FINAL REPORT
OF THE
PROTOCOL EVALUATION PANEL (PEP)
ON THE
RECREATION MONITORING PROGRAM
OF
THE GRAND CANYON MONITORING AND RESEARCH CENTER (GCMRC)

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EXECUTIVE SUMMARY

FINDINGS OF THE PEP REGARDING EXISTING MONITORING PROGRAM

1. There is a clear legal requirement to monitor recreation in the Grand Canyon Protection Act of 1992.
2. The quality of river recreation is influenced by flows from Glen Canyon Dam.
3. Recreation use of the Colorado River ecosystem is a major industry. About 180,000 passenger days of river rafting occur in Grand Canyon, along with visitation by 40,000 day use rafters in Glen Canyon and about 20,000 anglers. Visitors receive about $40 million in annual economic benefits and support nearly 600 jobs in northern Arizona.
4. The AMWG Goal for Recreation to maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP is an appropriate and worthwhile goal.
5. The five AMWG Management Objectives (9.1-9.5) are generally appropriate. However, many of the types of information proposed by AMWG to assess progress to these management objectives are problematic. The PEP recommends some alternative information needs.
6. Currently, the GCMRC devotes a very small percent of its $7 million budget to recreation monitoring despite recreation being the most publicly visible and sought after use of Glen and Grand Canyons. Consequently, recreation monitoring is not performed at regular intervals, does not always occur concurrently with flow experiments and does not provide comprehensive coverage of key recreation resources (e.g., little is done for Glen Canyon or for attraction sites in the Grand Canyon).
7. GCMRC programs could be both more efficient and effective if there was more collaboration and cooperation with the National Park Service, as well as between resource areas within GCMRC (particularly recreation, terrestrial biology and cultural resources).
8. GCMRC has made more consistent progress on MO 9.3 (monitoring of camping beaches) and MO 9.5 (maintaining visitor experience in the face of GCDAMP monitoring activities) than it has on MO 9.1 (Visitor Experience), 9.2 (Visitor Safety), and 9.4 (Wilderness Experience). The PEP provides recommendations for improving upon these.
9. **The highest priority information needs identified by the PEP are:**
    - To understand how flows (dam operations) influence the trip attributes and resource conditions that most strongly determine the quality of river experiences.
    - To determine visitor economic benefits as a function of trip attributes, and conduct a regional economic analysis of tourism related to Glen and Grand Canyons.
    - To compile a complete inventory of all current campsites and past campsites
    - To continue monitoring trends in beaches but expand the program to include multiple slope criteria, reflect systematic sampling of representative beaches, and include evaluative judgments regarding the level of and change in social carrying capacity of beaches in the critical reaches.

OVERALL RECOMMENDATIONS OF THE PEP

1. Provide expertise, representation and funding to Grand Canyon Monitoring and Research Center (GCMRC), Technical Work Group (TWG) and Science Advisory Board for monitoring recreation resources that is commensurate with the importance of recreation and more inline with what is provided for other resources.

2. Use an overall conceptual model, such as that in Figure 3.1 to guide monitoring.

RECOMMENDATIONS SPECIFIC TO EACH MANAGEMENT OBJECTIVE (MO)

A. MO 9.1 (Visitor Experience) and MO 9.4 (Wilderness)

1. The information needs with the highest priority are: (1) to understand how flows influence trip attributes and the quality of river experiences and (2) to determine visitor economic benefits as a function of trip attributes, and conduct a regional economic analysis of tourism related to Glen and Grand Canyons.
2. River experience quality can best be protected by using the conceptual model (Fig. 3-1) to understand the relationships between dam operations/NPS management and important recreation conditions and trip attributes experienced by visitors (e.g., size/number of rapids, encounters, discretionary time).
3. GCMRC/NPS/BR/AZGF can use the model relationships to understand how visitors trade-off different recreation conditions and trip attributes, and the economic values of trip attributes.
4. Other management relevant types of information include:
   - The role of agency information transfer on mitigating suboptimal flows/flow experiments on recreation experience and safety,
   - How flow affects rate of travel and user discretionary time, and the resulting personal benefits of additional user discretionary time and associated impacts on natural resources of this discretionary time
   - Understanding what visitors are experiencing particularly as it relates to trip attributes influenced by dam operations
   - The effects of visitor use levels and visitor encounters on solitude and the recreation experience.
   - Monitor recreation impacts on campsites, at Grand Canyon attraction sites and at day use sites in Glen Canyon.

