS GIS database, to compare all three. Figure 7.1 is a sample comparison of the three different GIS data sets, and it clearly illustrates the variation among the

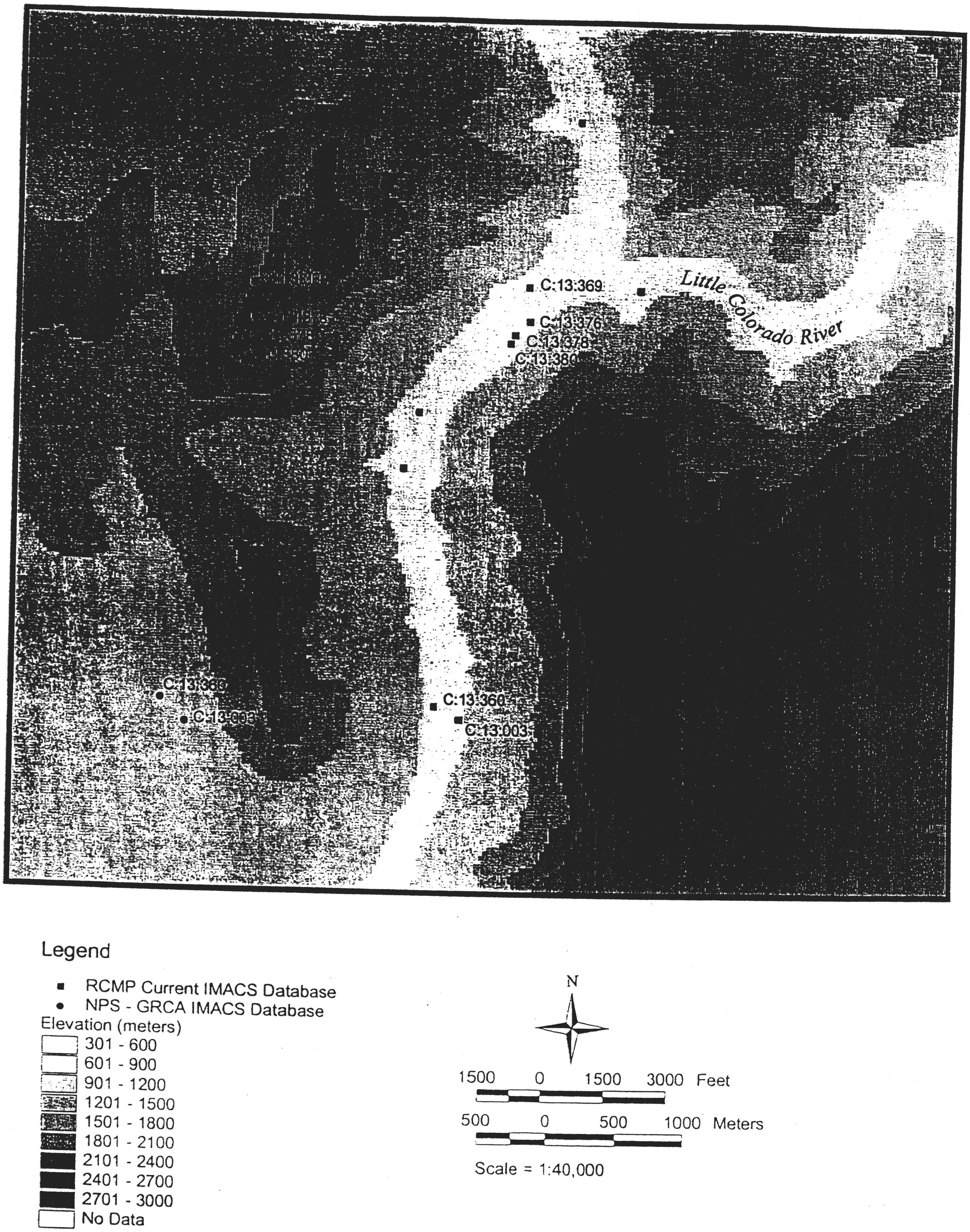


Figure 7.2. Sample comparison of two different GIS data sets derived from similar databases. (Note: the RCMP points will be kept, and the NPS plots [which are incorrect] will be deleted.)

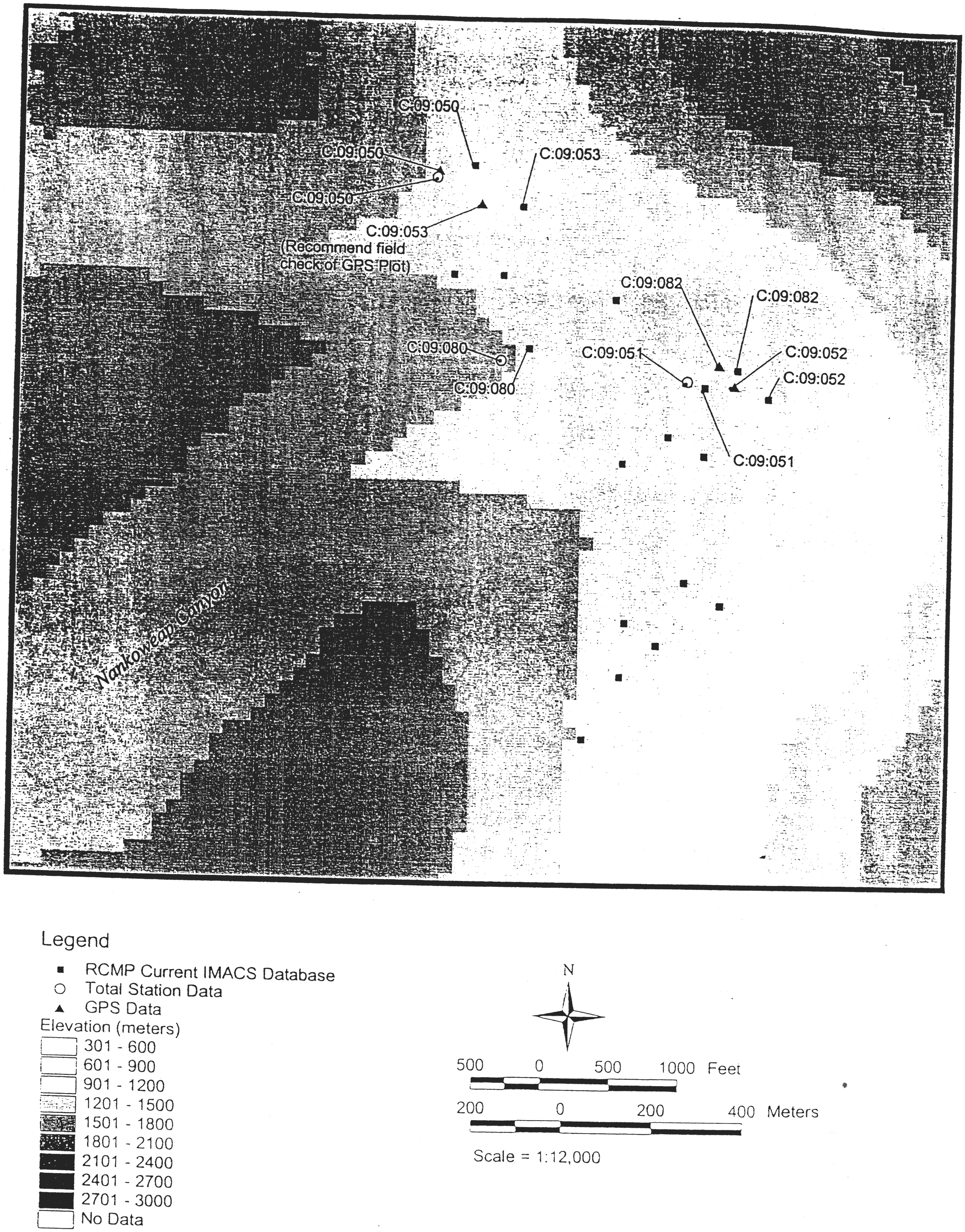


Figure 7.1. Sample comparison of three different GIS data sets.
(Note: Total Station and GPS data points will replace/update the RCMP points.)

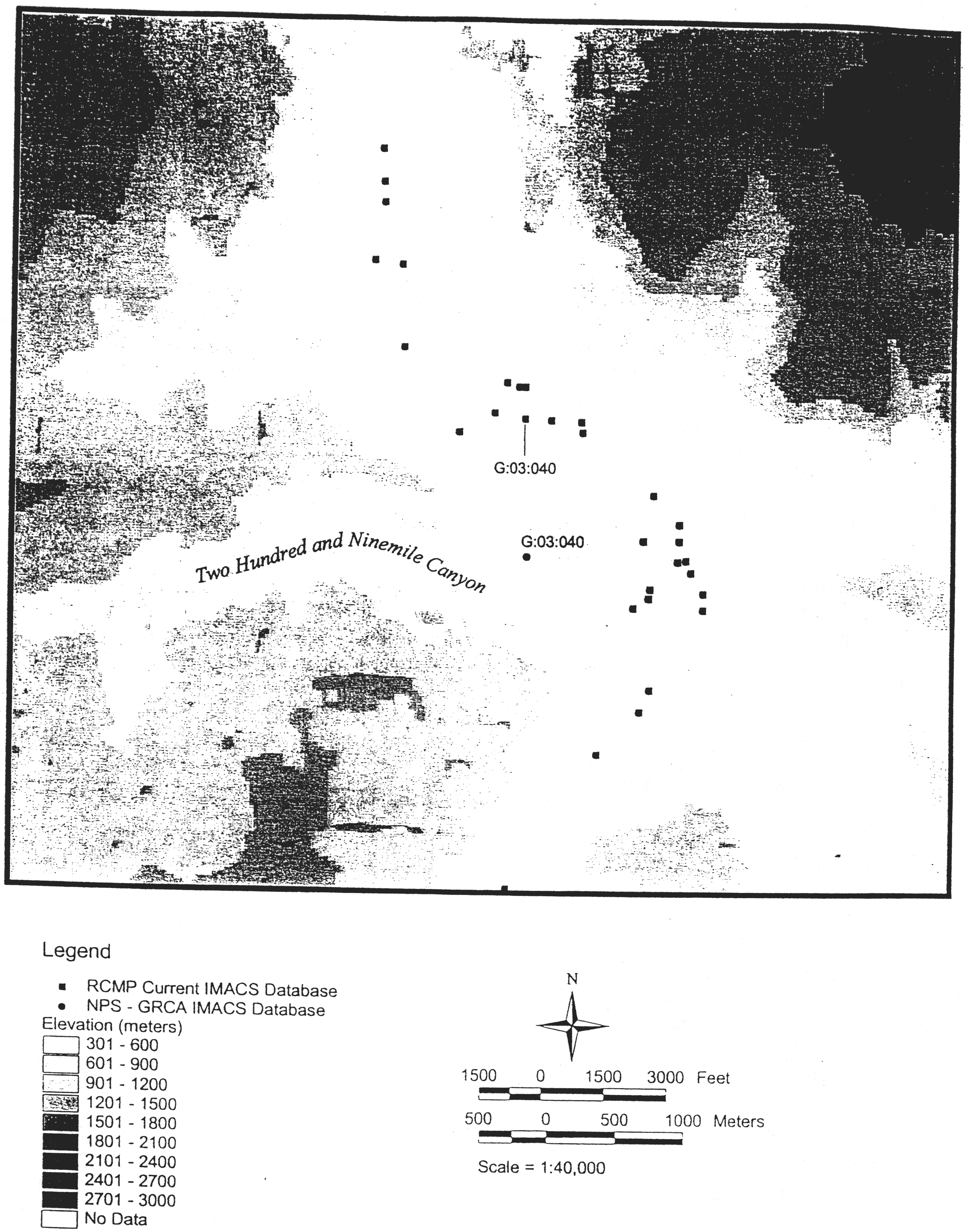


Figure 7.3. Second sample comparison of two different GIS data sets derived from similar databases. (Note: as in Figure 7.2, the RCMP point will be kept, and the NPS plot [which is incorrect] will be deleted.)

plots. The IMACS UTM coordinates were created by taking UTMs from USGS 7.5 minute quadrangle maps containing field plots of all the sites; therefore, the total station data are being used to update the survey plots, as are the GPS data in most cases. Some of the GPS points, however, have not been reliable. For instance, in Figure 7.1 the GPS plot for Site C:09:053 is far enough away from the survey plot to recommend a field check of the possible revised site location. The GPS plot for Site C:09:050, directly above C:09:053, is right on target with the total station point for the site, which will replace the survey plot for C:09:050.

The master GIS database that will be created by editing and compiling the four databases could be used for a variety of spatial applications, such as ordering the site plots by site type, cultural affiliation, date, and so forth.

TOTAL STATION MAPPING

RCMP archaeologists view total station mapping of sites in the river corridor as a remedial action, and they have proactively been doing more and more mapping each year since the effort was begun in 1995. (Unfortunately, additional NPS mapping efforts were not funded by BOR for FY1999.) After four years of total station mapping, 68 GRCA sites have complete baseline maps. Twenty-one were done in FY1996, 31 in FY1997, and 16 in FY1998 (Table 7.5). Nine maps are incomplete to date, including five from FY1995 (the first maps generated under the direction of Warren Hurley, BOR archaeologist), three in FY1997, and one in FY1998. According to Burchett (1997), 10 GLCA sites (C:02:032, C:02:035, C:02:038, C:02:071, C:02:073, C:02:075, C:02:077, C:02:79, C:02:081, and C:03:010) have also been mapped using the total station. Figures 7.4 and 7.5 represent examples of two completed total station maps. See Leap et al. (1997, 2000) for details of the procedures and criteria for conducting total station mapping. Generally, surveyors are used to generate the maps to ensure accuracy for mapping both topography and the location of archaeological features. Terrain is displayed at a 25-cm contour interval with up to a 10-cm degree of error.

New baseline site maps that were planned for FY1999 were to be based on those sites receiving intrusive remediation (i.e., checkdam construction and data recovery). Planting vegetation and trail obliteration work do not require total station maps.

From the 68 mapped sites, a sample of 10 was selected by GRCA RCMP to be remapped in FY1999. These selected sites have shown signs of abundant erosional activity as seen through RCMP's monitoring efforts. In particular, several gullies and arroyos have shown an obvious increase or decrease in sediment deposition and/or headward movement of nick points and headcuts. RCMP staff intended to remap or "update" these areas in an attempt to identify the rate and degree of change in comparison to the original base map, but budget cuts in FY1999 have stalled this effort. Figures 7.6 and 7.7 provide one means of illustrating elevation changes caused by drainage erosion on an archaeological site that has been remapped for this purpose.

Table 7.5. Total Station Maps Completed

Fiscal Year Baseline Map Completed	Site Number
FY95 (n=5)	*A:15:003
	*A:15:021
	*A:16:004
	*G:02:100
	*G:03:004
FY96 (n=21)	A:15:005
	A:15:030
	A:15:031
	A:15:032
	A:16:180
	B:11:272
	B:15:126
	B:15:143
	C:02:096
	C:13:365
	C:13:371
	G:03:002
	G:03:003
	G:03:024
	G:03:025
	G:03:026
	G:03:027
	G:03:028
	G:03:040
	G:03:058
	G:03:059
FY97 (n=34)	A:16:156
	B:10:121
	B:10:230
	B:10:236
	B:14:107
	C:02:101
	C:09:050
	C:09:051
	*C:09:058
	C:09:080
	C:13:006
	C:13:069
FY97, cont.	*C:13:098
	C:13:099
	C:13:100
	C:13:273
	C:13:321
	C:13:327
	C:13:338
	C:13:343
	C:13:346
	C:13:347
	C:13:348
	C:13:349
	C:13:356
	C:13:359
	C:13:367
	C:13:381
	G:03:019
	G:03:038
	G:03:041
	G:03:072
	*C:09:052
	C:13:384
FY98 (n=17)	A:15:017
	A:15:033
	A:15:048
	A:16:149
	A:16:174
	B:15:121
	B:15:132
	B:15:138
	C:02:098
	*C:13:010
	C:13:070
	C:13:291
	C:13:339
	G:03:020
	G:03:030
	G:03:055
	G:03:064

Note: after Leap et al. 1998:Table 14
*=excluded from total count because map is incomplete

Additional factors such as soil type, vegetation, and slope are also incorporated into calculations used to determine rate of erosion/deposition and degree of change. Remapping of active on-site drainages serves as the NPS RCMP's first method of truly quantifying change and the effects of dam operations on cultural resources, and, used in conjunction with the current geomorphic data generated by Thompson et al. (2000), can be a very valuable quantitative tool. In the past, qualitative data in the form of monitoring observations and photographic comparisons have been used to identify and monitor change. Total station mapping and remapping quantify volumetric change and can be used to support the monitoring data and recommendations made for remedial actions, as well as the success of particular preservation/environmental efforts.

In 1998 remapping had been carried out and new maps produced for 10 GRCA sites: A:15:005, A:15:033, C:02:101, C:13:070, C:13:099, C:13:347, C:13:349, C:13:371, G:03:038, and G:03:072). Figures 7.6 and 7.7 demonstrate the information that can be acquired through repeat mapping. Only the drainage areas are remapped, and measurements are taken of the volume of fill or cut that occurred since the site was first mapped. Repeat mapping therefore volumetrically and areally quantifies sediment movement, erosion, and deposition within the drainage systems on a site. Information on soil type, vegetation, and gradient/slope are variables that were used to form the predictive geomorphic model that will enable NPS RCMP archaeologists to determine which sites can be effectively stabilized and where on the sites these efforts will be most successful.

In summary, as an attempt to measure physical impact extent and severity, GRCA RCMP staff have produced total station maps for 78 sites. These maps are the single most important archaeological documentation available for quantitatively assessing the extent, severity, location, and causes of site erosion. Using total station maps, it should be possible to calculate the total volume (surface area × depth) of a site using detailed topography and measurements of site depth in different areas as exposed in cutbanks, arroyos, gullies, trails, test pits, and so forth. Second, the maps can be used to calculate the volume of physical disturbance, based on the length and depth of a drainage. Figures 7.6 and 7.7 illustrate the second point. Third, analysts can be even more specific, estimating volume represented by different types of features (rooms, pit structures, pits, middens, roasters, etc.) at each site and again calculating what percent of the volume of each feature has been disturbed. Finally, the maps can be used to come up with calculations of how much (again in terms of volume or area) of the disturbance was caused by particular impacts (physical, visitor-related, and subsets of these). Admittedly, much of this information would be based on estimates of what is buried and what is gone, but the current system seems more subjective than what we would propose. If one focuses solely on surface area for the site as a whole and surface area of disturbance, there is less estimating, but impacts could register across a total site surface area while leaving most of the subsurface materials intact. We also think that trying to figure out site depth, numbers and types of features, and so forth is important in assessing the site's significance (and, concomitantly, the nature and extent of resource loss). It is unfortunate that the total station mapping has not received continued funding from the BOR, eliminating the immediate opportunity to test some of these ideas for measuring severity and extent of impacts to a site.

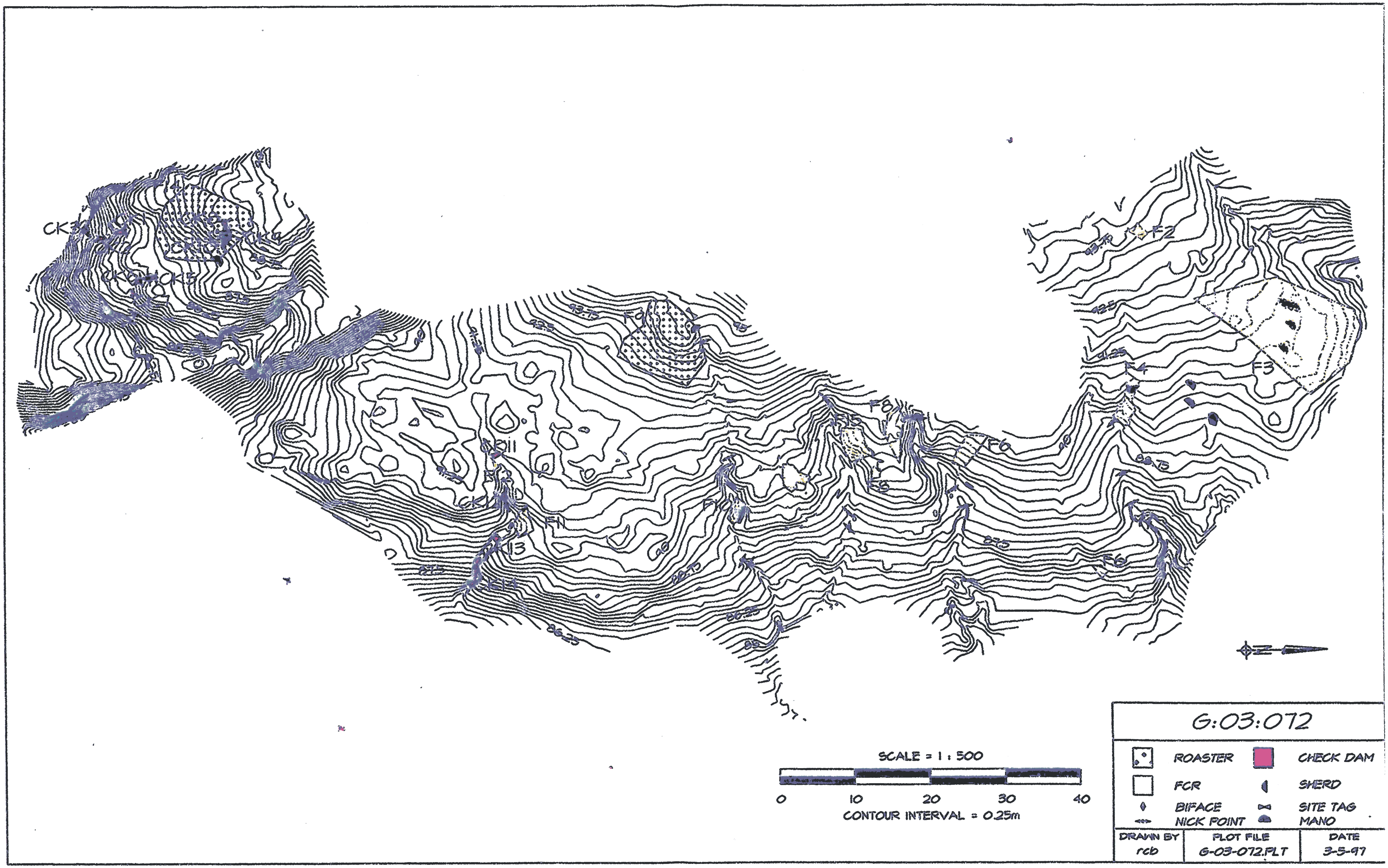


Figure 7.4. Example of Total Station map of Site G:03:072 showing archaeological features, point-located artifacts, remedial checkdams, and contours.

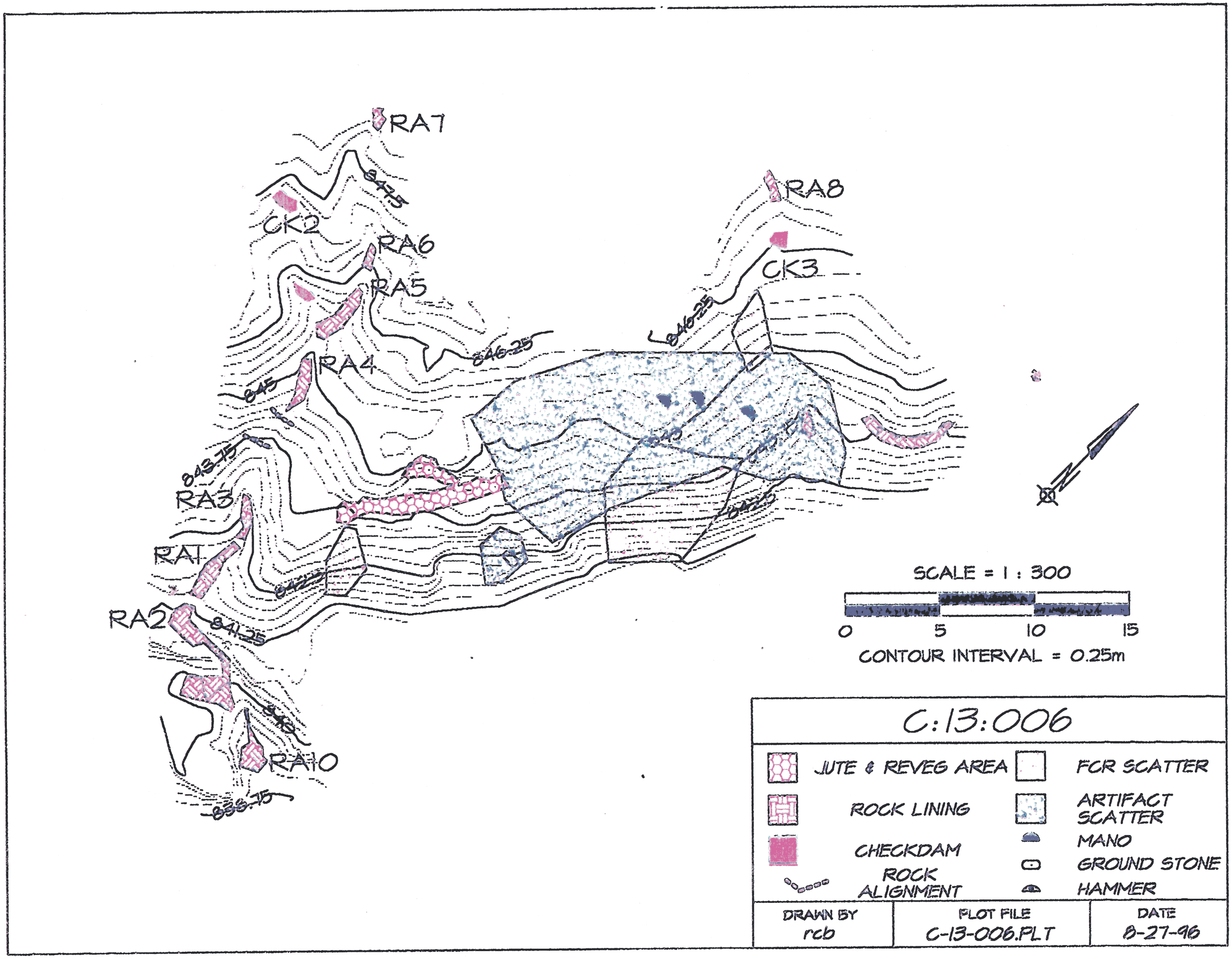


Figure 7.5. Example of Total Station map of Site G:13:006 showing archaeological features, point-located artifacts, contours, and remedial checkdams, rock lining, and jute mat/revegetation area.

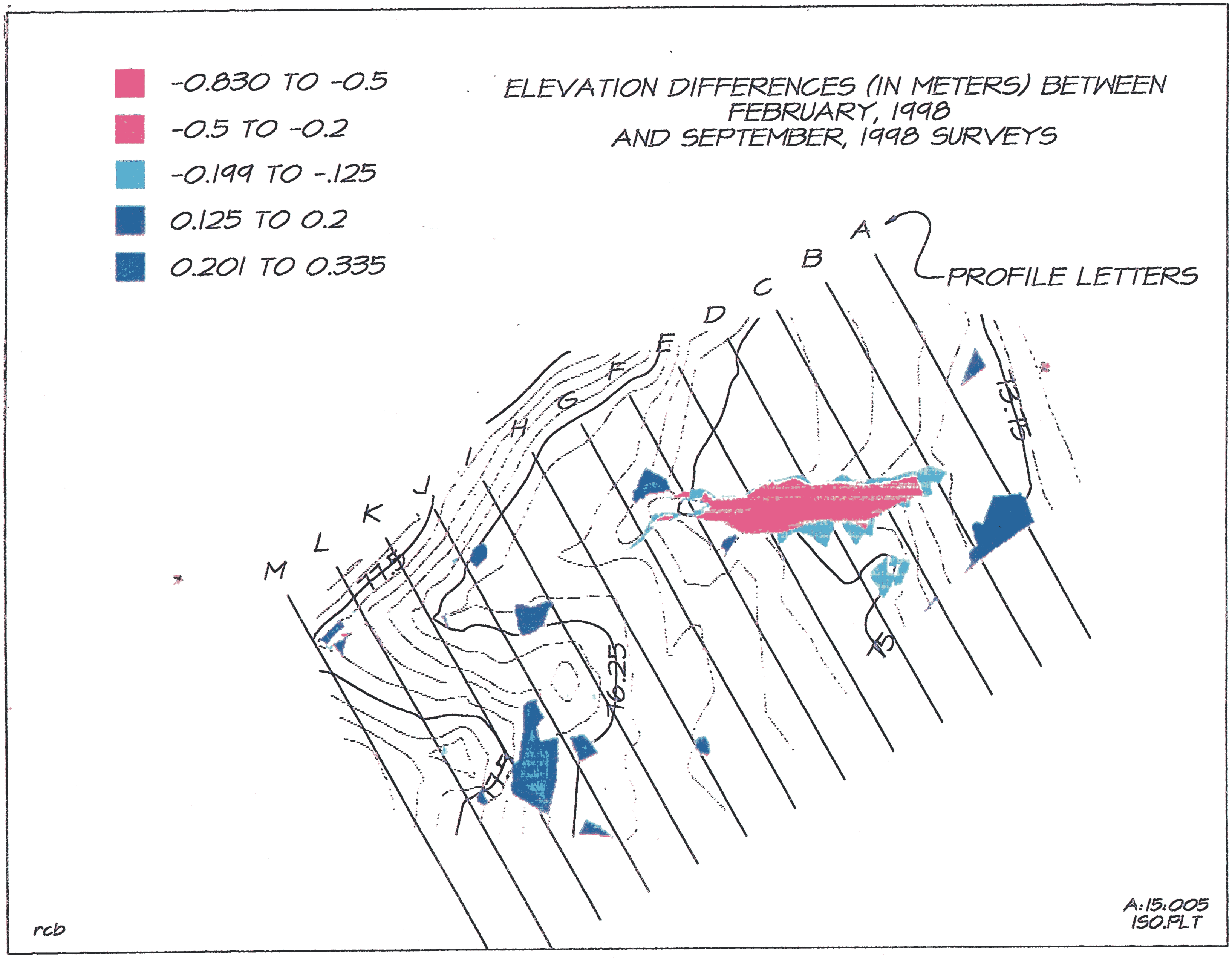


Figure 7.6. Total Station-generated detail map of Site A:15:005 showing elevation differences (in meters) over a seven-month period in 1998. Labeled profile lines correspond with profiles in Figure 7.7.

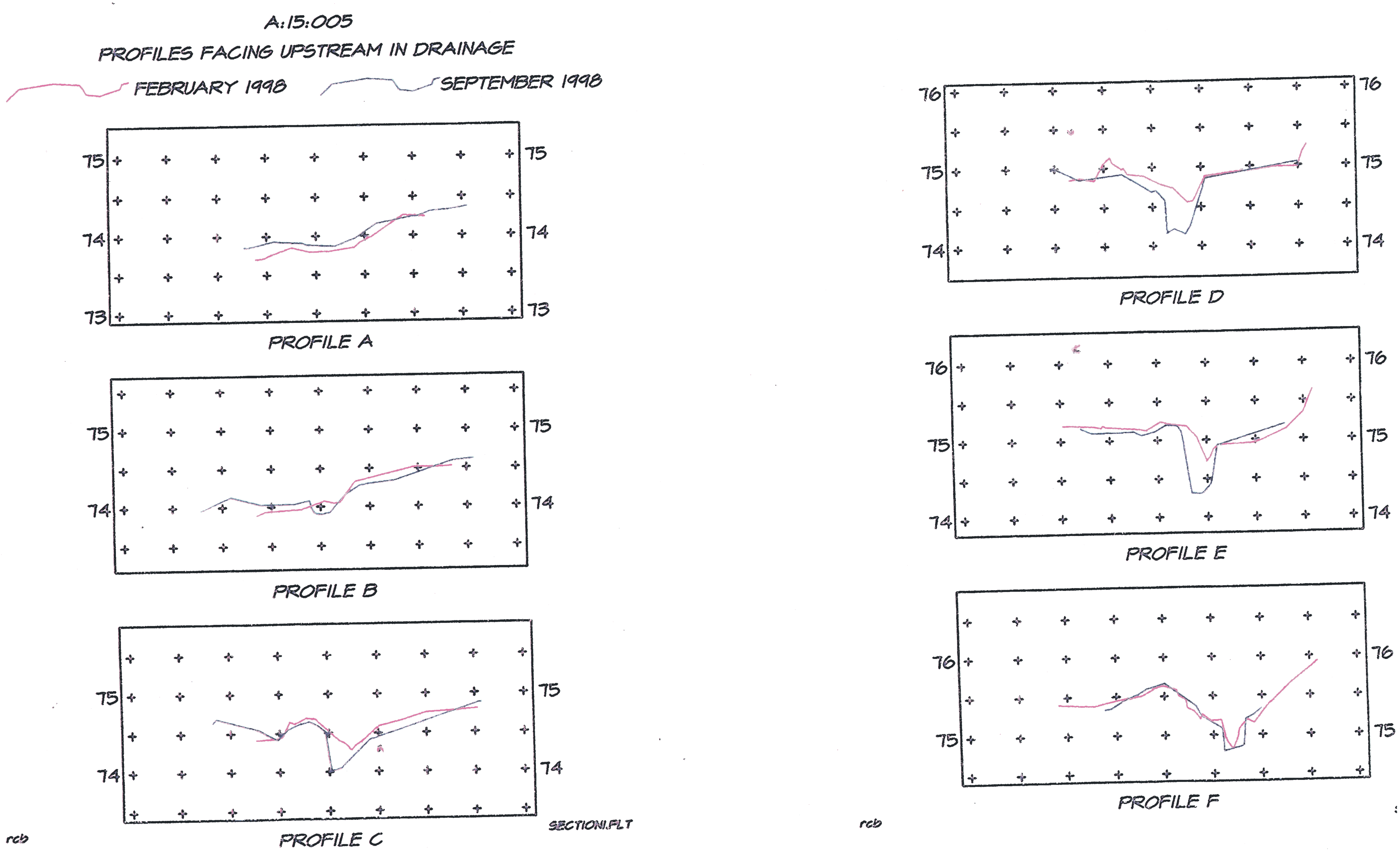


Figure 7.7. Profiles A-F across Site A:15:005 illustrating elevation differences in a single on-site drainage over a seven-month period in 1998.

PHOTOGRAPHIC DOCUMENTATION AND ARTIFACT ANALYSIS UNITS

Photographic documentation, particularly the use of repeat photography, has been an essential element of the RCMP's program to document change over time. The methods and uses of photography as related to the monitoring program are discussed in Leap et al. (2000) but will be summarized here. The monitors use photographic images in a variety of formats to visually document impacts observed and remedial actions taken on or near archaeological features. Photographs reduce the subjectivity inherent in recording and are heavily relied upon in the office to clarify questions raised when reviewing monitoring forms. Photographic images are also useful in illustrating observations for people who have not had the opportunity to go on a river trip. Clear and distinct photos are needed to show the cultural property types along the corridor, the impacts observed, and the preservation measures implemented, that is, documenting the success or failure of the implementations. Examples of this type of repeat photography are shown later in this chapter under the Preservation and Data Recovery Efforts sections.

GRCA images include 35-mm black-and-white prints and color slides, 8-mm videotape, and 5 × 7–inch medium format color and black-and-white prints, and GLCA has generated mostly color prints but also 35-mm black-and-white prints and color slides to document their sites. All GRCA site images documenting archaeological sites along the river corridor, some from as early as 1962, are logged in a Microsoft Access database. On the other hand, starting in 1993 GLCA archaeologists have only typed up their photo logs, using various word-processing programs; no database has been generated. To date, there are over 10,400 photo images in the database and archives, over 9000 images for GRCA and over 1400 color photos for GLCA. The photos generated by the inventory survey and monitoring program since 1992 are curated to the highest standards and are housed in acceptable facilities at Grand Canyon's Flagstaff office and Glen Canyon's cultural resources department in Page. At the GRCA offices both at the Grand Canyon and in Flagstaff, black-and-white negatives and photographs, color slides, and videotapes are kept in fireproof file cabinets, and negatives and photographs are stored in archivally stable polypropylene sleeves. These materials are also used at GLCA, but the sleeves are kept in three-ring binders.

Photography has been useful in visually illustrating erosion but can provide quantitative measurements of erosion only in conjunction with maps. For example, changes in the depth of an arroyo could be measured from a photograph, and changes in the length of the arroyo could also be measured from photographs if one could plot the location of the arroyo and the photo station on a map. The plotting of photo stations in relation to photographed natural and cultural features is already a current and consistent practice of the monitoring team. Thus, the photographs taken by river monitors over the past eight years could be analyzed to document quantitatively the severity, location, and causes of erosion, and greater time depth could be achieved by comparing photographs from the past eight years with historic photographs. This has been done in a few instances in monitoring reports and proves to be quite visually dramatic and effective. Scaled medium-format photography has also been conducted at 48 sites (Leap et al. 2000:xiv).

Beginning with the survey in 1990, Leap et al. (2000) have noted a decrease in the number of photographs taken on each monitoring trip. The exception to this occurs from FY1995 to FY1997. Prior to FY1995, photo documentation was incomplete, and many photos were not clear or detailed enough for field use. Therefore, from FY1995 to FY1997 baseline photographic documentation for every site monitored was completed. One obvious factor in the overall reduction in photographs taken is that the number of sites visited on each river trip has been reduced over the years. A second reason is that NPS RCMP personnel take photographs only where change in a feature's appearance is observed, as a result of physical or visitor-related impacts, preservation efforts, or data recovery.

Beginning in FY1992, RCMP staff experimented with two additional methods of data collection that they hoped would aid in understanding and documenting the mechanisms of change and quantifying that change: stationary cameras and surface artifact analysis units (in the Grand Canyon only). The stationary cameras were set up to "monitor" sites on a daily basis (a process called terrestrial photogrammetry), serving this purpose more in Glen Canyon than in the Grand Canyon. In the Grand Canyon the cameras were used primarily to document general beach erosion and deposition, which was the driving force behind the development of the stationary camera program. Specifically, in 1992 Dexter and Cluer (1992) developed a proposal to monitor sand bar stability on a daily time scale using terrestrial photogrammetry. The objective of the study was to determine if fluvial deposits were stabilized by interim flows. Cluer worked closely with GLCA and GRCA archaeologists at the time to determine locations where his objectives could be achieved in conjunction with documenting the potential effects of the interim flows on cultural resources (Neal and Leap 1992). The cameras therefore were positioned to document not only erosional processes, but erosion directly affecting cultural resources.

FY1992 marked the placement of five stationary cameras, at GRCA corridor sites A:16:180, B:10:229, C:13:003, C:13:359, and C:13:371. These cameras remained in use through FY1993, but in FY1994 one camera was moved to a new location overlooking C:13:006, and two cameras were removed. Three sites continued to be photographed in color daily through FY1996. GRCA RCMP staff did conduct informal analysis of their stationary camera photos in 1996 and noted no changes to cultural features at six sites. After FY1996 they recommended termination of the stationary camera program in the Grand Canyon. In the five years that the cameras were in use, only one incident of stochastic change was identified: deposition of large amounts of sand at C:13:003 as a result of a side-canyon flood (Coder et al. 1995). No changes to cultural features were documented through the use of the stationary cameras in Grand Canyon, only changes in beaches and sand bars.

In 1992 three stationary cameras were set up to photograph features at three sites: a cutbank containing a charcoal lens at C:02:032, a terrace-based drainage cutting C:02:100, and the Dugway (C:02:012) (Neal and Leap 1992). Currently, the GLCA cameras are situated at Nine Mile Terrace monitoring Sites C:02:032 and C:02:038 and across from the Charles H. Spencer Steamboat at Lees Ferry. Film retrieval and replacement occurs every 34 days at the two camera locations, involving day trips down the river from Glen Canyon Dam. At this time over 8000 of the stationary camera photos have been processed, that is, scanned and archived on CD-ROM, and a proposal by Mark Manone of NAU's geology department to conduct research using these images was submitted to

GCMRC in October 1999. The idea is to use the imagery to illustrate the erosion and deposition of fluvial sediments in relation to various streamflow regimes.

During FY1997 the potential value of continuing the stationary camera program at GLCA became apparent (Burchett 1997:57). Based on projected high runoff from the upper Colorado River basin states and expected high water levels in Lake Powell, BOR began releasing water at a maximum of 27,000 cfs during the spring of 1997. The higher flows have increased the amount of sediment loss from the high terraces in GLCA, the terraces containing cultural resources. Burchett (1997:57) notes that during the spring FY1996 habitat-building flow (at a maximum of 45,000 cfs), new sediment deposits developed at the base of some high terraces. Material for this development was probably derived from both the terrace cutbanks and the river channel. (It is hoped that mainstem flow modeling and sand bar studies can determine the proportions provided by each source.) Following the habitat-building flow, the cutbanks eroded back to an angle of repose, supported at the base by the new sediment deposits. The high flows of FY1997 had two effects on these deposits: (1) undercutting the sections of the cutbanks that had reached a desired angle of repose and (2) removing the sediment deposits, causing the upper unsupported sections of the cutbank to collapse. These impacts are forcing the almost vertical cutbank at Nine Mile Terrace (Sites C:02:032 and C:02:038) to erode back to a new angle of repose, resulting in a retreat of the terrace margin.