B. **MO 9.2 (Visitor Safety)**

1. NPS accident incident monitoring in relation to flow should be continued.
2. NPS shore observers of trips in Grand Canyon should be continued in conjunction with both regular flow patterns to establish a baseline, and with experimental flows that may impact visitor safety (e.g., very low flows, high flows, or high fluctuations).
3. Information on changes in flow patterns should be made available to visitors and trip leaders to minimize the effect of such changes in flow patterns on visitor safety.
4. Survey of private and commercial trip leaders should be instituted that records trip incidents and trip accidents.

5. Visitor safety and health monitoring (e.g., sanitary waste issues) should be expanded to routine monitoring of the Glen Canyon reach above Lee's Ferry.
6. Research is needed to determine if high flow conditions improve sanitary conditions at camping beaches.

C. MO 9.3 (Beaches and Campsites)

There are two high priority information needs related to this objective.

1. A complete inventory of all current campsites and past campsites should be compiled in the form of a campsite atlas. The inventory should include location, boundaries, size, sleeping capacity, shade, boat mooring, etc.
2. Monitoring of trends in beaches and their carrying capacity should be continued but improved by including multiple slope criteria, reflect systematic sampling of representative beaches, and include evaluative judgments regarding the level of and change in social carrying capacity of beaches in the critical reaches.

D. MO 9.4 (Wilderness Experience)

Recommendations regarding maintaining and improving visitor wilderness experience are included in recommendations for MO 9.1 and 9.4 above.

E. MO 9.5 (Maintain Visitor Experience effected by GCMRC monitoring activities)

1. Through NPS Research Permitting Process NPS should modify its Research Permit to include procedures to minimize GCMRC and other scientists impacts to visitor experience (e.g., attempt to minimize non-recreation related monitoring trips during prime recreation season, not stopping at non-essential attraction sites, avoid competing with visitors for prime camping spots in critical reaches).
2. Improve communication with private and commercial trip leaders of scientific research activities in Glen and Grand Canyon via press releases, posting at launch areas, rangers at launch areas, posting on NPS websites, etc.
3. It is important to add questions to any future social research on river users regarding their interaction and perceptions of research or education trips.

Details of each finding and recommendation are provided in Chapters 2 and 3, respectively.

Chapter 1.
Introduction and Justification for a Recreation Monitoring Program

Recreation on the Colorado River in Grand and Glen Canyons is internationally recognized and highly valued. Recreation quality and value is affected by operations of the Glen Canyon Dam. Monitoring of recreation resources is mandated by law.

The Grand Canyon is a World Heritage Site, and premier destination for river recreation. The Colorado River through Grand Canyon National Park provides one of the longest stretches of navigable whitewater in the world. Even with user limits placed by the National Park Service to protect the recreation experience, each year there are 120,000 passenger days of commercial whitewater rafting and 60,000 passenger days of private rafting use. This recreational resource produces about $34 million in economic benefits to the participants, and supports over 400 jobs in northern Arizona (Loomis, et al. 2005). The demand for private river permits has resulted in waiting lists of at least 12 years. Glen Canyon National Recreation Area below Glen Canyon dam provides outstanding trout fishing, averaging 20,000 angler days, providing nearly $4 million in annual economic benefits to anglers and supporting nearly fifty jobs in Northern Arizona (Loomis, et al. 2005). Glen Canyon NRA also provides day use rafting trips taken by 40,000 visitors, and valued at $2 million and supporting 100 jobs (Loomis, et al., 2005). Recreation is one of the dual mandates of National Parks (Loomis, 2002). Glen Canyon is a National Recreation Area, and as the name implies, recreation is a dominant purpose.

The Environmental Impact Statement (EIS) on the Operation of Glen Canyon Dam stated "Discharge from Glen Canyon Dam affects recreation through its influence on flow sensitive attributes or through changes in the recreation environment" (USDOI, 1995: 274). These flow sensitive attributes listed in the EIS include trip attributes such as fishing success and rafting trip quality.