We cannot know, until the proposed research work analyzing the images is carried out, whether continued monitoring with stationary cameras will provide information confirming the field observations discussed above. These data may also be useful overall as a comparative and collaborative data set to be used by researchers studying the sedimentation and hydrology of the Colorado River system.

In September 1993 several PA representatives accompanying GRCA RCMP monitors on a river trip suggested tracking artifact movement in locations where physical and visitor-related impacts were high by analyzing surface units. In FY1994, ten 1 × 1–m units were laid out at nine sites: C:09:051, C:09:052, C:09:083, C:13:006, C:13:070, C:13:100, C:13:101, C:13:272, C:13:321, and C:13:385 (Coder et al. 1995). The analysis units were visited twice by GRCA RCMP staff, and in FY1995 Coder et al. (1995) recommended that more precise methods be developed. The units did not enable monitors to identify processes working to transform the modern ground surface or give further insight beyond what was already being recorded on the monitoring forms. The analysis units were therefore terminated in FY1996 (Leap et al. 1996). Kurt Dongoske, archaeologist for the Hopi Tribe, communicated to us in 1998 that he would like to see the procedure re-evaluated to determine if there is still an effective means of measuring erosional effects on the distribution of artifacts.

RESULTS AND TRENDS FROM ANALYSIS OF MONITORING DATA

Combining the NPS RCMP's efforts with data from the corridor survey, monitoring data have been collected for over nine years in Glen and Grand canyons. This data set now has more time depth than that of the regular GRCA-based backcountry monitoring program prior to 1990. Since the onset of the corridor monitoring, those involved have known that it would be an evolving program, with no good comparative data for a program of this kind or extent. According to Kunde (1999), efforts to monitor cultural resources have primarily been limited to short-term programs, and previous monitoring programs for federal agency resource management have no guidelines for implementing monitoring protocols. No programs have yet moved beyond the information stage to develop a trigger mechanism for implementing management actions. Several programs have also been designed to gather data specifically for resource management related to human impacts. Additionally, the short-term nature of these programs did not lead to the identification of trends through time or the formulation of predictive models (Kunde 1999). We have analyzed the NPS RCMP's data, summarized monitoring trends and observations, and summarized and evaluated the appropriateness and effectiveness of site management treatments.

Monitoring efforts began in fiscal year 1992 after baseline site data had been generated by the inventory survey. Grand Canyon site monitors generally take four river trips a year, each lasting 16-18 days, monitoring an average of 116 sites per year and conducting remedial actions on 20 to 40 sites per year. Once on site, the monitoring crews typically spend 30 to 60 minutes at each site. At that time they fill out a monitoring form and take photographs if necessary to document change. Figure 7.8 illustrates that in seven years of monitoring in the Grand Canyon (1992-1998), crews have conducted 930 monitoring sessions (or episodes), visiting about 322 sites during 29 monitoring trips. On average, each site has been visited approximately three times in those seven years and 130 sites have been visited per year. Another interesting trend shown in Figure 7.8 is that the decrease in the number of sessions and sites monitored from 1996 to 1997 reflects a shift in emphasis from monitoring to the completion of remedial actions, not a reduction in overall effort. Looking at the same data for Glen Canyon from 1992 to1998 (Figure 7.9) shows that where a total of 54 sites or 70 locations are monitored, the number of sessions are essentially equivalent to the number of sites visited.

Figure 7.10 shows that of 322 Grand Canyon sites monitored since 1992, 113 have been visited only once, and only one or two sites were visited between 11 and 14 times. These frequently visited sites represent those that are most heavily eroded. At Glen Canyon (Figure 7.11), only one site has been visited just once since 1992, while three sites have had numerous visits. In fact, portions of one extensive site at Lees Ferry have been visited 39 times.

Despite the fundamental problem with the design of the monitoring forms for quantifying severity and extent of erosion, SWCA's review of the data gathered from 1992 to 1998 did suggest that certain conclusions can be drawn about the extent of the erosion problem and its causes at the monitored corridor sites. Our review also indicated that the RCMP has generally met the program's responsibilities as outlined in the MRAP, with assistance from the tribes, people from other disciplines such as geomorphology, and this synthesis. Of the 322 Grand Canyon sites monitored from1992 to1998 (Figure 7.12), 71 (22%) had been eliminated from the monitoring schedule by being discontinued (above the high water mark or ineligible to the National Register), and another 51 (15.8%) sites were considered to be inactive (stable) in terms of impacts received. Sites on a 3-5-

Figure 7.8. Number of Monitoring Sessions and Sites Visited per Year

Grand Canyon

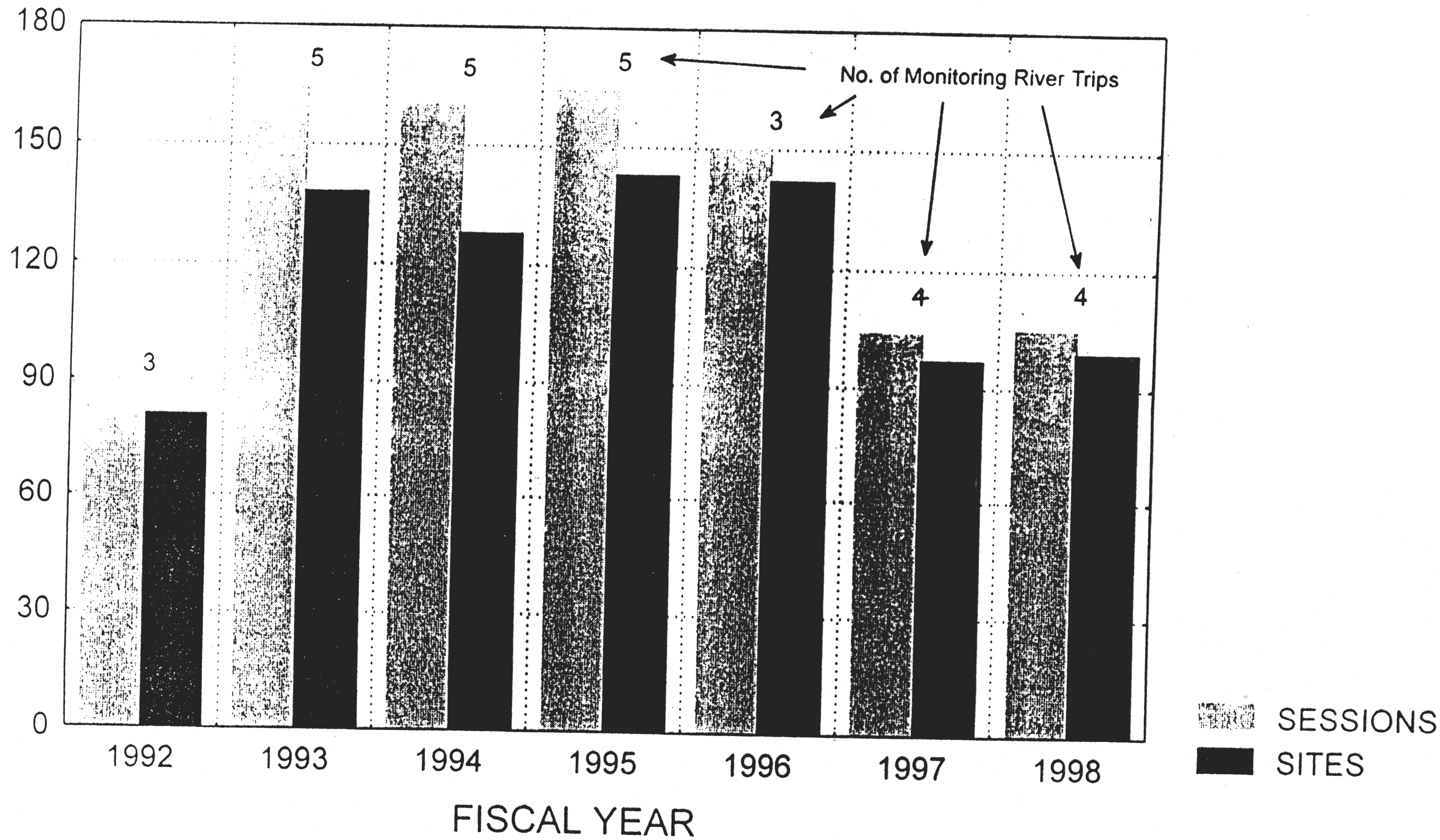


Figure 7.9 Number of Sites Visited per Year

Glen Canyon

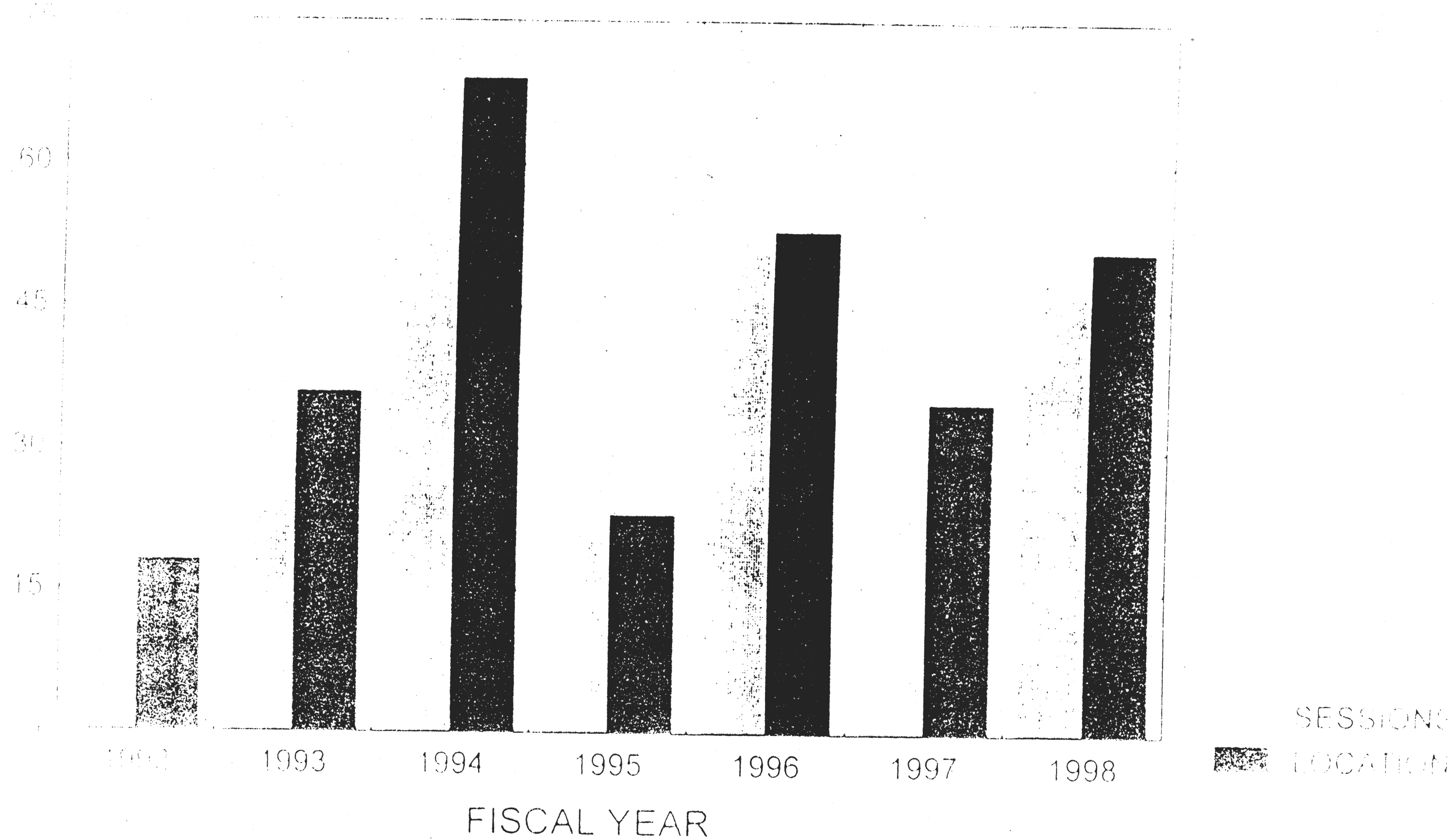


Figure 7.10. Frequency of the Site Visits

Grand Canyon

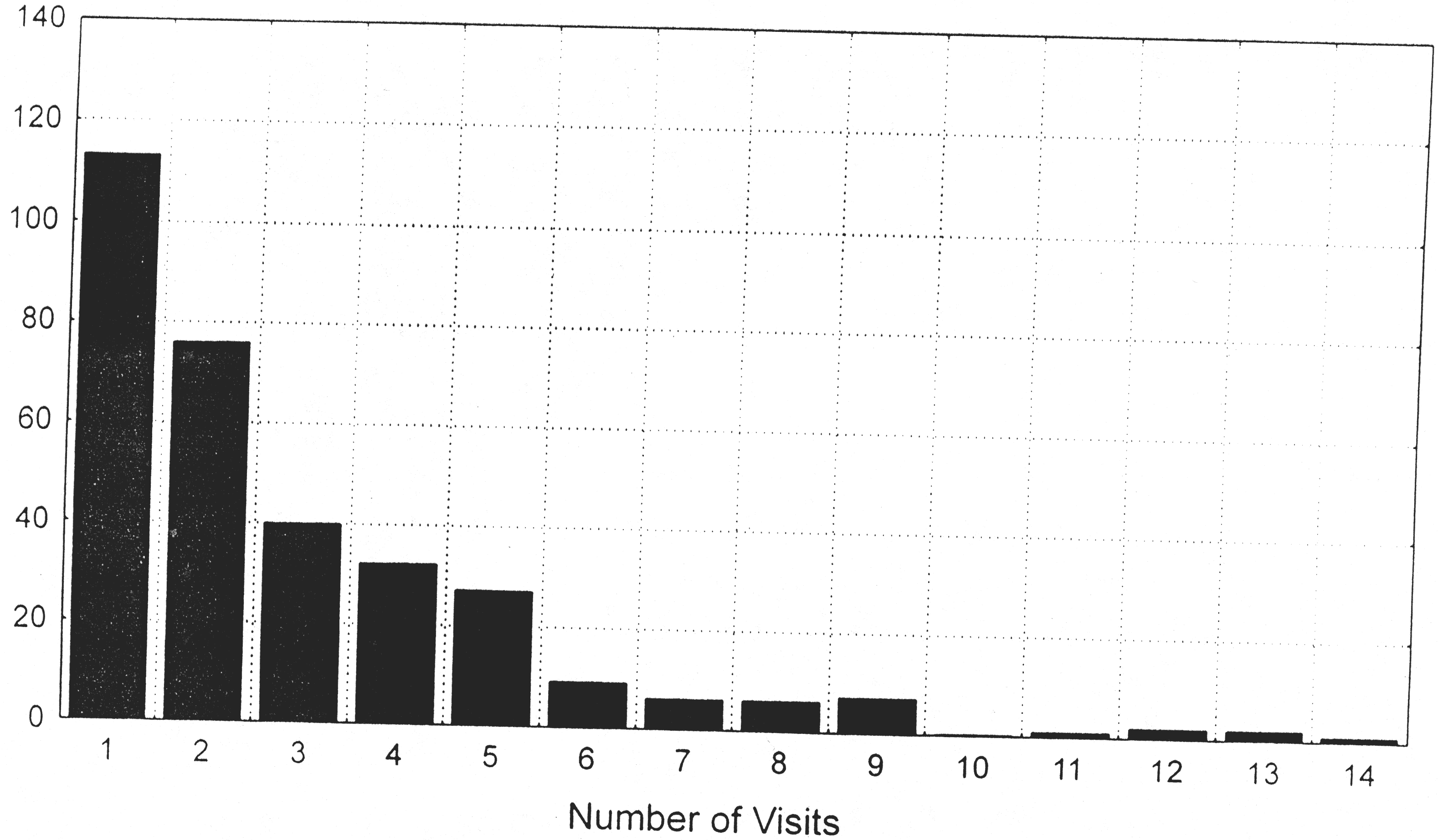
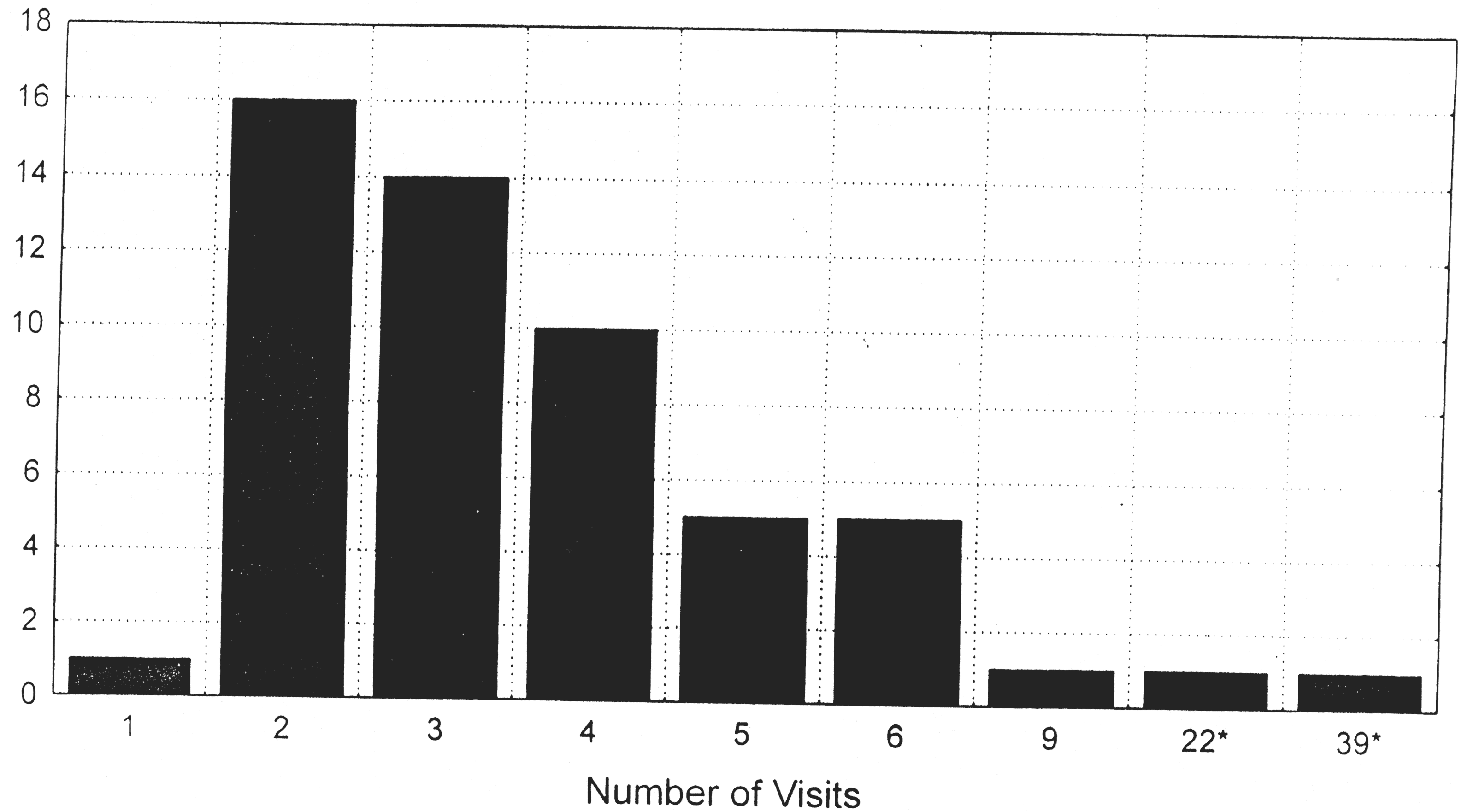


Figure 7.11. Frequency of Site Visits

Glen Canyon



* numbers represent individual feature visits being counted as site visits

Figure 7.12. Number of Monitoring Sessions and Sites Visited per Monitoring Schedule

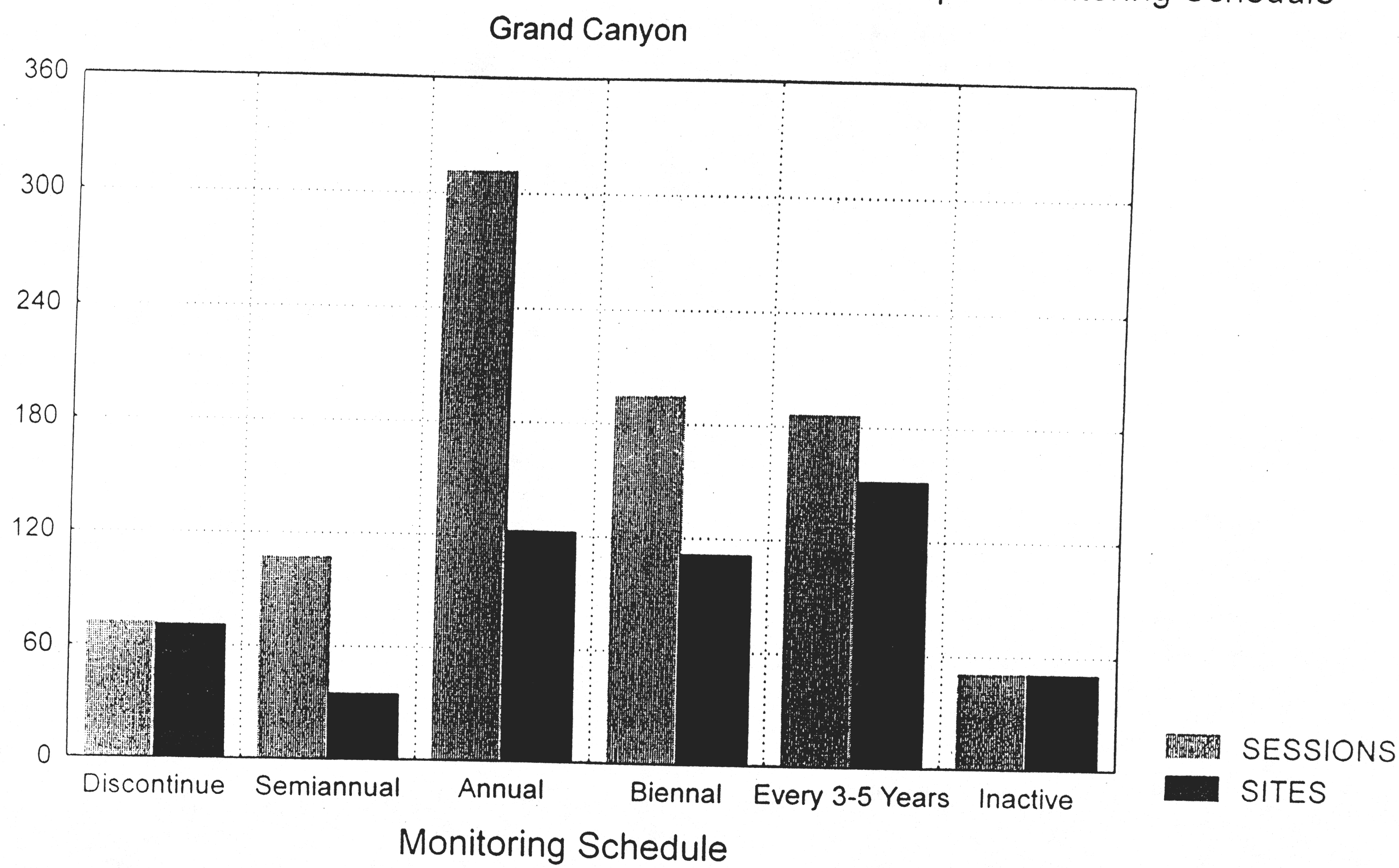
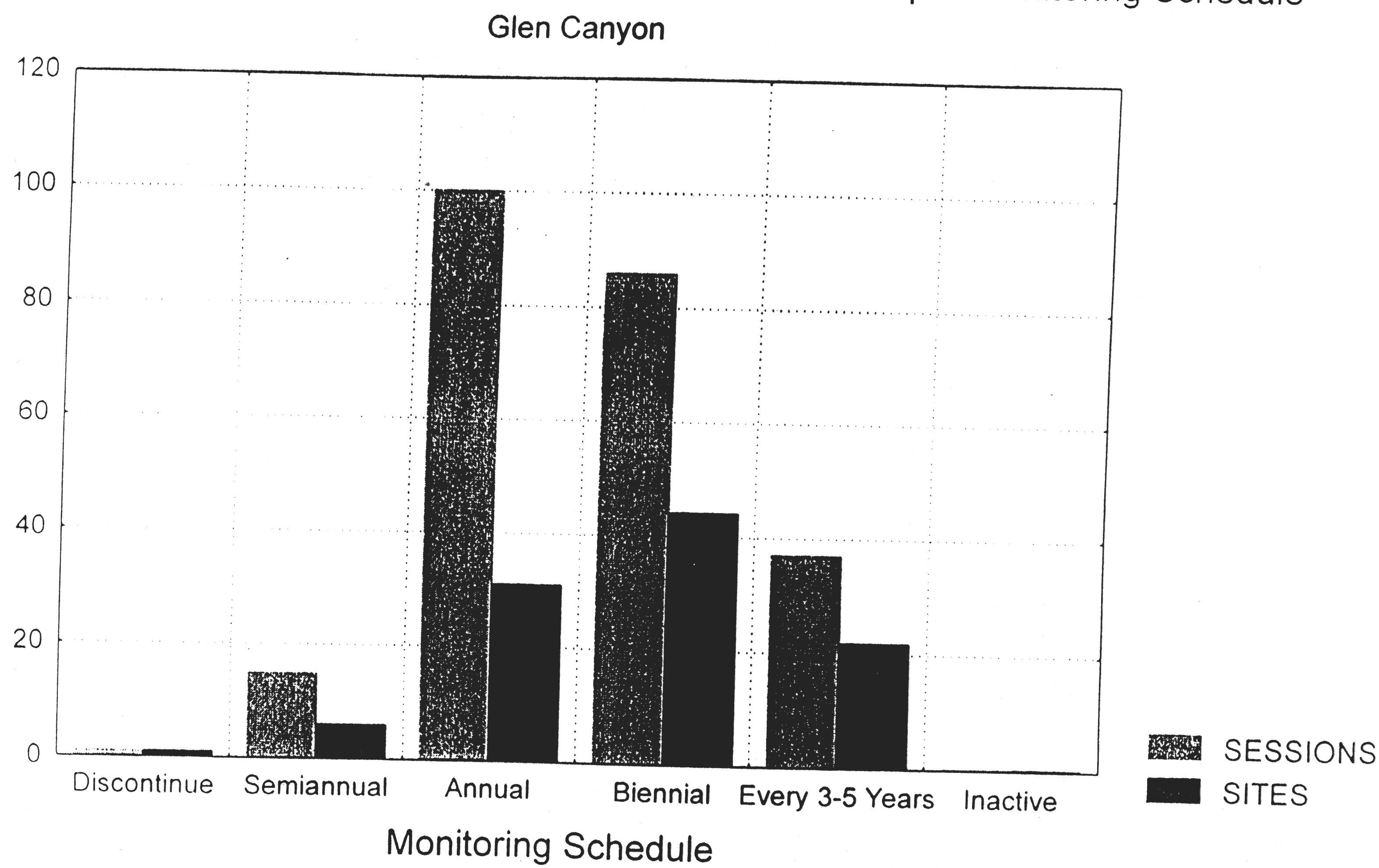


Figure 7.13. Number of Monitoring Sessions and Sites Visited per Monitoring Schedule



year monitoring schedule, which are considered relatively stable at times, totaled 151 (46.9%), and the biennial and annual sites were almost equal in number at GRCA, at 111 (34.5%) and 122 (37.9%), respectively. There were only 35 (10.9%) sites of such concern that they were monitored twice a year. (Note that these numbers, taken from our Appendix I, do not add up to the 322 sites monitored at one time or another by GRCA RCMP staff, since sites tend to receive more than one scheduling designation through time.) By comparison, as of 1999 only 3 (0.93%) sites are being monitored twice a year, 29 (9%) are monitored annually, 31 (9.6%) are monitored biennially, 128 (39.8%) are on a 3-5–year schedule, 87 (27%) are inactive, and approximately 44 (13.7%) have been discontinued (Lisa Leap, personal communication September 1999). (These numbers have since been refined to include only 177 sites that are actively monitored, rather than 191, based on continual evaluation of site impacts related to dam operations [Leap et al. 2000]). For Glen Canyon (Figure 7.13), only one site has been discontinued and removed from the monitoring schedule, probably a reflection of the overall smaller number of sites. At GLCA, the majority (n=44) of sites have had a biennial schedule. At one time, 322 Grand Canyon sites and 54 sites in Glen Canyon had been monitored since the initial survey inventory. Since those early years, including the initial monitoring evaluation as part of the survey, GRCA RCMP staff have refined the site impact categories to include only 264 sites that are considered to be NRHP-eligible and affected by the operation of Glen Canyon Dam. Currently, GRCA RCMP staff focus their monitoring efforts on the approximately 177 of the 264 sites that are considered to be potentially affected by dam operations and are in need of frequent monitoring. In Glen Canyon 53 sites were recently monitored, but in 1999 no monitoring activities were conducted, and GLCA cultural resources staff plan to cease monitoring activities and to concentrate on mitigating the effects of identified impacts to the corridor sites under their management (Chris Goetze, personal communication February 2000).

Acquiring the above data results involved interpreting statistics that were not really designed, however, to address the magnitude of erosion, but were instead designed primarily to help monitoring staff to decide *what sites (or portions of sites) to monitor, and how often*. In order to get at the magnitude and more specific causes of the impacts, SWCA researchers had to read between the lines to some extent, making assumptions about why various people working for the RCMP felt that some sites should be monitored frequently and some sites should not be monitored at all. Comments by the monitors are often included on the forms and transferred to the database, which helped to determine the reasons for a particular monitoring schedule.

A more effective means of assessing those sites considered to be inactive and those considered most disturbed was to look at both impacts recorded and management recommendations made. By looking at the actual monitoring impact data for the Grand Canyon sites from 1994 to1998, we were able to determine the most inactive ("stable") and most disturbed sites in the APE. By this method, 29% (n=94) of all the monitored sites showed no physical activity and no visitor impacts, meaning that these sites are considered inactive. For Glen Canyon, 28% (n=15) of sites monitored from 1994 to 1997 received no management recommendations and were considered to be inactive. Of the 135 Grand Canyon sites having impacts and receiving management recommendations for further action, 49% (n=66) had extensive impacts and were recommended for remedial action by the following fiscal year; these were the "most disturbed" sites. At Glen Canyon, 22% (n=12) of the 54 sites are in immediate need of remedial action (most disturbed). (The numbers for the Grand Canyon sites have since been updated to include FY1999 results in the site-by-site monitoring data synthesis prepared by Leap et al. [2000], but the overall numbers and percentages remain similar.)

Leap et al. (2000) provide site-by-site histories and assessments of these and other trends. These monitoring activities have resulted in an impressive database on site condition for river corridor sites in Grand and Glen canyons. Records from GRCA's database currently occupy some 26 linear feet of file-cabinet space, and the photo records occupy another 26 feet. Probably no area in the world has been inspected for archaeological site condition on such a detailed basis as often as the sites in Grand Canyon and Glen Canyon (Leap et al. 2000).

In determining which sites are truly being eroded by the operation of Glen Canyon Dam, recently completed geomorphological research that has resulted in a vulnerability rating for drainage catchment areas containing archaeological resources will indicate in some cases which site impacts from terrace-based drainage systems are exacerbated by the dam's operation. Currently, GRCA RCMP monitoring data show that about 70 of the 264 monitored sites have river-based drainages and 70 have terrace-based drainages. Sites with river-based drainages are considered to be directly impacted by dam operations and those with terrace-based sites to be indirectly impacted. Six additional sites have side canyon–based drainages cutting them, and these drainages follow a drainage development pattern similar to that of river-based drainages, since the side canyons themselves are river-based drainage systems. Overall, 86% of the sites with river-based drainages are in fair to poor condition and 67% are actively eroding. Sites with terrace- and side canyon–based drainages are commonly in good to fair condition (with only four sites in poor condition and only one of these actively eroding), but 38% show signs of active erosion (Leap et al. 2000:xii). Fourteen of the 118 sites with undeveloped drainages are in poor condition; however, only one site of the 14 is physically eroding. Thirteen other sites are reported to be in poor condition because of visitor impacts. Therefore, 91 sites are considered to be in poor condition, and many of these are actively eroding due to physical and visitor impacts.

SITE CONDITION OVER TIME AS RELATED TO PRESERVATION AND DATA RECOVERY EFFORTS

RCMP Preservation Efforts (FY1992-1999)

The primary goal of the PA participants and Adaptive Management Program stakeholders is to preserve in situ all downstream cultural resources and to take into account Native American cultural resource concerns in Glen and Grand canyons (BOR et al. 1997:27). Therefore, RCMP staff attempt preservation efforts as the first means of resource protection, using their monitoring observations and, more recently, geomorphic data to determine those sites in need of further action. As shown in Table 7.6, GRCA RCMP staff and other related researchers have been busy working to preserve sites that are being impacted by erosional processes that are often the indirect result of dam operations. Figure 7.14 illustrates a fairly obvious example of these erosional impacts. Preservation

Table 7.6. Preservation Measures Completed by Site (N=90)

Site	Action	Completed
A:15:005	Checkdams	FY99
	Obliterate Trail	FY97
	Medium Format Photos	FY97
	Retrail	FY97
A:15:018	Medium Format Photos	FY97
A:15:042	Obliterate Trail	FY95
	Retrail	FY95
A:16:001	Medium Format Photos	FY97
A:16:149	Checkdams	FY99
A:16:151	Obliterate Trail	FY97
A:16:159	Medium Format Photos	FY97
A:16:160	Obliterate Trail	FY97
A:16:163	Medium Format Photos	FY97
A:16:172	Medium Format Photos	FY97
A:16:174	Checkdams	FY98.99
A:16:179	Medium Format Photos	FY97
A:16:180	Checkdams	FY97
A:16:182	Obliterate Trail	FY97
B:09:317	Obliterate Trail	FY97
B:10:230	Medium Format Photos	FY95
B:11:272	Retrail	FY95
B:11:284	Medium Format Photos	FY97
B:14:105	Obliterate Trail	FY97
B:14:107	Checkdams	FY97
	Other	FY98
B:15:118	Medium Format Photos	FY97
B:15:124	Medium Format Photos	FY96
B:15:138	Obliterate Trail	FY97, 99
	Retrail	FY97
C:02:094	Medium Format Photos	FY97
	Other	FY97
C:02:097	Retrail	FY96
C:02:098	Obliterate Trail	FY96
C:02:101	Other	FY98
C:02:101	Checkdams	FY97
C:05:001	Medium Format Photos	FY97
C:05:007	Medium Format Photos	FY97
C:06:002	Medium Format Photos	FY96
C:06:003	Retrail	FY96
	Obliterate Trail	FY96
C:06:004	Medium Format Photos	FY96
C:06:005	Medium Format Photos	FY97
	Other	FY97
C:06:007	Medium Format Photos	FY97
C:09:030	Obliterate Trail	FY95
	Medium Format Photos	FY97

Site	Action	Completed
C:09:031	Obliterate Trail	FY97
	Retrail	FY97
C:09:034	Obliterate Trail	FY97
	Retrail/Medium Format Photos	FY97, 96
C:09:050	Checkdams	FY97
	Medium Format Photos	FY96
	Other	FY99
	Medium Format Photos	FY95, 96, 98
C:09:051	Obliterate Trail	FY96, 99
	Retrail	FY96
	Other	FY99
	Medium Format Photos	FY95, 96, 98
C:09:052	Obliterate Trail	FY96
C:09:083	Obliterate Trail	FY97
C:13:003	Medium Format Photos	FY97
C:13:005	Obliterate Trail	FY96
C:13:006	Obliterate Trail	FY96
	Checkdams	FY96, 97
	Plant Vegetation	FY97
	Other	FY98
	Medium Format Photos	FY96
C:13:009	Medium Format Photos	FY96
C:13:010	Close Site/Medium Format Photos	FY85, 97
C:13:069	Checkdams/Medium Format Photos	FY96, 97
C:13:098	Obliterate Trail	FY99
	Retrail	FY99
	Medium Format Photos	FY95, 96, 98
C:13:099	Checkdams	95, 97, 98
	Other	FY95, 98
	Obliterate Trail	FY95, 97
	Retrail	FY95
	Medium Format Photos	FY95, 96, 98
C:13:100	Other	FY98, 99
	Checkdams	FY95
	Obliterate Trail	FY95, 96
	Retrail	FY95
	Medium Format Photos	FY95, 96

Table 7.6. Preservation Measures Completed by Site (N=90), continued

Site	Action	Completed
C:13:132	Medium Format Photos	FY97
C:13:272	Medium Format Photos	FY96
	Obliterate Trail	FY99
C:13:291	Retrail	FY97
	Obliterate Trail	FY97
	Medium Format Photos	FY96
C:13:321	Medium Format Photos	FY99
C:13:327	Retrail	FY97
	Obliterate Trail	FY97
	Checkdams	FY97
C:13:336	Checkdams	FY99
C:13:338	Other	FY/97
C:13:339	Retrail	FY95
C:13:340	Retrail	FY96
	Obliterate Trail	FY97
C:13:346	Checkdams	FY97
C:13:347	Medium Format Photos	FY96
C:13:348	Checkdams	FY97
C:13:349	Medium Format Photos	FY96, 97, 98
C:13:359	Checkdams	FY97
C:13:362	Obliterate Trail	FY97
C:13:365	Medium Format Photos	FY96
C:13:371	Checkdams	FY96, 98
	Medium Format Photos	FY96, 98
C:13:381	Checkdams	FY97, 98
G:03:002	Obliterate Trail	FY96
	Checkdams	FY97
G:03:003	Retrail	FY96
	Obliterate Trail	FY96
	Checkdams	FY96, 99

Site	Action	Completed
G:03:003 cont'd	Medium Format Photos	FY95
G:03:004	Retrail	FY95, 97
	Obliterate Trail	FY95, 97
	Medium Format Photos	FY97
G:03:020	Obliterate Trail	FY99
G:03:024	Obliterate Trail	FY96
	Checkdams	FY97
G:03:025	Obliterate Trail	FY96
	Checkdams	FY96, 97
G:03:026	Plant Vegetation	FY96
	Retrail	FY96, 97
	Obliterate Trail	FY96, 97
	Checkdams	FY96, 97, 99
G:03:028	Retrail	FY96
	Obliterate Trail	FY96
	Plant Vegetation	FY96
G:03:038	Checkdams	FY97
G:03:040	Checkdams	FY97
G:03:041	Checkdams	FY97
G:03:044	Obliterate Trail	FY97
G:03:052	Obliterate Trail	FY97
G:03:058	Obliterate Trail	FY97
	Checkdams	FY97
G:03:064	Medium Format Photos	FY95
G:03:067	Obliterate Trail	FY96
G:03:072	Checkdams	FY97
G:03:077	Medium Format Photos	FY97
G:03:080	Medium Format Photos	FY97

measures carried out at a total of 90 GRCA sites through FY1998 include trail obliteration, retrailing, revegetation, medium-format photography (which produces a high-quality 5 × 7–inch scaled negative for use in photo replication), and checkdam construction in a variety of styles in drainages and along slopes. (Leap et al. [2000] note that the site count is now 96 and that most preservation work has been completed on sites with river-based drainages and on sites in fair to poor condition.) As of 1997, only two GLCA sites had received preservation treatment, with 17 sites having a high priority ranking to receive treatment (Burchett 1997). Trail obliteration and retrailing were conducted at C:02:038, a heavily visited petroglyph panel, in 1992 and FY1996. Retrailing was also conducted in FY1996 at C:02:081.

Figure 7.14. Site C:13:349, Feature 2, looking upstream at a large active arroyo photographed in April 1993 (upper) and again in February 1995 (lower). (Note: the shallow gully's cutbank edge that the woman was standing on in 1993 is much deeper and wider in 1995, with the woman now standing in the gully. They are documenting the erosion of Feature 2 in the cutbank.)

In FY1997, GRCA RCMP created a remedial action documentation form (shown in Appendix M) to track specific preservation efforts by site to supplement the monitoring forms. Furthermore, before significant levels of remedial activity occur, proposals are submitted for approval by BOR and/or the PA signatories (Leap 1996; Leap and Burke 1996; Leap and Kunde 1997).