1.1 Legal Mandates and Goals for Recreation Monitoring in Glen and Grand Canyons

The Grand Canyon Protection Act of 1992 specifically mentions recreation as one of the three elements to be monitored in the section labeled Research (Sec. 1805(b): "Long-term monitoring …shall include any necessary research and studies to determine the effect of the Secretary's actions… on the natural, recreational and cultural resources of Grand Canyon National Park and Glen Canyon National Recreation Area."

The Grand Canyon Protection Act of 1992 specifically mentions research and studies of recreational resources. Both the current Grand Canyon National Park General Management Plan (USDI National Park Service) and the proposed Grand Canyon National Park River Management Plan (Grand Canyon National Park, 2004) require monitoring of visitor experiences and recreational resource conditions. The charter of the Adaptive Management Work Group also mentions monitoring visitor use (Behan, 2000).

The National Research Council (a unit within the National Academy of Sciences) provided an external review of the Grand Canyon Monitoring and Research Center's Long Term Monitoring and Research Strategic Plan. The National Research Council review of Socioeconomic resources (which includes recreation) concluded "This strategy fails to anticipate the types of social

scientific knowledge needed for adaptive management… The Center should begin to develop internal expertise in techniques for nonmarket valuation of ecosystems and their services". (NRC, 1999: 13). Recreation is one of the more prominent ecosystem services provided by the Glen Canyon NRA and Grand Canyon National Park.

1.2 How the PEP was Conducted

The PEP was conducted over several months during the summer of 2005. PEP members participated in a two week Grand Canyon trip in June. Prior to the trip, Helen Fairly of GCMRC compiled a list of questions for the PEP team to address. These questions guided the PEP inquiry, recommendations and report writing. Our review of the existing monitoring program in Chapter 2 and our recommended monitoring program in Chapter 3 address these questions. The exact text of the questions is provided in Appendix B. Also prior to the trip, PEP team members were provided with and reviewed past recreation research on Grand and Glen Canyon. During the trip, representatives of GCMRC and the NPS, along with several scientists, gave briefings to the PEP members. Details on literature and briefings are provided in Appendix B. The river trip was followed by a work day in Flagstaff to finalize the initial outline of the PEP report. During the remainder of the summer the PEP team members researched and expanded their initial drafts, participated in conference calls, reviewed the emerging document, and reached consensus on the findings and recommendations.

Chapter 2 Status of the Existing GCMRC Recreation Monitoring Program

2.1 Limitations of Current Administrative Framework and Cooperative Arrangement of GCMRC and NPS and Arizona Game and Fish

GCMRC has recognized recreation as a component of the overall monitoring and adaptive management process since its beginnings. However, the PEP noted several factors that have worked against GCRMC's ability to build an effective, efficient and comprehensive recreation monitoring program consistent with other program areas. While the GCMRC has developed extensive monitoring programs (most notably for sediment), it has not invested proportionately in staff, studies or monitoring of recreation and economic components. Specifically:

- **Lack of a Separate Recreation Team Leader**. Unlike other program areas, GCMRC does not currently have a separate team leader trained in recreation planning/management to head recreation monitoring program. Within GCRMC there is neither a trained recreation specialist or recreation economist on staff. Without such expertise (a point noted in the 1999 National Research Council report), the organization has a gap in its capability to develop, implement and sustain a research and monitoring program for recreation of the type warranted for the world-class resources of Glen and Grand Canyons.
- **Lack of Science Advisory Board Representation for Recreation**. Currently there are no members of the GCMRC Science Advisors who have recreation expertise or social science backgrounds. Without such expertise, the Science Advisory Board is limited in its ability to provide adequate attention and oversight to human dimension of the program. Having professional social science expertise available on the Science Advisory Board would allow for recreation monitoring program feedback and evaluation.
- **Out of Date Economic Assessments**. There has been a paucity of economic research and assessment work conducted as part of the GCMRC science program. There has been no recreation valuation work conducted or funded by GCMRC since the EIS. Without up-to-date economic analysis to fully understand and document the recreation economic benefits and regional tourism businesses there are times when changes in dam operations and flow experiments are made without understanding of the full effects on visitor benefits and local economies.
- **Need for Increased Inter-Agency Coordination in Monitoring and Research.** GCRMC and Grand and Glen Canyon National Parks share many recreation and social science research needs. There is a clear opportunity to improve efficiencies and leverage limited resources by sharing costs and coordinating monitoring efforts, particularly in understanding the relationships and monitoring physical resource impacts and quality of visitor experiences related to flows. The need for better integration and opportunities for coordination of resource monitoring programs and research efforts of NPS and GCMRC was repeatedly noted by the PEP.
- **Unrealized Opportunities for Promoting Partnership and Collaboration**. There are significant unrealized opportunities for GCRMC to develop partnerships and cooperative research and monitoring efforts with outside organizations, universities and outfitters. Strengthening relations, and designing and conducting shared research with non-governmental and educational organizations would help build a comprehensive, long-term and diversified research and monitoring program. Cooperative efforts would leverage resources and help further a broad base of knowledge about recreation,

economics and social science related to the Grand Canyon. In addition, the PEP identified opportunities for improved coordination and collaboration in recreation monitoring and research with AZ Game & Fish.

- **Need for Regular evaluation of recreation monitoring program.** Consistent with a viable adaptive management approach, periodic review of the recreation monitoring program would provide adequate oversight, peer evaluation, and improve scientific credibility and consistency of the recreation monitoring program.

2.2 Parity in monitoring program investment. While the Grand Canyon Protection Act clearly calls for the monitoring of "recreational resources", the PEP noted the lack of funding made available for the recreation monitoring program. Contrary to its mandate, GCRMC has not invested proportionately in social science or economic assessments. Some reasonable or proportional level of investment would be appropriate to place monitoring and understanding of social elements on par with the biological and physical resources. Without adequate funding priority, the viability and scientific defensibility of GCRMC's recreation resource monitoring program is at risk and does not fulfill the intent of the Grand Canyon Protection Act.

2.3 The PEP's Evaluation of Current AMWG Recreation Information Needs and Progress to Date

The most recent version of goals, management objectives and information consists of one goal for recreation: "maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP goals". This is an appropriate goal. Five management objectives have been developed to provide further specificity to this goal. For each of these objectives, we assess progress to date and comment on the information needs contained in the GCDAMP, updated June 25, 2003. While some of the proposed information needs are clear and valid, we believe that some of the stated information needs are not specific enough, some ask for information that does not address objectives well and some types of information important to meeting objectives are not included. In Chapter 3 we propose a comprehensive program of monitoring and research that we believe would best meet the goals and management objectives of the GCDAMP.

2.3.1. MO 9.1. Maintain or improve the quality and range of recreational opportunities in Glen and Grand Canyons within the capacity of the Colorado River ecosystem to absorb visitor impacts consistent with the NPS and tribal river corridor Management Plans.

To date, GCMRC has funded several research projects related to this objective, including three that relate visitor experiences to flow levels (Stewart et al. 2000, Roberts and Bieri 2001, SWCA Inc., 2002). These three studies provide a start to understanding how to maintain or improve experience quality, particularly how Glen Canyon Dam can best be operated to maintain or improve experience quality. There has also been research supported by others, particularly the National Park Service (e.g. Hall and Shelby 2000) that contributes needed information.

One of the core monitoring needs is to determine and track visitor satisfaction for river-related recreational opportunities. Conceptually visitor satisfaction is an important element of a recreation monitoring program. However, monitoring overall visitor satisfaction has several important weaknesses, including its currently undefined nature and problems of visitor displacement and other coping mechanisms whereby overall visitor satisfaction may be high

even though the type of recreation experience provided on the river may be quite different than what was intended or appropriate. Consequently, we do not emphasize monitoring overall visitor satisfaction by itself. Instead, we recommend conducting research to identify relationships between dam operations, recreation resource conditions, recreation trip attributes and visitor satisfaction with specific resource conditions and trip attributes. **We believe that the AMWG management objectives can best be met by conducting initial research that relates dam operations directly to trip attributes that influence visitor satisfaction.** Once these relationships are established, there should be less need for annual monitoring of visitor satisfaction with resource conditions and trip attributes, but rather just monitoring of the dam operations that have been shown to influence the resource conditions and trip attributes that are related to visitor satisfaction. Only periodic (e.g., every five years) monitoring of visitor experiences and satisfaction would be necessary to ensure that the relationships among dam related trip attributes and the visitor satisfaction remain unchanged.