Possibly one of the most effective and efficient ways currently being used to slow physical erosion is the construction of checkdams in active arroyos and gullies, as determined through follow-up monitoring, mapping, and repeat photography used to document the success of this technique. Archaeological monitors will also be working with the geomorphologists to better identify those site areas where checkdams are not a useful preservation method. It was agreed upon during a 1995 stabilization workshop hosted by the NPS RCMP that traditional Zuni checkdam styles would be constructed under the supervision of Zuni Conservation Projects. The purpose of installing these checkdams is not to stop erosion but to decrease water velocity and increase sediment deposition, thus increasing vegetal growth. Checkdam types include log checks or brush checks (Figure 7.15, left), rock checks, rock lining or filling (Figure 7.15, right), horseshoe checks, and basket-weave checks. Jute mats have also been used to line drainages and to promote the growth of vegetation.

All checkdam types have worked successfully in different drainage environments, but GRCA RCMP preservationists have found that it is not always easy to determine which environment is best suited for a particular checkdam type, because the results are not consistent. Palisades Delta in eastern Grand Canyon is a particularly interesting example of a site where remedial actions, namely in the form of checkdams, have had both positive and negative results. The main factor in the success of the checkdams is geomorphic environment, and it is very difficult to control erosion on a delta. In order to do so at Palisades Delta, erosion control measures need to be conducted farther upstream, and in this case above the 300,000 cfs level, to control impacts occurring to cultural resources downstream. Checkdams placed on-site are "acting too late" to slow the force of the runoff from above. Erosion control measures in this situation must occur at drainage headwaters and nick points at the toe of the talus slope, not in the delta. The Palisades Delta case study exemplifies the need to work with the geomorphic model, which will be essential in aiding the archaeologists to determine where and when to use checkdams as a means of preservation. Overall, RCMP staff have experienced varying degrees of success with the different preservation techniques that have been applied, but in general most sites have benefited from the stabilization treatment and have required regular but minimal maintenance (see dates in Table 7.6.). The successes and failures of erosion control techniques were also recently reported on by Leap (1999a) and Cheama (1999) at a March meeting of the Technical Work Group.

To date, GRCA RCMP staff members have observed no whole-site improvements since the implementation of preservation treatments in 1995 (Leap et al. 2000:xiv). As recognized by the National Research Council (NRC 1996), however, discussion of the success of short-term preservation actions can be premature when evaluating a long-term monitoring program and may not yield significant results. Nonetheless, GRCA RCMP staff have documented sediment collection in gullies and arroyos behind constructed checkdams (see Figure 7.15), vegetation growth from transplanted and newly planted seedlings, and successful trail obliteration and retrailing projects. The best means for evaluating the short-term success of preservation actions is to conduct frequent visits to a site, documenting in quantitative detail the condition of the preservation work carried out. This type of quantitative monitoring was conducted in FY1997 and FY1998 using a total station, but because of the redistribution of funds in FY1999, this method of tracking success or failure by quantifying change has been halted. Other methods for tracking the results of preservation treatments are currently being investigated by GRCA RCMP personnel and GCMRC. Thus far, preservation treatments have rarely affected the frequency of site monitoring. Zuni Conservation Projects and GRCA revegetation crews have assisted by conducting annual monitoring at some checkdam locations and in some areas where trail work has been completed. GRCA RCMP staff feel that the success of these treatments should be evaluated intensively for several years and anticipate a considerable decline in overall monitoring efforts and schedules following this evaluation period.

RCMP Data Recovery Efforts (FY1992-1999)

As outlined in the draft HPP, a responsibility of the BOR under Section 106 of the NHPA is, in cases where in situ preservation is not possible, to design mitigative strategies using a scientific approach that fully integrates the full consideration of the values of all concerned tribes (BOR et al. 1997:27). In keeping with this mandate, NPS RCMP staff have taken the targeted goals to heart in the order in which they appear in the HPP, giving preservation precedence over mitigative efforts whenever possible. As of early 1999, GRCA RCMP archaeologists had found it absolutely necessary to conduct data recovery efforts at 26 sites (Table 7.7) where erosion or other site impacts have posed an immediate threat that archaeological information may be lost and no other means of protection or preservation were available. The measures taken consist of artifact collection or special documentation, test excavations, and feature excavations: 13 feature-based excavations at 11 sites, 11 sites tested for depth and feature significance, three incidences of artifact collection or special documentation, and one site with testing and feature excavation. Carbon samples were collected from 20 sites (with five site counts duplicated from other data recovery efforts in the late 1980s and early 1990s) in conjunction with research completed by Hereford et al. (1991, 1993).

Five of the GRCA sites at which data recovery efforts were conducted (A:15:030, A:16:180, C:13:273, C:13:338, and C:13:359) were investigated in 1997 and were only recently reported (Yeatts 1998); all of the sites were also mapped prior to excavation using the total station (see Table 7.5). At sites A:15:030, A:16180, C:13:273, and C:13:359, roasting features were the focus of excavations, one at each site. (We should also note here that site types with a roasting or thermal feature make up the majority (46%) of the property types monitored along the river corridor [Leap et al. 2000]. By excavating this feature type, GRCA RCMP researchers are therefore adding to the database of what is known about Grand Canyon roasters. Furthermore, Duane Hubbard, a graduate student in the Anthropology Department at NAU and a GRCA RCMP staff member, is doing his thesis on the roasting features of Grand Canyon.) Feature 5, the roaster at C:13:273, (Figures 7.16 and 7.17), was eroding from the large cutbank. Before Feature 5 was exposed in the cutbank, it appeared as just a small concentration of thermally altered rocks on the ground surface. Testing was also conducted at C:13:273 in 1995, along with data recovery at C:13:339, in both cases to provide clearance for trail building activities (Leap 1995). During the 1997 excavations at C:13:338, two adjacent features were excavated, a roaster (Feature 3) and a slab-lined cist (Feature 4).

One site, C:02:098, was recommended for data recovery activities in 1996 (Leap et al. 1996) and included in a 1996 proposal with the five sites that were excavated in 1997 (Yeatts and Leap 1996).

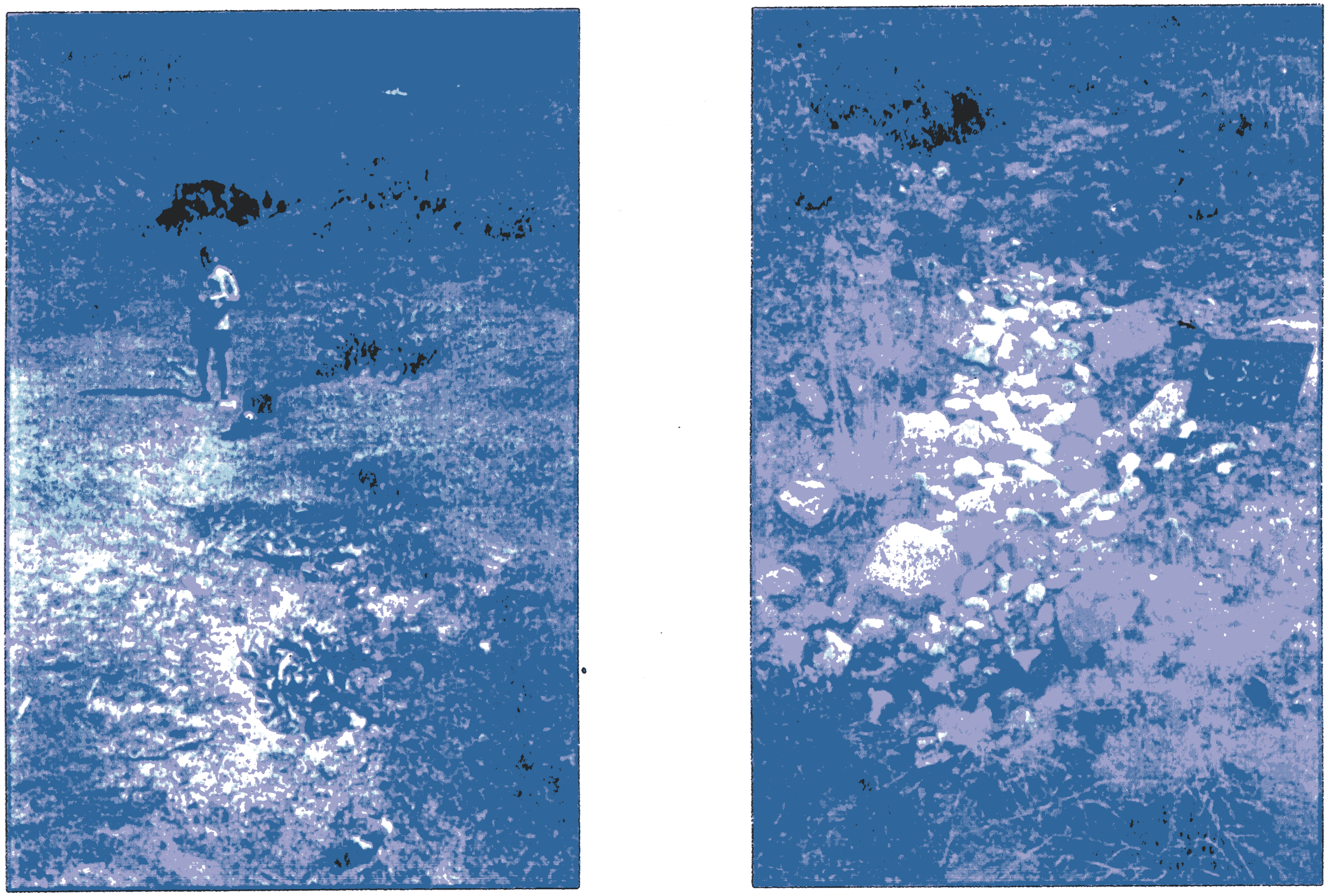
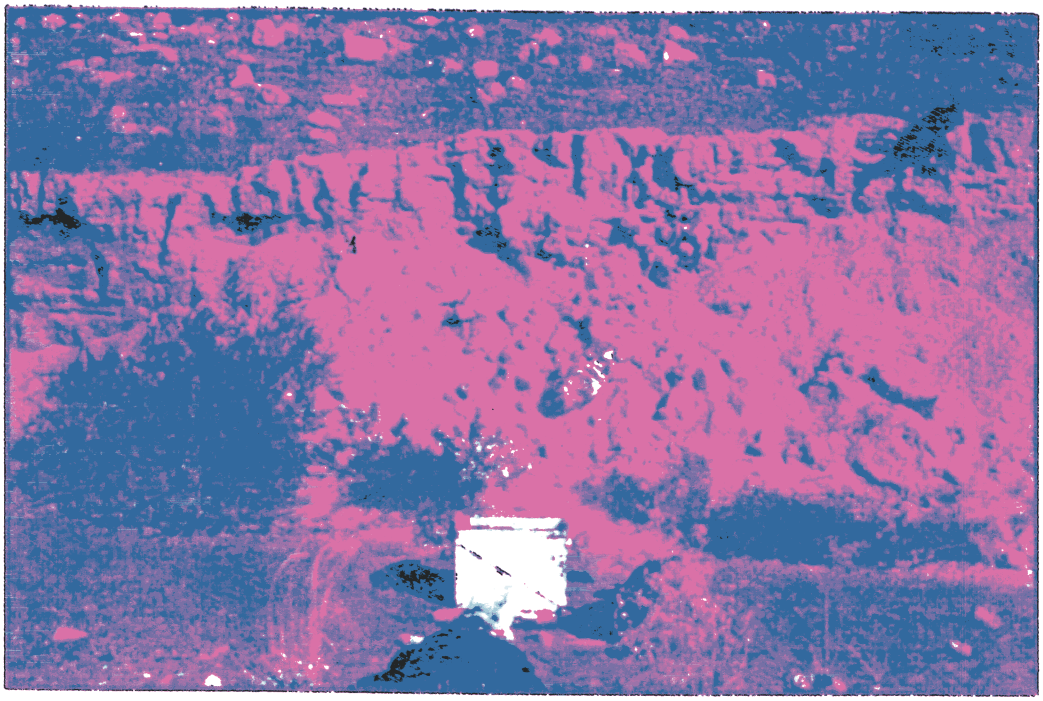


Figure 7.15. Site G:03:040, overview of non-intrusive brush checks 3 and 4 with new grass growth (left); and Site C:13:006, rock lining (Check 8) in drainage with new cacti and vegetation (right). (Note: these are both examples of highly successful stabilization efforts.)



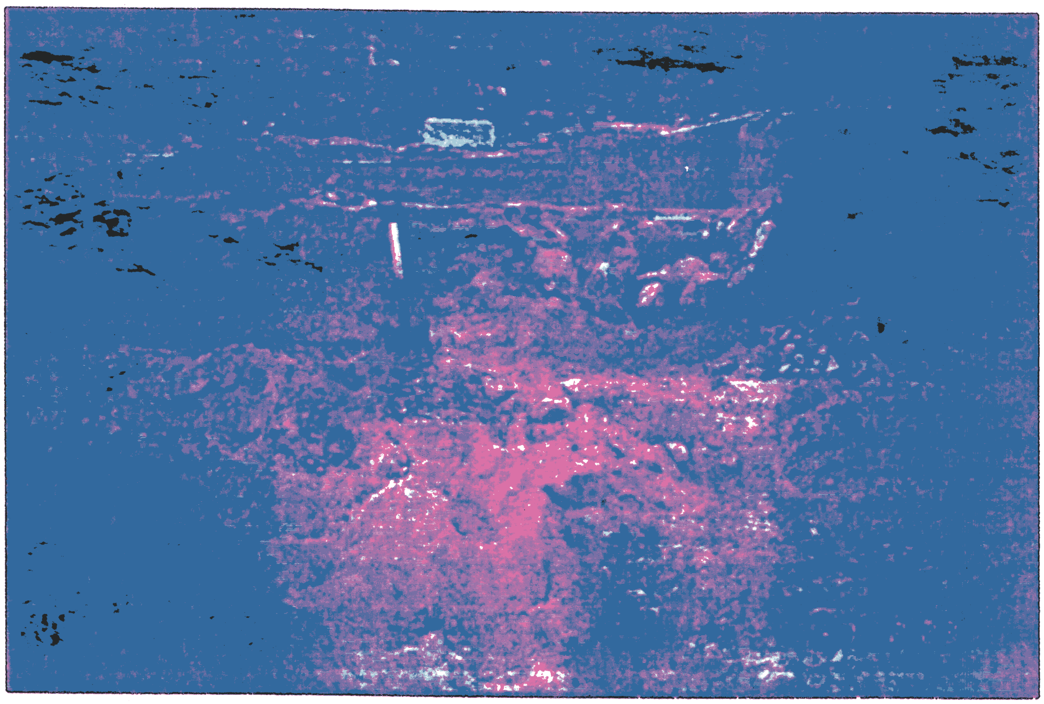


Figure 7.16. Site C:13:273, Feature 5 (a highly eroded roaster feature) before excavation (upper) and after (lower). (Note: before it was exposed in the cutbank, Feature 5 appeared on the ground surface as just a small concentration of thermally-altered rocks.)

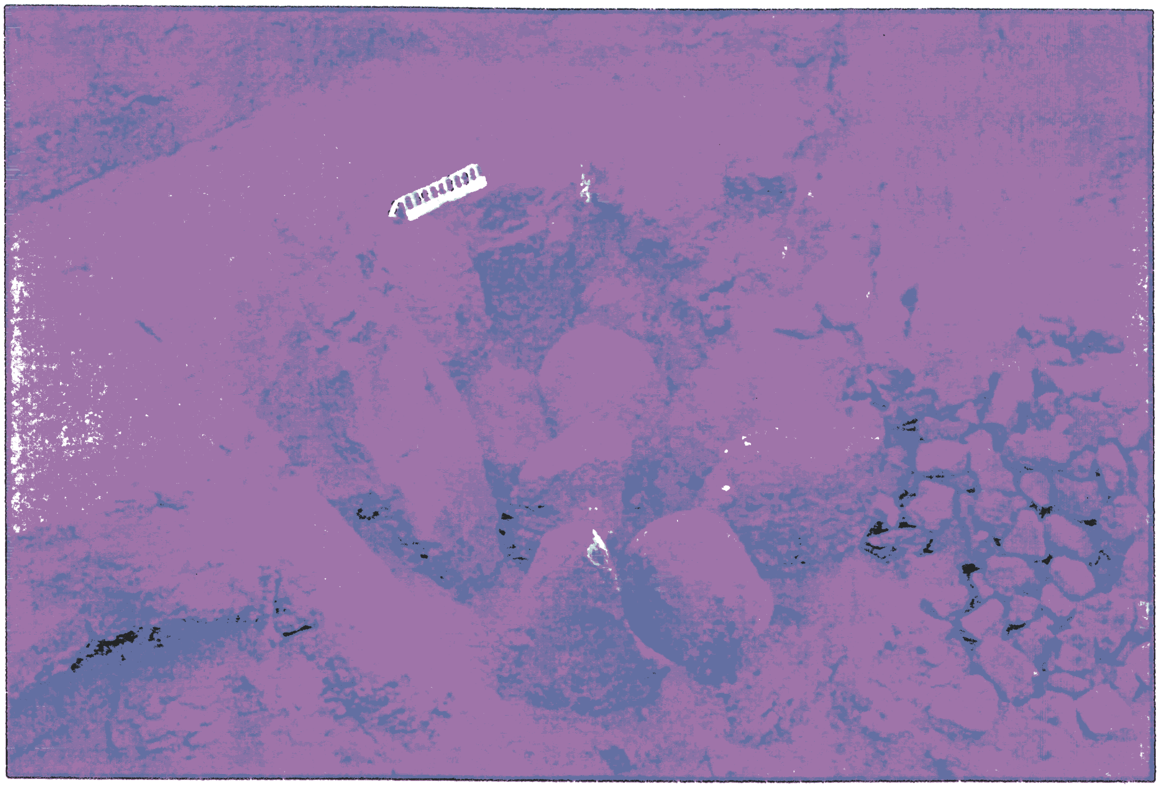


Figure 7.17. Site C:13:273, Feature 5: after excavation, a significant archaeological feature with definitive form became apparent.

Table 7.7. Recovery Measures Completed by Site (n=26) in Grand Canyon

Site	Action	Date Completed
A:15:030	Data Recovery	FY97
A:15:048	Data Recovery	FY99
A:16:180	Data Recovery	FY97
B:10:230	Collection (sandal)	FY96
C:02:096	Test	FY99
C:02:098	Special Documentation	FY98
C:09:051	Data Recovery	FY97
C:09:069	Test	FY99
C:13:010	Data Recovery (3)	FY98 (2), FY99
C:13:070	Test	FY99
C:13:099	Data Recovery	FY99
C:13:273	Test	FY95
	Data Recovery	FY97
C:13:321	Test	FY96
C:13:338	Data Recovery	FY97
C:13:339	Data Recovery	FY95
C:13:343	Test	FY99
C:13:347	Test	FY95
C:13:349	Data Recovery	FY99
C:13:356	Test	FY99
C:13:359	Data Recovery	FY97
C:13:365	Test	FY96
C:13:371	Test	FY96
C:13:387	Special Documentation	FY97
G:03:020	Data Recovery	FY99
G:03:033	Test	FY99
G:03:064	Test	FY99

However, a repeat visit to C:02:098 later in 1996 for mapping purposes resulted in a reassessment; no features in need of data recovery remained at C:02:098 (Yeatts and Leap 1996), so the site was just mapped, in April 1998 (see Table 7.5).

In 1997 Yeatts and Leap (1997) proposed another site for testing: C:09:051, a large pueblo on the Lower Nankoweap Delta, adjacent to Nankoweap Creek. Limited testing and data recovery focused on Locus D, particularly a vertical cutbank created by a flash flood of the creek. The flood removed Feature 3, a probable habitation structure, from the cutbank and uncovered Feature 4, a midden deposit derived from a room block in Locus A. The work consisted of creating a clean face in the cutbank to profile and collecting appropriate samples (pollen, flotation, radiocarbon) from Feature 4. The fieldwork was completed in August 1997; the report is in preparation, pending incorporation of radiocarbon dating results (Lisa Leap, personal communication February 2000).

In the spring of 1998, salvage excavations were conducted at C:13:010, the Furnace Flats site. This report is still in progress, awaiting the necessary funds to submit samples (e.g., botanical, radiocarbon) for analysis (GRCA RCMP staff, personal communication September 1999). Anne Trinkle Jones produced the original map for the site and conducted salvage excavations there in 1984 (Jones 1986). According to Lisa Leap (personal communication September 1998), this site is proposed for additional excavations over the next five years. In January of 1998, Site G:03:030 was also mapped in preparation for data recovery efforts.