Another aspect of maintaining quality recreation within capacity to absorb visitor impacts is the need to track and mitigate the impacts of visitors on campsites, in side canyons and at archaeological and other attraction sites. While GCMRC has supported some monitoring of archaeological sites, there has been little support for other types of impact monitoring at other types of attraction sites (e.g., Elves Chasm). The NPS has supported some impact monitoring, particularly of a sample of river camps, but more is needed because of the contribution of the overall aesthetics of campsites, day use areas, and attractions to maintaining high quality recreation opportunities along the Colorado River corridor. While human impacts on recreation sites have the potential to change the nature of a site, the amount of change tolerated on any site becomes a managerial decision. Informed managerial decisions, which are driven by data collection and on-going recreational impact monitoring, allow for the creation of sustainable recreation environments. A formalized monitoring program, which satisfies the criteria of both valid and reliable data, needs to be established to protect the quality of recreation experiences and integrity of the resources of GCNP and GCNRA.

There has not been any monitoring of visitors economic benefits since the passage of the Grand Canyon Protection Act of 1992, despite the recommendation of the National Research Council in 1999. The evidence available from the 1980's suggests that the recreation benefits are potentially quite large ($40 million annually) and sensitive to changes in flow (i.e., Grand Canyon rafting and Glen Canyon fishing—see Loomis, et al. 2005). There has been one monitoring of regional economic effects associated with the low summer steady flow. The PEP agrees with the previous National Research Council (1999) recommendation to GCMRC that economic benefits is an important indicator to track in a recreation monitoring program. Potentially, the indicator of user economic benefits (i.e., their consumer surplus) would reflect quantitative changes in the quality and satisfaction with the recreation experience. Thus, periodic recreation economic benefits monitoring and monitoring during experimental flows would provide one quantitative measure of how recreation quality has changed. We describe how this can be accomplished by GCMRC within the proposed conceptual model in Chapter 3.

2.3.2. MO 9.2 Maintain or improve the quality and range of opportunities in consideration of visitor safety, and the inherent risk of river-related recreational activities.

Overall, visitor safety and risk management on the Colorado River has been well protected through the efforts of NPS. A major concern related to river use safety is focused on the flow levels of the Colorado River, especially daily fluctuations in flow. The NPS maintains

two data collection processes to help determine the relation of flow to injuries and accidents. The first process is an on-going study which assesses impacts and potential risks of whitewater boating during variable flows. Baseline data was collected in 1985-86 during high flows, then in 1990-91 during low and medium flows, during the experimental "flood" in 1996, and finally in 2000 for flows of 8,000 cfs. The process included week long observations at a sample of rapids and the occurrence of accidents or incidents. The NPS also maintains an on-going data base of river related injuries and accidents. In this case, trip leaders are responsible for reporting incidents where over $500 damage is incurred to rafts/equipment. Additionally, all medical rescues on the river are reported in the database. An annual report on river incidents is produced each year with the goal of decreasing injuries, accidents, and fatalities. **These existing monitoring efforts should be continued and supplemented by GCMRC, particularly during periods of experimental flow.**

2.3.3 MO 9.3. Increase the size, quality and distribution of camping beaches in critical and non-critical reaches in the mainstem within the capacity of the Colorado River ecosystem to absorb visitor impacts consistent with NPS and tribal river corridor management plans.

Related to this objective, GCMRC has been funding monitoring of campable area on a non-random sample of beaches (Kaplinski et al. 2005). Along with earlier studies of Grand Canyon's beaches, dating from the 1970s, this monitoring makes it clear that the size, quality and distribution of camping beaches are in decline. Monitoring after experimental flows has also provided some insight into how dam operations might minimize this decline, but there is no clear prescription for maintaining beaches. The beach monitoring program has developed relatively precise and efficient methods for monitoring changes on beaches. However, the effects of such changes on carrying capacity (the number, size and types of recreational groups that the Colorado River ecosystem can support), is not clear. **Trends in carrying capacity, as limited by the size, quality and distribution of beaches, is a critically important information need that has not been adequately addressed.**

Currently, a recreation impact monitoring program has been established for GCNP river corridor campsites. Impact data is being collected on 47 sites on an annual basis. There are a variety of sites included in the monitoring sample including heavy use sites, emerging sites where use is on the rise, and bottleneck areas where campsites are in high demand. One area of critical importance to GCNP, which is included in the monitoring program, is impacts appearing and increasing in the "old high water zone". Impacts in the "old high water zone" are especially important because they appear to be a good indicator of beach loss. As the available beach area decreases, visitors are forced to camp in the primarily undisturbed desert vegetation above the "old high water zone". These impacts are especially significant due to the fragile nature of the vegetation, wildlife, and soil resources above the beach areas.