Data recovery work at Sites B:10:230, C:13:321, C:13:365, and C:13:371 (see Table 7.7) was conducted in 1996. At B:10:230 GRCA RCMP monitors collected a yucca sandal fragment. In February 1996, prior to the 45,000 cfs habitat-building spike flow, RCMP conducted testing at C:13:321, C:13:365, and C:13:371 (Andrews et al. 1996). Feature 4 at C:13:321, a suspected cultural feature, was tested and was determined not to be a cultural manifestation. At C:13:365, a rock alignment (Feature 1) was tested with negative results. At C:13:371, a 1 × 1–m test unit was placed at the southeast corner of Feature 8, a suspected rubble mound, which turned out to represent a debris flow. RCMP proposes to conduct excavations within the next five years at C:13:371, Features 2, 3, 5, 6, and 7 (Lisa Leap, personal communication October 1998).

Testing and/or radiocarbon sample collection was conducted at seven sites (C:02:096, C:09:069, C:13:070, C:13:343, C:13:356, G:03:33, and G:03:64) in FY1999, and these efforts were documented in the trip reports, but a formal report of these findings is also pending until receipt of radiocarbon dating results. In the spring of 1999, limited data recovery in the form of feature excavations took place at five sites (A:15:048, C:13:010 [Furnace Flats], C:13:099, C:13:349, and G:03:20) (see Table 7.7); the report on this work is still in progress and will include the work at Furnace Flats (C:13:010) in the spring of 1998.

Other data recovery work was conducted in the mid 1990s by RCMP staff or associated researchers within the GRCA portion of the corridor. A research team was involved in dating hearths at C:02:085, the Axehandle Cove site, just upstream from C:02:096 (O'Conner et al. 1994). Radiocarbon samples were collected and submitted for dating, but very little remains of C:02:085 (Lisa Leap, personal communication October 1998). In 1994 Helen Fairley of GRCA collected charcoal samples for radiocarbon dating from C:13:384. Leap (personal communication October 1998) informed Neal that in 1994 or 1995 wood tongs for gathering prickly pear were collected from Site B:09:317 (164.6 mile) by GRCA RCMP monitors. Generally, charcoal samples have been collected and curated from several sites by monitoring program staff as an emergency treatment measure. Charcoal samples were also taken from 20 sites within the APE prior to the monitoring program. Specifically, Richard Hereford collected a number of charcoal samples from sites in the Nankoweap, Unkar Delta, Furnace Flats, Granite Park, Tanner, and Palisades areas as part of his geomorphic research. Radiocarbon analysis of Hereford's samples provided dates for both archaeological sites and the sedimentary deposits in which the sites occur (Hereford et al. 1991, 1993).

In general, much of GRCA RCMP's proposed data recovery in the next five years will occur in Reach 5 (roughly from the confluence of the Little Colorado River to the Furnace Flats area), with occasional data recovery planned in other reaches. Full data recovery has just recently been recommended and proposed by NPS RCMP for 12 sites in the Grand Canyon within the APE, including Lower Unkar (C:13:070), Upper Unkar/the Ivo Site (C:13:291), Lower Tanner (C:13:343), Lower Tanner/Upper Cardenas (C:13:347), Palisades (C:13:099 and C:13:100), Furnace Flats

(C:13:010), Crash Canyon (C:13:3710), and four smaller sites (C:02:96, C:02:98, G:03:043, G:03:072). These are considered to be some of the most significant, extensive, and severely disturbed (at least portions of them) sites along the corridor.

Limited data recovery has been conducted within the GLCA portion of the corridor, but the recent mandate along the Glen Canyon portion is to actively mitigate impacts to those sites under GLCA management and to cease monitoring activities (Chris Goetze, personal communication February 2000). Burchett (1997:Table 11) lists monitoring location–specific recovery options in his FY97 monitoring summary report. Twenty-eight sites were listed as in need of recovery treatment, and specific work has been conducted at five of these sites. Thirty-five sites were originally recommended for total station mapping, 10 of which have been done. This data collection option is an essential baseline component of the preservation option to install checkdams, and of recovery options including surface collection, testing, and excavation. Fourteen sites were recommended for testing; the work has been completed at three (C:02:081 in FY1995, C:03:010 in FY1996, and C:02:75 in FY1999 [Neff and Wilson 2000]). C:03:010 had also been recommended for excavation, which was conducted in conjunction with the testing efforts to recover data prior to possible impacts from the spring FY1996 habitat-building flow. Surface collecting the entire site was recommended for four sites, and this work has been completed at two of those sites (C:02:081 and C:03:010).

In 1992 Neal and Leap (1992) conducted testing at C:02:032 in GLCA, where two samples of charcoal and one sample of flood-deposited macrobotanical material were collected. A 1 × 1–m test unit was excavated to determine if the charcoal lens exposed in the cutbank at this site continued northward into the terrace and whether subsurface cultural materials were present. No artifacts were found, but the charcoal lens did appear in the bottom of the test unit, where it was much thinner than in the cutbank. The two charcoal samples were calibrated and dated between 1582 and 1317 B.C. (sample from the cutbank) and A.D. 134 and 430 (from a test unit); overall, the lens was suspected to represent natural burning episodes, and the antiquity of and variation in the dates remains unexplained. In the same year, Neal and Leap took a charcoal sample from a buried hearth at C:02:100, and the result of the radiocarbon analysis was a date range of around 790-390 B.C.

Pre-RCMP Data Recovery Efforts

During the 1990-1991 corridor survey, a redware pitcher was discovered eroding from a terrace slope at Site C:09:050 (Figure 7.18, upper). When this pot was removed for fear of loss, five additional ceramic vessels were discovered eroding out from behind the pitcher (Figure 7.18, lower). All six vessels were collected and are curated at GRCA's curation facility at Grand Canyon, Arizona.

Multiple charcoal features were sampled on and in the vicinity of archaeological sites in the late 1980s during geomorphic research along the river corridor by Hereford et al. (1991, 1993), who were attempting to date the pre-dam river terraces and then document the effects of regulated flows on the erosion of archaeological sites on these terraces. Charcoal samples were taken from areas in association with Palisades, Tanner, Basalt, Unkar Delta, and Cardenas creeks and the Furnace Flats area (from approximately 65 mile to 75 mile). Often these samples were taken from eroding hearths on sites associated with the creeks. The actual provenience of the samples, i.e., site number or feature number within a site, was not always well documented. These geomorphic sampling areas were mapped, however (Hereford 1996a; Hereford et al. 1993; Hereford and Thompson 1993). Charcoal sampling and geomorphic mapping were also conducted farther upstream, at Nankoweap Creek (Hereford, Burke, and Thompson 1996; Hereford, Thompson, and Burke 1994b). The Granite Park area was also sampled and mapped as a part of this terrace dating study (Hereford, Thompson, and Burke 1994a; Thompson, Burke, and Hereford 1996). Additional charcoal samples were collected between river miles 115 and 126 (Lisa Leap, personal communication, October 1998). Several samples were also collected from the Arroyo Grande area at 207 mile, on and in the vicinity of Site G:03:064.

In the early to mid 1980s, Jan Balsom and Helen Fairley of GRCA collected charcoal samples from Feature 3 at C:13:099 and submitted a sample or samples for radiocarbon dating analysis. In the 1980s geologist Ted Melis took a charcoal sample from Feature 1 at Site C:13:069, in conjunction with his geologic work for the Glen Canyon Environmental Impact Statement.

In 1984 (reported by Jones in 1986) limited data recovery was conducted at Furnace Flats (C:13:010) in the corridor monitoring area. Finally, the Bright Angel site (B:15:001) at Phantom Ranch was excavated by Douglas Schwartz (Schwartz, Marshall, and Kepp 1979) and developed for visitation in the 1970s. This stabilized site is within the river corridor monitoring area, but ranch personnel maintain it because of its proximity to the ranch.

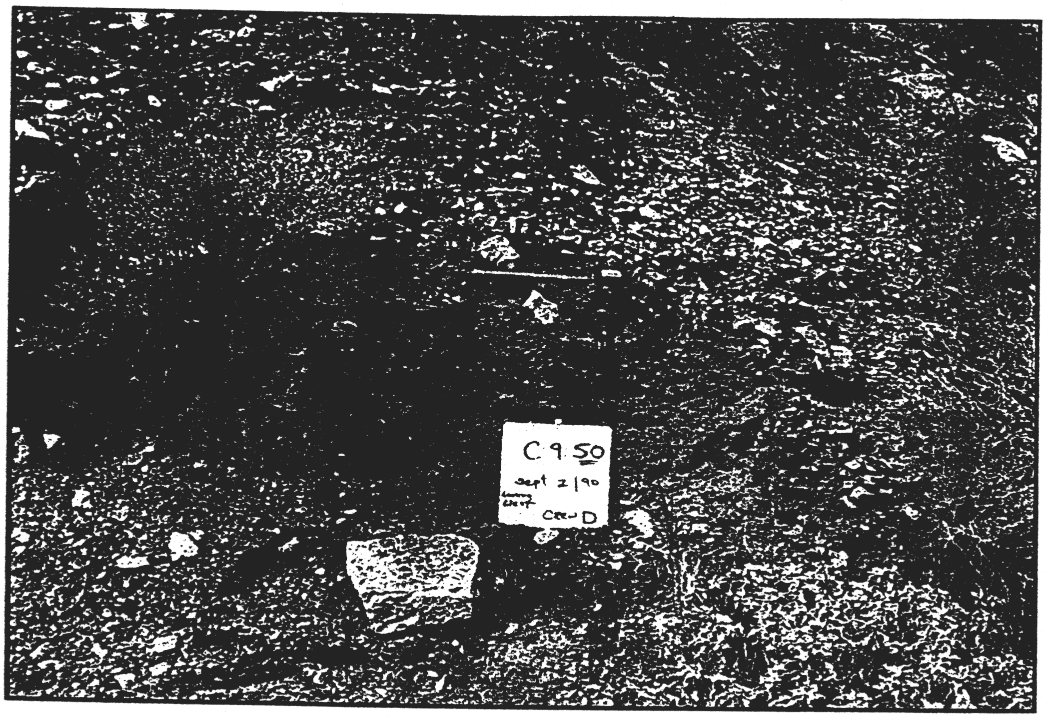
Data Recovery Efforts Within the River Corridor but Outside the Monitoring Area

In 1984 data recovery work was conducted at C:13:004 (Beamers Cabin on the Little Colorado River), B:15:007 (around 115-120 mile), B:10:004 (a site across from Deer Creek), and A:16:001 (near Whitmore Panel) by Anne Trinkle Jones of NPS GRCA (Jones 1986). Granaries (C:09:001) above Nankoweap Creek were excavated and stabilized in 1987 under the auspices of GRCA (Lisa Leap, personal communication October 1998). In 1998 GRCA archaeologist Phil Wilson was actually working on a proposal to do additional stabilization work on the granaries.

Under Robert C. Euler, GRCA archaeologist at the time, excavations were conducted at A:16:001 at 188 mile in the late 1970s (Lisa Leap, personal communication October 1998). Leap said that this site is near the corridor monitoring limits but is not visited by monitors.

The South Canyon site, C:05:001, was excavated or some collections were made during Euler's latter days as the GRCA archaeologist in the late 1970s. Excavations and specialized studies were also conducted at Stanton's Cave, C:05:003, in 1969, 1970, 1976, and 1982 (Euler 1984).

From 1967 to 1970, data recovery efforts were conducted at the Unkar Delta site (C:13:001), in an attempt to investigate the prehistoric relationship between peoples in the Unkar Delta and Walhalla areas and their movement from place to place (Schwartz, Chapman, and Kepp 1980; Schwartz, Kepp, and Chapman 1981). The extensive Furnace Flats habitation site is just upstream from Unkar. In the Deer Creek area (136 mile), charcoal samples were taken from Sites B:10:001 and B:10:004, and NPS personnel took a core from the Anasazi (log) Bridge for tree-ring dating.



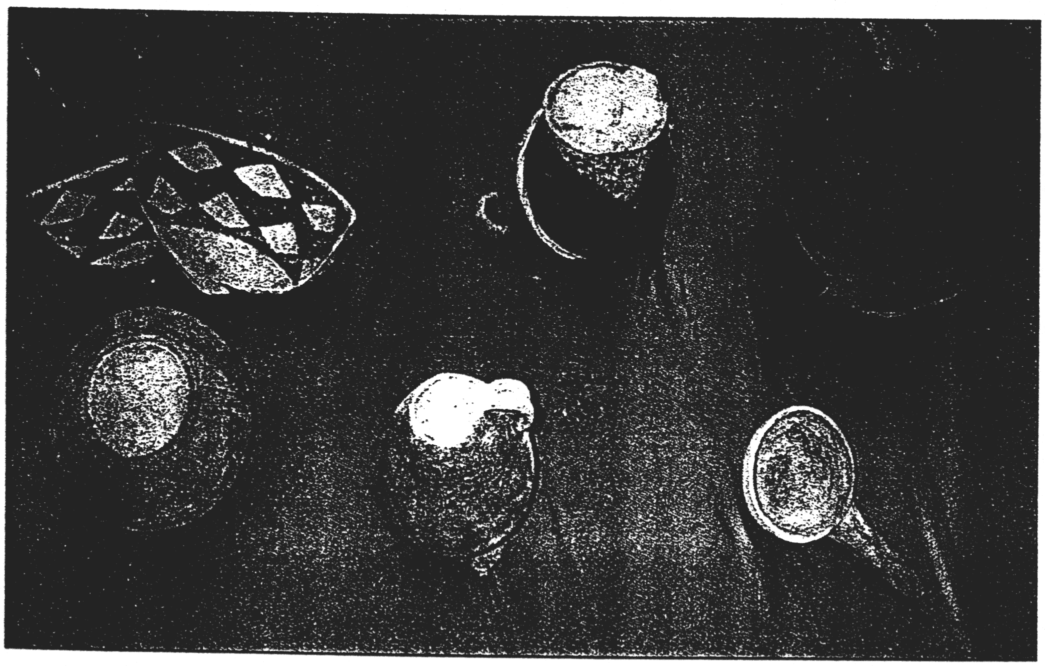


Figure 7.18. At Site C:9:50 part of a redware ceramic pitcher can be seen in the center of the photograph (upper) eroding from a terrace slope. The lower photograph illustrates the black-on-red pitcher at center, along with five other ceramic vessels that were eroding from behind and around the pitcher.

Overview of Data Recovery Results

Overall, data recovery work conducted to date within the GRCA and GLCA river corridors has been spotty, mostly involving emergency efforts, except for the work of Schwartz at Unkar Delta (Schwartz, Chapman, and Kepp 1980) and Bright Angel (Schwartz, Marshall, and Kepp 1979), Euler (1984) at Stanton's Cave, and Jones (1986) at five corridor sites. The bulk of the data recovery conducted to date has also been descriptive in nature, unguided by a corridor-specific research design. The following discussion provides a synopsis for research purposes and a framework for recently proposed data recovery efforts.

Some of the most significant, extensive, and severely disturbed sites are at Lower Unkar Delta (C:13:070) and Upper Unkar Delta (C:13:291), downstream of Tanner Canyon (C:13:343 and 349), upstream of Cardenas Creek (C:13:347), and at Furnace Flats (C:13:10), Palisades Creek (C:13:099 and 100), Granite Park (G:3:003), Arroyo Grande (G:3:064), and Basalt Canyon (C:13:009). Most of these sites are on wide river terraces cut by a variety of drainage types that often do not flow directly into the Colorado River. Nevertheless, the extent and nature of these sites on these open terraces make them especially susceptible to increased erosion. Most significant from a cultural resource management perspective, these are among the largest and most interesting sites in the canyon, because the various drainages provided relatively reliable and manageable water sources for agriculture. The Unkar Delta site proper (C:13:001) (which is not monitored by the GRCA RCMP) is an ancestral Pueblo site dating from A.D. 900 to 1150, covering 125 acres and containing 52 separate habitation units and agricultural features. Furnace Flats (C:13:010) consists of at least 11 significant structures (including three pit houses, seven surface rooms, and one block of three or four rooms) and 40 other features. Granite Park, a Pai or Paiute site, includes at least one rock shelter, five wickiup rings, 14 roasting features, one bedrock mortar, and numerous scatters of fire-cracked rock and artifacts. Arroyo Grande is a large Pai or Paiute site upstream from Granite Park that consists of roasters and agricultural features in a filled-in eddy. Basalt Canyon is a Pueblo II/early Pueblo III site with a minimum of 24 architectural and non-architectural features, including an extensive and badly eroded room block. Even at these sites, the severity of erosion is not quantified in monitoring reports or forms but is qualitatively discussed and assessed repeatedly. Full data recovery has been recommended and funding has been requested by GRCA RCMP in a proposal submitted to PA representatives in Spring 1999 for 12 sites in Grand Canyon within the APE, including Lower Unkar, Upper Unkar, Lower Tanner, Palisades, Furnace Flats, Crash Canyon (C:13:371, with at least two surface structures, two roasting features, and two fire-cracked rock concentrations), and five smaller sites. (See Leap et al. 2000 for a current list of sites selected for excavation, in order of priority. In the 1999 draft of this report, two sites had been added to the list, and two sites were to be assessed in FY2000 for data recovery treatment.)

Conclusions for RCMP Preservation and Data Recovery Efforts

The RCMP staff has prioritized preservation and data recovery treatments based on the findings of their monitoring efforts through FY1998 (GLCA) and FY1999 (GRCA). Although each site is assessed individually for various treatments, certain qualitative generalizations can be made to assess treatment priority, and GRCA RCMP personnel have done this in particular in their synthesis report (Leap et al. 2000). Based on descriptive analyses, they have concluded that the stages of erosion are more advanced at sites with river-based drainages and that most of these sites are actively eroding and in poor condition. This situation is demonstrated at Sites C:13:099 and C:13:100 at Palisades Creed, even after checkdam construction (Leap et al. 2000:xiv). Generally, checkdam maintenance has been performed at sites with river-based drainages more often than at sites with terrace- or side canyon–based drainages. All checkdams installed in various drainage types need to be more closely assessed to fully determine their effectiveness in these different drainage environments. This work entails detailed mapping of these areas to measure volumetric change in sediment deposition or erosion. Until this research is completed and coupled with the findings of the recently completed geomorphic research (Thompson et al. 2000), conclusive evidence does not exist to suggest that river-based drainages, at least in some circumstances, cannot be effectively stabilized. However, because of the advanced stages of erosion, GRCA RCMP staff have recommended that all sites with river-based drainages that are recommended for data recovery should be the PA's first responsibility for such work. Of the sites currently recommended for data recovery in Leap et al. (2000), six had already been slated for excavations prior to the release of that report.

It has been difficult for BOR to obtain the necessary funds to complete data recovery, and the completion of the final Historic Preservation Plan is also critical, since it is expected to include a corridor-specific research design to guide excavations. As a result, very few data recovery projects have been initiated, and very few of those have been completed. In the meantime, GRCA RCMP project staff are doing what they can to delay the destruction of these archaeological sites until funds are allotted for the proposed excavations. Sites recommended for data recovery will continue to be monitored, and in emergency situations limited data recovery will be conducted pending full funding.

The PA's first priority for preservation treatment should be sites with terrace- and side canyon–based drainages, then sites with undeveloped drainages. The goal is to prevent any drainage system from becoming river based. Hereford et al. (1991, 1993) speculated, and Thompson et al. (2000) have in some cases confirmed, that after drainages become river based, erosion control is nearly impossible because the drainages are too advanced and are connected to a much larger erosive force, the Colorado River. GRCA RCMP staff members therefore recognize the need to focus on those sites that do not have river-based drainages for preservation treatment. Their condition is very fragile, and if preservation in place is postponed, it is very likely that these sites will be listed for data recovery in the future. For preservation work, PA members should consider not only the archaeological potential of the site but certain other factors as well. First, the geomorphological setting is extremely important, and the work of Thompson et al. (2000) should be consulted for properly identifying geomorphic setting and specific physical characteristics of a given site area. Vegetation, sedimentation type, catchment systems, slope, and general drainage cross sections should all be considered prior to implementing a preservation treatment. Specifically in relation to vegetation, the maturity of plants and their root systems has an impact on the success or failure of a preservation project. Much of this additional archaeological, geomorphological, and botanical information is supplies on the original survey forms. The task of incorporating these data into the current monitoring database is substantial; however, the GRCA RCMP staff believe that it will provide necessary and valuable information in making future preservation and data recovery treatment determinations (Leap et al. 2000).

CHAPTER 8

PUBLIC EDUCATION EFFORTS AND INFORMATION SHARING

Jean H. Ballagh, Lynn A. Neal, and Dennis Gilpin

EXISTING OUTREACH PARTICIPATION

A number of continuing programs, both formal and informal, are currently in place for educating the public about archaeological resources in and around Grand Canyon National Park. At the park itself, GLCA and GRCA interpreters present information to the general public about archaeology along the river corridor (BOR et al. 1997). GRCA RCMP staff and several tribal representatives participate annually in the land-based and river-based Grand Canyon Guides Training Seminars, and since 1994 GRCA RCMP staff have participated annually in the Arizona Archaeology Expo in Phoenix. An excellent synopsis of public education and outreach efforts by GRCA RCMP personnel and of some efforts involving the entire PA group appears in Leap et al. (2000). Some sections of that report are excerpted here.