The current campsite monitoring program contains a diversity of impact variables including camping capacity, evidence of sanitary waste, litter and food scraps, campfires, and rock impacts. Variables which are particularly critical to the integrity of the resource base include number of social trails, cryptobiotic soil impacts, vegetative impacts, and destruction or loss of vegetative islands on beaches. The results of the monitoring are reviewed by GCNP staff each year and appropriate managerial prescriptions related to user behaviors may be based on the data collected.

2.3.4 MO 9.4. Maintain or enhance the wilderness experience in the Colorado River ecosystem in consideration of existing management plans. To date, GCMRC has made no progress related to this management objective. However, we believe that this objective can be largely subsumed within MO 9.1. As such, attainment has been limited as described in MO 9.1.

2.3.5 MO 9.5 Maintain or enhance visitor experiences as a result of GCDAMP research and monitoring activities. NPS has a detailed administrative process that attempts to minimize the effect of research trips on visitor experience and the natural environment. This process is a first step in meeting this objective, and in Chapter 3 we provide suggestions for what we believe are the logical next steps to fully meet this objective.

Chapter 3. Proposed Comprehensive Recreation Monitoring Program

3.1 Conceptual Model to Guide Development of a Comprehensive Monitoring Program

The overarching AMWG goal of the recreation program is to maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem. To approach this goal, monitoring information is needed about how management actions, particularly those related to operation of the Glen Canyon Dam, influence the quality of recreational experiences by three primary user groups: Grand Canyon white water rafters, Glen Canyon anglers and Glen Canyon day-trip rafters.

For this purpose, we propose the following conceptual model linking management actions to recreational experiences (Fig. 3-1). This model draws from well-researched models of recreation management (Clark and Stankey 1979; Knopf, 1988; Jubenville and Twight, 1993; Manning, 1999, Stewart, et al. 2000) and economics (Lancaster, 1966; Morey, 1981; Holmes and Adamowicz, 2003).

As shown in Figure 3-1, the initial drivers or determinants of the quality of visitor experiences are:

- Management Control by USBR (flows), NPS (launch schedule) and AZ Game and Fish
- Natural Characteristics of GCNP and GCNRA (e.g., depth of the canyon)

These drivers influence what we call recreation conditions and trip attributes. For example, the size, quality and distribution of camping beaches (MO#3) is influenced by river flows as well as the naturally occurring amount of sediment entering the Grand Canyon from the Paria River and below. NPS limits on number of visitors and the launch schedule influences the underlying social conditions that a visitor will experience. It is these conditions and trip attributes, and visitors' evaluations of these individual attributes that determine experience quality (visitor evaluations of their experience).