Tribal efforts at public education are summarized in Chapter 3. All of the PA signatories have made efforts to disseminate the results of their research, primarily through presentations at professional meetings (see citations in Chapter 3). More public presentations by Begay and Roberts from the Navajo Nation are also summarized in Chapter 3. Undoubtedly, other tribes have made similar public presentations, but unfortunately these are not documented. Two public programs that are well documented are those by the Hualapai Tribe and the Southern Paiute Consortium. These programs are designed to involve more tribal members, especially youth and elders, in Colorado River corridor research.

The Hualapai Tribe has developed a computer program, *Hwalbcy Madwi: Winiyigach Guyay'I Hak Ama*, for public presentations (Jackson 1999). This program has six components: introduction, student experiences, elders and educators, plant studies and cultural sites, Granite Park songs, and acknowledgments. The program is effective in presenting the results of the Hualapai Tribe's research to a wide range of audiences, and discussions are ongoing on the possibility of making it available at GRCA.

The Southern Paiute Consortium maintains a tribal monitors training program and the Southern Paiute youth environmental education program. The Consortium also plans to develop a multi-media CD-ROM module on Southern Paiutes in the Colorado River corridor and make it available to the public through the Kaibab Cultural Center and the participating tribes in the Consortium (BOR et al. 1997).

SPECIFIC CONTRIBUTIONS

Professional personnel and other interested individuals have taken part in a variety of professional and public outreach events over the past several years. These efforts have increased as the focus on public education has received greater emphasis. All documents described here are listed in the bibliographies at the end of this report (Appendix A). In 1993 GRCA RCMP staff presented a paper entitled "Cultural Resource Inventory and Monitoring in Grand Canyon National Park" at the Second Biennial Conference on Research on the Colorado Plateau at Northern Arizona University in Flagstaff. They presented another paper on this topic, "Monitoring River Corridor Sites in Grand Canyon National Park," at the 1994 Pecos Conference at Mesa Verde National Park.

In 1995 RCMP staff again presented a paper on the monitoring program at the Pecos Conference, in Mimbres, New Mexico, as well as at the Third Biennial Conference on Research on the Colorado Plateau at NAU, where they discussed physical and visitor-related impacts to cultural resources along the corridor. A stabilization workshop hosted by NPS RCMP at Lees Ferry involved participants from BOR, GRCA, GLCA, Pacific Northwest Laboratory, the Department of Agriculture National Sediment Lab, USGS, AZSHPO, GCES, the Havasupai Tribe, the Hopi Tribe, the Hualapai Nation, the Navajo Nation, the San Juan Southern Paiute Tribe, the Southern Paiute Consortium, and the Pueblo of Zuni. The workshop and the fieldwork completed as a result of the workshop at Palisades were filmed, and a videotape was produced by GRCA and RCMP staff and disseminated to PA members and various federal agencies. Also in 1995 Lawrence Loendorf, consultant to the Southern Paiute Consortium, presented a paper at the 60th annual meeting of the Society for American Archaeology (SAA).

The number of presentations and consultations on the monitoring program increased in 1996. Paiute Consortium, Hualapai, and RCMP personnel wrote two letters to the Colorado River Guides Newsletter concerning certain locations on the river. Tribal programs and a Guides Training Seminar river trip utilized project consultation and expertise. Since river runners have a high level of interest in archaeological sites, river guides are in a good position to encourage public protection of the canyon's cultural resources. The Southern Paiute (Diane Austin, Angelita Bulletts, Brian Fulfrost, Cynthia Osife, Richard Stoffle) participated in that year's Society for Applied Anthropology conference with a discussion on Southern Paiutes and the Glen Canyon Dam EIS. An additional presentation was given at the National Association of Environmental Professionals conference in 1996.

In addition to public outreach presentations on the NPS RCMP at the Pecos Conference in Flagstaff and the Guides Training Seminar land-based program in Lees Ferry, Arizona, the most significant educational effort in 1996 was a symposium on the PA program at the 61st annual SAA meeting in New Orleans. Presenters at this session, entitled "Below the Dam: Cultural Resources and the Colorado River below Glen Canyon Dam," included representatives from GRCA, GRCA RCMP, BOR, USGS, NAU, the Hopi Tribe, the Pueblo of Zuni, the Navajo Nation, the Hualapai Nation, the Southern Paiute Consortium, AZSHPO, and the Advisory Council on Historic Preservation. Presentation topics were:

The Realities of Management: A Federal Responsibility and More (Balsom and Larralde 1996a)

Geoarchaeology of the Colorado River in the Eastern Grand Canyon (Hereford 1996b)

Awash in the Sands of Time: Settlement History and Interpretation of Human Occupation along the Colorado River (Fairley and Balsom 1996)

Monitoring the Health of Cultural Resources: A Case Study from Grand Canyon National Park (Downum, Kunde, and Andrews 1996)

Site Preservation Methods at Palisades Delta (Leap, Hubbard, and Coder 1996)

Rehabilitation and Wilderness: They Can Co-Exist (Crumbo 1996)

Öngtupka niqw Pisisvayu (Salt Canyon and the Colorado River): The Hopi People and the Management of Glen Canyon Dam (Ferguson, Jenkins, Dongoske, and Yeatts 1996)

A Zuni Perspective on the Protection of Cultural Resources in the Grand Canyon (Dishta 1996)

Navajos and the Grand Canyon (Begay 1996)

The Hualapai Tribe's Involvement in the Glen Canyon Environmental Study (Honga and Jackson 1996)

Southern Paiute Research on Cultural Resources in the Colorado River Corridor (Bulletts 1996)

Arizona State Historic Preservation Office Perspective (Howard 1996)

Advisory Council on Historic Preservation Perspective (Stanfill 1996)

Another significant research event that received a good deal of public attention was the first experimental habitat building flow in Glen and Grand Canyons in the spring of 1996. A volume better known as the "Spike Flow" report describing mitigation and monitoring efforts of cultural and botanical resources in response to the flow was quickly turned around in December 1996. This volume was edited by Jan Balsom and Signa Larralde (1996b) of GRCA and the Upper Colorado Region of BOR, respectively, and they also teamed on the volume's introduction. Authors for the five other chapters and active participants in the research were from Glen Canyon (Tim Burchett), Grand Canyon (Christopher Coder and Lisa Leap), Hopi (Michael Yeatts), Hualapai (Loretta Jackson and Arthur Phillips), Northern Arizona University (Nancy Andrews and Duane Hubbard), and Southern Paiute Consortium (Diane Austin and Cynthia Osife). Collaborative research topics and issues were addressed by Andrews, Burchett, Hubbard, and Leap (1996), who reported on cultural resources mitigation; Austin and Osife (1996), who conducted ethnobotanical monitoring; Burchett, Coder, and Hubbard (1996), who discussed monitoring of archaeological sites; Phillips and Jackson (1996), who studied the effects of the flow on ethnobotanical resources at five sites; and Yeatts (1996), who assessed cultural resources stabilization by evaluating high elevation sand deposition and retention. Several of these contributors have presented their results at meetings, and at least one article about the effects of the experimental flow on cultural resources has been accepted for publication (see below).

In March of 1997 the George Wright Society met in Albuquerque, New Mexico, for its ninth Conference on Research and Resource Management in Parks and on Public Lands. GRCA RCMP personnel were among the presenters at the session entitled "Below the Dam: Partnerships in Cultural Resources Management on the Colorado River," along with representatives from GRCA, NAU, BOR, USGS, the Hopi Tribe, the Pueblo of Zuni, the Navajo Nation, the Hualapai Nation, and the Southern Paiute Consortium (Harmon 1997). Most of the topics addressed at the 1996 SAA meetings were covered, by many of the same presenters (Dishta 1997; Downum, Andrews, and Kunde 1997; Ferguson et al. 1997; Hubbard 1997; Leap 1997; Osife, Bulletts, and Austin 1997). Also in March RCMP personnel participated in the 1997 Arizona Archaeology Expo in Coolidge, Arizona, where members of the public had an opportunity to learn about natural and cultural resources within GRCA and along the Colorado River (listed in Leap et al. 1997). In November NAU forestry students were educated on identification of and avoidance of impacts to cultural resources along the Colorado Plateau (listed in Leap et al. 1998). Also during this year, the Southern Paiute presented a paper at the International Association of Impact Assessment conference (Austin and Osife 1997).

In 1998 GRCA RCMP staff presented a poster session, "Current Archaeological Investigations at the Grand Canyon, Arizona," at the 63rd annual meeting of the SAA in Seattle. Among the presentations was "Archaeology and Current Site Management along the Colorado River Corridor, Grand Canyon National Park" (Leap 1998). GRCA RCMP staff also were on hand to answer questions at the 1998 Arizona Archaeology Expo in Phoenix. RCMP personnel submitted six articles about the PA to *GRCA Nature Notes*; three (Hubbard 1999; Kunde 1998; Leap 1999b) have been published. GRCA RCMP personnel also got out to the schools in 1998, with a presentation on the project at Coconino High School in Flagstaff, and in1999 they gave a slide presentation to GRCA employees and visitors at the South Rim, and an archaeology presentation at a Montessori school in Flagstaff.

All of the tribes except the Navajo made presentations to the Technical Work Group (TWG) at a meeting in Phoenix in March of 1999. Cheama (1999) discussed how employees of the Pueblo of Zuni called the Zuni Conservation Projects have participated in stabilizing Colorado River corridor sites by constructing checkdams. Yeatts and Dongoske (1999b) described the general perspective of the Hopi with regard to the Grand Canyon, then went on to discuss the Hopi Tribe's current ethnobotanical research. Drye (1999) summarized the Southern Paiute research on the Colorado River corridor, and Jackson (1999) did the same for the Hualapai, presenting portions of the interactive computer program developed by the Hualapai. The Southern Paiute Consortium has developed an extensive educational program described in Stoffle, Austin, et al. (1995:136-153) and Austin et al. (1996). Lisa Leap (1999a) also discussed cultural resources monitoring at the March 1999 TWG meeting, and Lynn Neal (Neal and Gilpin1999) presented the results of this synthesis report. Andre Potochnik highlighted the preliminary findings of the geomorphic study being conducted by Kate Thompson and himself, following a review presentation of the base-level hypothesis for pre-dam terrace erosion by Richard Hereford.

In 1999 Jan Balsom, GRCA RCMP Manager and GRCA Park Archaeologist, discussed the Section 106 process as it relates to the corridor's cultural program in an article in *Cultural Resource Management* (Balsom 1999). An article on cultural resources in relation to the 1996 experimental habitat building flow has been accepted for publication by *Ecological Applications* (Balsom 2000).

As requested in the RFP, SWCA presented a paper (Neal and Gilpin 1999) on our project in February 1999 at the Glen Canyon Dam Adaptive Management Program's Colorado River Ecosystem Science Symposium. At this same symposium, Yeatts presented an update of Hopi ethnobotanical research conducted along the river corridor (Yeatts and Dongoske 1999), and Potochnik presented preliminary results of the recently finalized geomorphic study. Neal also presented a summary of SWCA's findings at the land session of the Grand Canyon River Guides Training Seminar in March 1999 (Neal 1999a) (as did Potochnik for the geomorphic work) and in a poster session at the August 1999 Pecos Conference (Neal 1999b). In addition to providing the technical synthesis report, SWCA will also make every effort to disseminate the monitoring and research data in an appropriate peer-reviewed journal, subject to government and tribal restrictions on sensitive information.

FUTURE OUTREACH

The new data continually being accumulated through the RCMP need to be used to increase public as well as professional understanding of Colorado River corridor cultural resources. Recommendations for additional and continuing efforts, as proposed in the draft HPP of June 1997, include a number of possibilities (see Objective 5 in Chapter 2). Information from the many existing technical reports listed in the comprehensive annotated bibliography, along with the photographic record, can be distilled into public or popular versions, offering both overviews of the cultural resources in the Colorado River corridor and more focused publications, perhaps on specific types of resources (structures, artifacts, rock art, cultures), the environments within the canyon, and general (non-confidential) data on tribal associations. As Roberts, Begay, and Kelley (1995) have observed, for example, Navajo history in the canyon has been largely overlooked in public education. These same topics can be presented through videos, displays, mobile exhibits, schoolroom presentations, slide shows, and evening lectures. The monitoring data must be used with caution, balancing information that will help visitors to understand how fragile the cultural resources are with protection of site locations. Public educational efforts will also require full involvement of the participating tribes to ensure that Native American concerns are addressed and that sensitive information is protected, as well as to provide a broader, more diverse perspective on these resources than is found in traditional archaeological literature.

Much of the new information on river corridor cultural resources has come from the extensive tribal participation in the monitoring program, contributing to both general understanding of the cultural history of the area and understanding of the Native American role in that history and the spiritual significance of the canyon for Native American groups of this region. As Gilpin (Chapter 3) points out, the BOR and other PA signatories have offered the participating tribes an opportunity to conduct cultural resource studies from within their own frame of reference and as they wish to see them carried out. Four of the tribes have prepared reports that are available to the general public, Hualapai reports are confidential, and the San Juan Southern Paiute (since leaving the Southern Paiute Consortium) and the Havasupai have not produced any reports to date. All tribes except the San Juan Southern Paiute and the Havasupai have participated in symposia, published papers, and/or made presentations at professional meetings (see list in Chapter 3). An area with significant potential is the opportunity to develop educational opportunities for Native American students.

The GCMRC is actively involved in carrying out education and outreach through its Cultural Resources Program, with particular attention to Native American involvement and educational opportunities. GCMRC's efforts include development of cooperative education agreements and the presentation of differing perspectives on canyon resources.

The monitoring program is in an optimal educational setting with the Park Service's cooperative agreement with Northern Arizona University. University oversight by a consulting professor provides students the opportunity to work on the project, which several have taken advantage of. A Hopi student worked for the program while attending school, and one of the four current employees of the RCMP has an undergraduate degree from NAU and is in the Master's degree program. The other three RCMP staff members have received Master's degrees from NAU.

Probably one of the most valuable forms of public education takes place on the river itself. Many times there are spaces available on NPS RCMP or tribal river trips for volunteers and GRCA interpretive staff. The interpreters relate what they have learned about the cultural resources along the river and share their knowledge with visitors to the canyon rims. GLCA archaeologists also work with the park's interpretive staff to educate them about the monitoring project and the archaeological resources along the river. The commercial boaters who lead these trips are legitimately interested in and very willing to learn about archaeological concerns within the canyon. These professionals see firsthand the erosive processes affecting archaeological sites from both physical and visitor-related impacts, as well as the preservation treatments implemented to address these problems. They take this knowledge back to their friends and co-workers, who in turn communicate what they have learned about the canyon's many resources to their hundreds of passengers. This pyramid of communication is very effective and productive.

CHAPTER 9

MANAGEMENT SUMMARY: AN EVALUATION OF MANAGEMENT DATA RELATIVE TO LONG-TERM MANAGEMENT GOALS

Dennis Gilpin and Lynn A. Neal

SYNTHESIS SUMMARY AND CONCLUSIONS

As outlined in Chapters 1 and 2, SWCA was asked to address seven objectives, most of them involving a synthesis of a particular data category or data set. The first objective was to synthesize the existing National Park Service (NPS) and tribal databases related to cultural resources monitoring and research along the Colorado River corridor. SWCA responded to Objective 1 in Chapter 3 (tribal data) and Chapter 7 (NPS data). In Chapter 6, SWCA responded to Objective 2 by synthesizing and evaluating data on isolated occurrences (IOs) to assess whether they represent the last remains or the first exposure of archaeological sites. The third objective had three parts. Part 1 involved synthesizing NPS and tribal resource management activities, addressed in Chapters 3 and 7 with the data syntheses. Part 2 of Objective 3 called for an assessment of site condition over time relative to the activities conducted; this discussion appears primarily in Chapter 7. The third part of this objective, formulating recommendations for future management activities, is addressed throughout Chapters 3-8 but is reiterated and expanded in this chapter. Objective 4 asked us to summarize the results of geomorphic studies (Chapter 5), ethnobotanical studies (Chapter 4), and mapping (Chapter 7). These studies were also evaluated relative to the overall objectives of the Programmatic Agreement (PA), and some of these evaluations are included in this chapter. Chapter 8 describes Objective 5, public information, outreach, and educational efforts accomplished through the PA program and beyond and recommendations for future efforts. Objective 6 constitutes the body of this chapter, in which we attempt to evaluate the available management data relative to the long-term goals discussed in the draft Historic Preservation Plan HPP (BOR et al. 1997) developed under the PA. Finally, the last objective asked us to synthesize the results of data recovery conducted to date at river corridor sites, which is included in Chapter 7. We were also asked to make recommendations for changes in the data recovery program that would improve its utility to meet PA objectives, provided in this chapter. The archaeology of the river corridor is reviewed in the Preface to this report.

The question that has been put to the program's archaeological monitors, tribal researchers, and others conducting studies along the river corridor is, "What is the effect of the operation of Glen Canyon Dam on cultural resources in Grand Canyon?" The question that we posed in response was, "Are the monitors and researchers collecting the data that they need to properly document the effects of the operation of Glen Canyon Dam on cultural resources?" SWCA's short answer was, "Almost but not quite," and after looking through and evaluating the data several times, it is fair to say that the PA members who are actively documenting and evaluating the project area's cultural resources have been headed and are heading in the right direction. The RCMP staff in particular have understood that it is necessary to establish proper baseline conditions at the monitored sites and to devise effective ways for measuring change over time. SWCA found, however, that the RCMP monitoring form is most effectively designed to document the presence or absence of different types of erosion at each site but not to indicate the severity of erosion for the different types in a quantitative way. On the other hand, the total station mapping of sites and the collaborative relationship with the corridor's geomorphic modelers will allow different types of erosion to be quantitatively measured as a percentage of the volume of sites and specific features on sites. Both research methods also offer a strong basis for evaluating management decisions involving the appropriateness and effectiveness of remedial actions. Both of these avenues have been pursued by Grand Canyon (GRCA) River Corridor Monitoring Program (RCMP) staff, who have advocated for continuation of the baseline and repeat total station mapping to quantitatively assess change, and who have wholeheartedly adopted the recently developed geomorphic model for assessing a site's vulnerability to gully erosion. The monitoring efforts of RCMP staff and the vegetation studies by some tribal groups in the corridor have qualitatively indicated to them the usefulness of these tools for documenting rates of erosion and the link between these erosional processes and dam operation.

The photographs taken during the past eight years of monitoring could be used in conjunction with the total station mapping to analyze the erosional history of a site, and SWCA recommends that this work be conducted as a separate study. The recently completed synthesis of site-by-site monitoring data for FY1992-1999 by staff of GRCA RCMP and Northern Arizona University (NAU) staff (Leap et al. 2000) is an excellent companion piece to this synthesis and, coupled with additional tribal data and the geomorphic data, should exceed the 5-year synthesis requirement outlined in the PA. It should be noted that out of the 322 sites in the Area of Potential Effect (APE) along the river corridor that are eligible for the National Register of Historic Places (NRHP), about 78 (23%) are significantly eroded. Of the 264 sites that have been actively monitored in the Grand Canyon, 49 (18.6%) have deteriorated over the past eight years (Leap et al. 2000:xii), and only about 15 (5.7%) are being eroded so severely that GRCA RCMP management has recently recommended major testing and data recovery efforts for these sites and requested specific funding. The low number of sites recommended for data recovery may be partly due to the success of preservation efforts, a possibility that could be quantitatively examined by using the geomorphic data, repeat mapping, and scaled photography.

All in all, the monitoring data do indicate a shift from monitoring to conducting necessary preservation and data recovery efforts in the last few years, and this trend appears to be continuing. GRCA RCMP personnel are also focusing their continued monitoring efforts on a smaller number of the most disturbed sites and are eliminating those that are considered to be stable, are outside the APE, or are determined to be ineligible for the National Register. In Grand Canyon, 78 sites are considered stable, showing no signs of erosion, and nine others have been put on the inactive monitoring list for other reasons (e.g., under NPS GRCA management, site integrity and therefore eligibility is questionable, or data potential is exhausted [ineligible]) (Leap et al. 2000:xiii). Monitoring activities at the 53 Glen Canyon (GLCA) sites have virtually ceased, and GLCA personnel are actively seeking to carry out recommended and necessary remedial actions to the sites under their management (Chris Goetze, personnel communication February 2000).

SUMMARY OF NATIONAL PARK SERVICE AND TRIBAL RESOURCE MANAGEMENT ACTIVITIES

The initial 1990-1991 archaeological survey of the Colorado River corridor by GRCA and NAU archaeologists resulted in the identification of 475 archaeological sites and the recording of 489 isolated occurrences (IOs) (Fairley et al. 1994). Archaeologists and cultural advisors from the Hopi Tribe surveyed 12 miles of the Little Colorado River above its confluence with the Colorado River, recording 11 sites (six archaeological sites and five traditional cultural properties [TCPs]), five IOs, and two possible resource procurement areas (Yeatts 1995a). Archaeologists from GRCA RCMP and archaeologists and cultural advisors from the Hualapai Tribe surveyed the Colorado River from Separation Canyon to Pearce Ferry, recording nine sites (Hualapai Tribe 1994a). GRCA RCMP staff have also recorded an additional three sites and one IO in the river corridor since the initial inventory survey.

Research by the Hopi Tribe, Hualapai Tribe, Navajo Nation, Southern Paiute Consortium, and Pueblo of Zuni was designed to provide Native American perspectives on previously identified cultural resources and to identify previously unrecognized TCPs. In at least 31 river trips (seven by the Hopi Tribe, 12 by the Hualapai Tribe, three by the Navajo Nation, four by the Southern Paiute Consortium, and at least five by the Pueblo of Zuni), tribal researchers visited more than 116 locations in the Colorado River corridor (the exact number of locations visited by the Zuni researchers was not reported). In addition, however, the tribes identified as significant *cultural* resources plants, animals, minerals, water sources, and other resources that non-Native Americans might consider *natural* resources. The five "active" tribes have disseminated the results of their PA-related research through presentations at professional meetings, chapters in books, articles in newsletters, or some combination of these, and four of them have produced publicly available reports on their corridor research (the Hualapai reports remain confidential). Public education efforts of the tribes have included the above activities as well as videos and youth programs, but except for Chapters 3 and 8 of this volume, no formal compendium of these efforts has been compiled. Maintaining an ongoing, centralized record of the tribes' public education efforts would allow the public greater access to the nonproprietary results of tribal research. The Hopi Tribe has conducted research trips to document plants, has aided in archaeological testing and data recovery efforts on GRCA RCMP river trips, and has proposed additional trips to conduct ethnobotanical research. Tribes are responsible for the databases and archives they have generated, and they have control over how these databases and archives are used. It is unclear, however, how well or in what manner these data repositories are being managed.

Concurrently with the tribal studies, GRCA and GLCA RCMP staff have been monitoring since 1992. GRCA RCMP personnel have actively monitored 264 sites out of the 338 identified as being within the APE during the original survey. GRCA RCMP have eliminated 87 sites from their active monitoring list and now only monitor approximately 177 sites; GLCA staff are in the process of eliminating monitoring activities at the 53 sites under their management, and they did not monitor these sites in FY1999. Between 1992 and 1999, GRCA RCMP archaeologists conducted 33 monitoring river trips: three in 1992, five each year in 1993-1995, three in 1996, and four each year in 1997-1999. Monitoring procedures have included mapping and photography (including photo replication of impacted features and areas), recording artifact distributions, recommending remedial actions, and evaluating stabilization measures. RCMP researchers have presented summaries of monitoring data in annual reports. In conjunction with monitoring, RCMP archaeologists have conducted total station mapping at 78 sites (68 in GRCA and 10 in GLCA); the mapping of sites and of drainages that cut through them is documenting precisely the degree and rate of erosion impacting the sites. Photogrammetric studies at numerous sites are beginning to produce excellent quantitative data on the effects of the operation of Glen Canyon Dam on archaeological sites in the project area and have contributed to geomorphological studies conducted in the vicinity of archaeological sites. In conjunction with mapping, the recent geomorphological studies confirm that most site erosion is caused by gullies that cross the sites rather than by the Colorado River directly (Hereford et al. 1991, 1993; Thompson et al. 2000). However, river processes, and more specifically the lack of sediment replenishment, are exacerbating the erosion caused by gullies cutting the pre-dam terraces containing archaeological sites. RCMP researchers have conducted stabilization activities (including redirecting or obliterating trails, closing sites to visitation, constructing checkdams, revegetating areas, stabilizing stream banks, and stabilizing structures) at 96 sites to date. RCMP researchers have also conducted testing, data recovery, or both at 46 sites, including 20 where radiocarbon samples have been collected. Yeatts (1998) has completed a report for data recovery treatment of five sites that was carried out in 1997, and testing was recently completed and reported at a sixth site in Glen Canyon by personnel from the NPS Western Archeological and Conservation Center (Neff and Wilson 2000).

GRCA and GLCA RCMP monitoring and remediation have generated large amounts of data that, from a practical standpoint, are easily attainable and accessible in Flagstaff for GRCA and in Page for GLCA. The offices keep their archives and databases well organized, and only site location information is not readily accessible, for security reasons. Problems do not arise with the monitoring data until attempts are made to compile and analyze the information. SWCA's recommendations regarding data variable changes, including changes to the monitoring form, were taken very seriously and have already been addressed (with assistance from NAU) in the GRCA RCMP's recent site-by-site assessment of their monitoring and remedial action data (Leap et al. 2000). For years prior to 1992, however, it is not as clear where files (electronic and hard copy) are kept; most are at the respective parks. The Grand Canyon Monitoring and Research Center (GCMRC) library, on the other hand, is not complete and is managed by a part-time employee. Results of RCMP research have been reported primarily in annual reports and trip reports that are not widely available beyond the PA signatory audience. It would be a good idea to put a copy of each RCMP trip report and annual report in the GCMRC library. The survey report (Fairley et al. 1994) is publicly available, and RCMP activities have been published as chapters in books (Harmon 1997; NRC 1996). In addition, results of RCMP research have been presented at professional meetings. As was true of the public education efforts of the tribes, the public education efforts of the RCMP could be better documented and assessed if there were formal procedures for reporting, archiving, and cataloging these efforts. The listing of numerous public efforts in the GRCA RCMP synthesis report (Leap et al. 2000) is an excellent start, and it includes tribal presentations and publications.

LONG-TERM MANAGEMENT GOALS

Five management targets relating to cultural resources outlined in the June 1997 draft HPP (BOR et al. 1997), four specifically for cultural resources and one for sediment management, provide the context for management recommendations. The cultural resources targets are: (1) preservation in situ of all downstream cultural resources, taking into account Native American concerns in Glen Canyon and Grand Canyon; (2) where in situ preservation is not possible, designing mitigative strategies that integrate the scientific approach with full consideration of the values of all concerned tribes; (3) for participating tribes, protecting and providing access to cultural resources and properties for religious purposes within the river corridor; and (4) developing appropriate research strategies to maximize data collection from mitigation and monitoring efforts. The sediment management target calls for preserving terrace deposits at pre-dam levels.

A number of specific information needs are listed under each of the management targets. Target 1, preservation of cultural resources, calls for development of data and monitoring systems to document adverse impacts, development of a predictive model of geomorphic processes related to site erosion, development of data systems to assess risks from dam operations, evaluation of flood terrace stability, development of tribal programs for monitoring impacts to resources, and identification of, evaluation of, and management recommendations for tribal cultural resources. Information needs under Target 2, mitigative strategies, are characterization of historical and current values associated with resources, development of mitigation strategies and costs, and evaluation of the effectiveness of monitoring procedures. Target 3, resource protection and access for participating tribes, requires characterization of historic and current religious associations, development of tribal monitoring programs for impacts to sacred sites, and assessment of potential effects of flow regimes. Needed under Target 4, development of appropriate research strategies, are characterization of specific management/research needs for all sites, design, development, implementation, and maintenance of integrated relational data systems, development of technology and procedures for providing data to appropriate groups, and ensuring the confidentiality of the locations of and esoteric knowledge relating to cultural sites.

Information needs under the sediment management target relate to scientific understanding and analysis of potential impacts to cultural resources. Specific actions include development of data systems to assess risks from dam operations and other sources, study of geomorphological processes promoting erosion and factors governing rates of erosion, study of effects on terrace erosion of both dam operations and other erosional processes, understanding long-term impacts of flows on lateral bank retreat and arroyo headwalls, and modeling impacts to terraces and stabilization potential.

RECOMMENDATIONS FOR FUTURE MANAGEMENT ACTIVITIES RELATED TO MANAGEMENT GOALS

The agencies and tribes overall must consult and coordinate efforts to resolve the documented adverse effects caused by dam operation and work to make decisions regarding the most effective treatments for affected resources. The interdisciplinary approach to both monitoring and site protection should also be continued and enhanced to effectively identify appropriate treatments. More on-site interaction among cultural resource specialists, tribal researchers, geomorphologists, revegetation specialists and botanists, and trail maintenance technicians is now the key to continued success in determining which sites are still in need of monitoring and which should be slated for preservation or data recovery treatment. Nevertheless, some additional research is still needed by the tribes to properly identify cultural resources. For example, the Hopi Tribe is currently conducting additional ethnobotanical studies, the Navajo Nation conducted research during the summer when certain types of stories cannot be told and some information thus cannot be communicated, and the Southern Paiute Consortium visited a *sample* of sites in what the Paiutes regard as a cultural landscape, a view of Grand Canyon cultural resources shared by all of the tribes. There are also some known resources that still need to be recorded; for example, the Hopi Cultural Resources Advisory Task Team has said that they have identified some unrecorded rock art.

Nevertheless, almost all of the cultural resources in the project area have been identified. RCMP staff are now focusing their attention on assessing the effects of the operation of Glen Canyon Dam for treating cultural resources, making recommendations on how to mitigate adverse effects, and implementing site stabilization and data recovery efforts. These remedial recommendations will be supplemented by the geomorphic model, which will be the key to predicting impacts to cultural resource sites. Application of this model will be the driving force in selecting sites that can be effectively preserved, and the model should also aid in identifying whether there are differential impacts to particular site types. Are certain site or property types being lost to erosion because of impacts to a particular geomorphic setting where such sites are located? Resources that are being impacted by the operation of Glen Canyon Dam and that cannot be effectively preserved will require mitigative data recovery efforts.

Current procedures for site photography and mapping appear to be producing the data needed to quantitatively understand how the operation of Glen Canyon Dam is affecting archaeological sites. However, changes in RCMP recording techniques and variables over the years have made databases between some years somewhat incompatible, and changes in monitoring procedures need to be better justified and documented. Furthermore, the absolute lack of and requirement for a central tribal database and the fact that each tribe keeps its own database makes it impossible to physically synthesize the NPS RCMP and tribal databases.

The effects of the operation of Glen Canyon Dam on TCPs are not well documented. The tribes need to continue monitoring these properties and reporting whether they are being degraded and, if so, what processes seem to be most destructive. The impression conveyed by the tribes' public reports is that visitation is the greatest threat to TCPs and that changes in visitor management by GRCA would provide more protection than changes in the operation of Glen Canyon Dam. This impression needs to be explicitly confirmed, because it is unsupported in the RCMP's monitoring data. Recent studies of various recreational user groups in the Canyon by Bill Stewart may offer another line of evidence for the types and extent of visitor impacts to the Canyon's resources (Jan Balsom, personal communication 1999). In addition, tribes need to be presented with results of botanical studies on stability and change in plant distribution and density within the Colorado River corridor in connection with their expressed goal of preserving and enhancing plant diversity and density.

Overall, both gathering and management of information need to be made more efficient. Greater attention needs to be directed to management of tribal databases and archives as well as GCMRC libraries and to fine-tuning the GRCA RCMP databases. Testing and data recovery need to be guided by an explicit research design, and final reports on testing and data recovery need to be completed or undertaken. Once documented effects to cultural and significant natural resources (e.g., botanical resources) have been clearly demonstrated, management recommendations need to be implemented.

To more explicitly define our general recommendations, we discuss them here in relation to the four target areas outlined under the long-term management goals in the draft HPP (BOR et al. 1997). Target 1 deals with preservation-in-place, which appears to be a common goal for all PA signatories. Preservation efforts should continue to be the primary means of curtailing erosional impacts to cultural resources in the corridor. However, to better determine which actions are more effective and in which environments, the conceptual geomorphic model needs to be applied immediately. For example, at the sites on Palisades Delta the most effective means of dealing with impacts will most likely be data recovery; checkdams have not been successful on the delta proper but are quite successful in small terrace-based gullies when placed near their headwaters. The geomorphic model provides the best means for first predicting the susceptibility or vulnerability of recorded cultural resources to degradation from geomorphic processes. The model will greatly aid in determining which sites are affected by dam operations, which should continue to be monitored, which should undergo preservation efforts and subsequent monitoring, and which may require data recovery (Target 2). The use of the geomorphic model also relates to the Sediment Management Target, which calls for preservation of terrace deposits at pre-dam levels. Archaeological monitors should also use the model in documenting sites (see below).

Under Target 2, data recovery will be carried out when preservation efforts are not likely to have a long-term success rate. Currently, data recovery efforts need to be continued and dramatically expanded at sites that are being destroyed by erosion and for which preservation in place is neither cost- nor time-effective. These significant and extensive sites are primarily in Reach 5 from Nankoweap Canyon to Unkar Creek. Whenever possible, however, the efficacy of various preservation methods should be evaluated before carrying out data recovery recommendations.

Target 3, which deals with tribal concerns for protecting and providing access to resources of cultural importance, was discussed in the introduction to this section. Basically, tribal representatives have to work with other disciplines or other data (i.e., geomorphology, botany, monitoring databases) to better assess the effect of dam operations on traditional cultural resources. Work under the PA has allowed representatives of different tribes more access to important sites and needs to be continued. Tribal involvement also needs to be revitalized, particularly relating to decision making involving data recovery efforts.

The need for developing appropriate research strategies to maximize data collection from mitigation and monitoring efforts is addressed by Target 4. With the necessary change in emphasis from monitoring to carrying out management recommendations, what is required before essential and unavoidable data recovery efforts continue is a corridor-specific research design to guide any significant excavations. Right now excavations are being conducted as salvage operations, unguided by design and yielding solely descriptive reports. Since site significance and National Register eligibility under Criterion D should be addressed in terms of what could be learned from a site, the lack of a formal research design has contributed to some of the problems in prioritizing monitoring efforts, designing monitoring forms, evaluating severity of impacts to sites, and making recommendations. The Bureau of Reclamation and NPS, as well as other signatories of the PA, are uniquely positioned to take the lead in developing a research design that incorporates anthropological and tribal perspectives and focuses attention on the values of cultural resources in the Colorado River corridor. Among the research topics that should be considered are:

- Paleoenvironmental reconstruction and site formation processes
- Archaic dates, subsistence base, subsistence strategies (site types, settlement system, seasonality, demographic relationships [site organization]), cultural tradition affiliation, territoriality and exchange (lithic raw materials), ritual (as represented by rock art, offerings of split-twig figurines), and where the inhabitants went/why they left
- Brief Puebloan and Cohonina colonizations (what prompted them, where did they come from, what changes did they have to make to live in the canyon [subsistence base, subsistence strategy, household/community organization, ceramic production, trade]), whether they constituted a single community or multiple communities, their relationship to people outside the canyon, what cultural and social attributes they took with them to Hopi
- Arrival of Patayan/Pai groups and the development of a relatively stable adaptation to the Grand Canyon
- Arrival of the Paiutes (timing and adaptation)
- Historical archaeology: lifeways and material culture of different groups (explorers, miners, river adventurers) as relatively undocumented participants in the capitalist economic system
- Tribal perspectives on and interpretations of archaeological sites in the Grand Canyon. Hopi research interests offer a specific example of how research might be tailored to tribal concerns. Perhaps the key historical process referred to in traditional Hopi history is the "gathering of clans," in which ancestral Pueblo peoples migrated in their search for a permanent home and eventually amalgamated at Hopi. Archaeological research at GRCA could add to the understanding of this process by gathering data on the social organization of the Puebloan occupants of the Grand Canyon, the ways in which this organization could have led to the formation of one or more clans, and the degree of formation of a societal identity among the Grand Canyon Puebloans as evident in localization and differentiation in their material culture as well as in their trade relationships with other groups.

As general themes, researchers might consider (1) patterns of colonization by various groups and (2) the instability of Puebloan, Cohonina, and pioneer Euroamerican adaptations in contrast with the stability of Archaic, Patayan/Pai, and Paiute adaptations.

A more specific and immediate research contribution and database need of data recovery efforts conducted to date is the compilation of all C^{14} samples collected by NPS personnel and other reasearhers working in the river corridor, providing locational information and calibrated dates for those that have been analyzed.

In addition, the continuation of the monitoring program is critical to early detection of sites in need of remedial action. The data generated through the program can be maximized by making them more quantitative. Archaeological monitors should quantitatively document erosional impacts to sites and their associated catchments by applying the geomorphic model, continuing but refining their total station mapping and scaled repeat photography, and including simple repeat measurements of erosional features at each catchment in their documentation repertoire.

Total station mapping should be continued on all sites currently being monitored to provide necessary baseline maps. The application of Global Positioning Systems and Geographic Information Systems technology is also essential to enhancing data analysis of the corridor's cultural resources. The over 10,400 photographic images generated by the RCMP over the past eight years and the 8000+ photos from stationary cameras have not been systematically analyzed; this needs to be done along with analysis of the site maps and monitoring and site databases. The analysis would result in statistics describing what percent of a site's volume is eroded and, potentially, the volume percentage of individual features on each site that are eroded. The monitoring form should also be revised slightly to adequately document stream types and provide spaces to take field measurements of drainage width, depth, and length. Nickpoints can also be measured, including the distance between them. Ideally this information should be plotted on total station–generated maps and recorded on quantitatively focused monitoring forms. In the absence of maps, however, the measurements could be taken and plotted at a later date. Figure 7.18 in Chapter 7 illustrates an excellent yet basic example of the types of information and resources that can be lost without documentation if monitoring is not continued along with preservation and, as appropriate, data recovery. Minimally, stabilization efforts must be monitored on a regular basis to maintain any repairs. By applying the geomorphic model, we can predict where these erosive events might occur.

Some qualitative analyses (and basic statistics) have been conducted using the monitoring data (this report; Kunde 1999; Leap et al. 2000), and these efforts should continue. Such analyses allow for interpretive information on the sites and more frequent detection of inadequacies in the databases, which can then be compensated for.

Isolated occurrences may be an under-recorded data category; they were poorly defined and inconsistently recorded, with locational data not recorded for 53. As many as 183 (41.9%) of the IOs would have been recorded as archaeological sites using a definition of a site such as the one employed by the Arizona State Museum. IOs represent types of human behavior not represented at sites, since cairns, stacked rocks, dry-laid masonry walls and rock alignments, charcoal stains (particularly if they were not associated with artifacts), and fragments of charcoal (especially in overhangs and protected areas) were routinely recorded as isolates. Although the lack of an easily accessible spatial database for IOs makes the evaluation of formation processes represented by these cultural resources quite difficult, charcoal stains are the type of IO most likely to represent either sites starting to be exposed by erosion or final remnants of sites destroyed by erosion. Specific recommendations for determining whether some IOs are such evidence of sites, and of which kind, are given at the end of Chapter 6. Minimally, a database of the IO table should be created, and attempts should be made to find out if there were indeed 53 IOs that were not plotted on the aerial photographs. A GIS database of the IO plots would also make it possible to compare the distribution of IOs to sites. Field checking of IOs is also warranted.

Other miscellaneous recommendations include the need for more tribal involvement in interpreting and evaluating the physical erosion issues. The tribes seem to comment solely on visitor-related impacts, which are significant in scope but not in scale at corridor sites when compared to physical impacts. It would also be a good idea if GCMRC would keep a plant list database, including lists created by the tribes, and keep it current.

Finally, we want to note that the GRCA RCMP has been re-evaluating site eligibility and the 300,000 cfs impact area, instead of relying on the original determinations made following the inventory survey. This policy is reflected most significantly in their monitoring schedule of "discontinue," which includes sites that are determined to fall outside the 300,000 cfs level and sites that are determined in consultation with the Arizona State Historic Preservation Office to be ineligible for the National Register (Leap et al. 2000:Chapter 3). Locating the 300,000 cfs mark is not easy, and RCMP monitors consult with the geomorphologists working in the canyon to determine this level at various sites that are marginally within the APE. To date, RCMP staff are confident of the 317 NRHP-eligible sites (264 in GRCA and 53 in GLCA) that they have identified within the APE. Efforts should continue to focus on those sites that are NRHP-eligible and are being significantly impacted by gully erosion related to dam operation. As other studies are made available regarding cfs locations and vulnerability to erosion, GRCA RCMP and the tribes are encouraged to adjust and refine accordingly their management recommendations and activities for mitigating adverse effects to cultural resources.

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