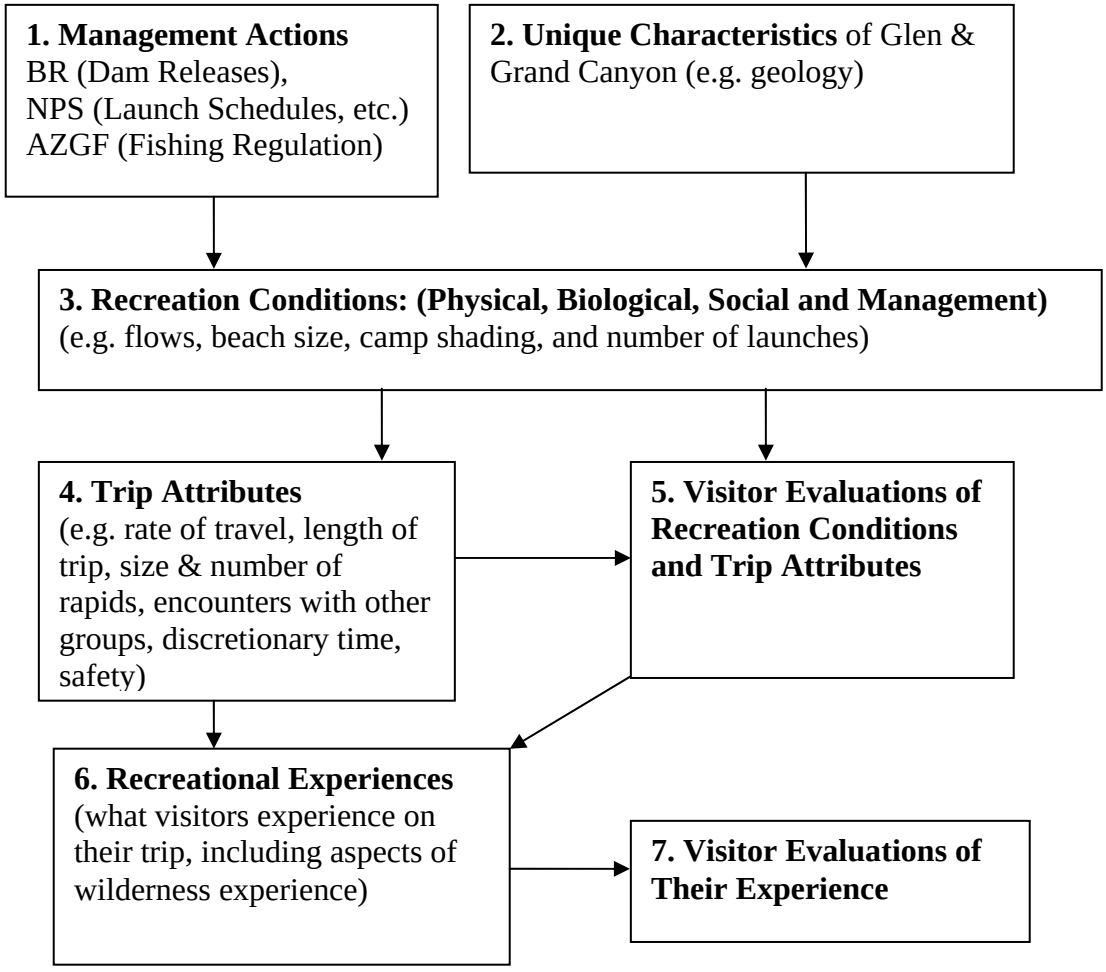
This model helps organize information needs related to the five management objectives. Management Objectives 1 and 4, related to recreation and wilderness experiences, lie in Box 6, suggesting the need to either monitor experiences or describe relationships between management actions, including dam operations and experiences. Visitor safety (MO 9.2) and science trip encounters (MO 9.5) are trip attributes (Box 4), while beach size, quality and distribution are recreation conditions (Box 3).

Knowing how each recreation resource condition and trip attribute contributes to trip satisfaction and how these conditions are related to dam operations and other management actions provides the information BR, NPS and AZ Game and Fish need to maintain recreation experience quality. Once these relationships are known, then GCMRC and others can focus monitoring on these relevant resource conditions and trip attributes and infer what is occurring to the visitor experience. It also provides information needed to modify management actions that may be leading to a decrease in visitor satisfaction or to mitigate the adverse effects of such actions. For example, the need for very high or very low flows (for sediment management reasons) may adversely affect visitors' "once in a lifetime" trip. Knowing this, the change in flow might be scheduled for a time when there are fewer boats on the river or, alternatively, information be

made available ahead of time to visitors and guides so they too can adapt to the new flow regime during their trip.

An additional advantage of the trip attribute model in Figure 3-1, is that it provides managers an understanding of how visitors trade-off different levels of trip attributes in terms of their experience satisfaction or quality. For example, higher flows often mean larger rapids, but smaller beaches. Using a quantitative trip attribute model described below, the relative effect of each of different levels of trips attributes can be compared in terms of relative contribution to overall trip satisfaction. As also described in more detail below, organizing monitoring around a trip attribute model can simultaneously allow for quantifying the economic benefits received by the visitors. This allows addressing Core Monitoring Information Need 9.1.4 with mostly additional statistical analysis rather than a separate data collection effort.

Figure 3-1 A Conceptual Model of River Recreation to Guide Monitoring



3.2 Details of a Proposed Recreation Monitoring Program by Objective

The PEP took a broad view of recreation monitoring, delineating what should be done by all agencies responsible for recreation management in GCNRA and GCNP, including AZ Game Fish. The details of which agency performs which types of monitoring and research is left to negotiation and the expertise of each agency. In the sections that follow, we briefly describe important information needs, organized under each management objective. The information needs that we believe are most important and related most directly to dam operations are noted as high priority. This does not imply that the other information needs are not important, however.

3.2.1. Management Objective 9.1 Recreational Quality and 9.4 Wilderness Experience

MO9.1 Maintain or improve the quality and range of recreational opportunities in Glen and Grand Canyons….
MO9.4 Maintain or enhance the wilderness experience in the Colorado River ecosystem…

MO 9.1 and MO 9.4 are grouped together as it is PEP's view that MO9.4 on Wilderness Experience is a subset of MO9.1. If the NPS maintains the current high quality experience it will achieve a high quality wilderness experience (with the exception of motors).

3.2.1.1. Research Information Needs for MO 9.1 (Addresses CMIN 9.1.1 and 9.1.3)

1. How Flow Influences the Quality of River Experiences.

Ideally, we would be able to monitor visitor experiences (Box 6) and/or understand the relationships between management actions, particularly dam operations, and visitor experiences. While there have been a multitude of studies of outdoor recreation experiences, many of them conducted on rivers, and several of them focused specifically on the Colorado River in Grand Canyon (SWCA, 2002, Stewart et al. 2000), these studies have not specifically identified the cause and effect relationships between management actions, trip attributes and recreational experiences in the context of the Colorado River. **Therefore, we recommend, at least in the near-term, focusing research/monitoring on recreation resource conditions such as physical, biological, social and management conditions (Box 3), trip attributes (Box 4) and visitor evaluation of resource conditions and attributes (Box 5) that are important to providing the types of visitor experiences that make the Colorado River ecosystem unique and world-class.** This essentially involves estimating the linkages in the conceptual model in Figure 3-1 for Grand Canyon boaters, Glen Canyon day use rafters and Glen Canyon anglers.

The first step in this recommendation is to synthesize the work done to date. Extending the work of Hall and Shelby (2000), Stewart et al. (2000) and Shelby and Whittaker (2005) on the importance of characteristics and trip attributes to high quality trips is needed. For example, Hall and Shelby (2000) had visitors identify attributes that make the Grand Canyon better than other rivers. Stewart et al. (2000) asked visitors to rate the importance of various attributes they experienced on their Grand Canyon trip. These attributes seems particularly important to maintaining experience quality and a number of them are strongly related to dam operations (e.g. whitewater, sense of challenge and ability to explore). The next phase would involve estimating how flows and NPS management influence these important characteristics and trip attributes. By understanding these relationships, it is possible to predict how flow and NPS management affects visitor experience, recreation quality and visitor satisfaction. Thus, instead of focusing

monitoring solely on overall visitor satisfaction (which can problematic, as noted earlier), core monitoring can focus on monitoring resource conditions such as flows and trip attributes. Only periodically, (e.g. every five years or so) would it be necessary to survey to reevaluate visitor evaluation of resource conditions and trip attribute relationships in the conceptual model.
Priority: Highest priority projects and clearly related to GCMRC.

2. Visitor Economic Benefits

The economic benefits of recreation can be measured as part of the trip attribute model presented in Figure 3-1, especially box #5. For example, a typical trip attribute survey would have visitors rate satisfaction they would have on a 1-10 scale associated with different trip profiles or choose between two or more different trip profiles that have different levels of the trip attributes relevant for that activity/setting (e.g., fishing in Glen Canyon or whitewater rafting in Grand Canyon). Equation (1) presents a stylized example for the Grand Canyon:

Visitor Satisfaction Rating= Bo+B1(#Rapids)+B2(#Site Attractions Visited) -B3(#River Encounters)-B4(Trip Cost)

The multiple regression coefficients B1…B4 tells the agencies how the visitor rating of their trip satisfaction changes with each of the trip attributes and resource conditions. This allows calculation of how trip satisfaction changes with each trip attribute. The ratio of the regression coefficients (e.g., B1/B2) calculates the relative importance of one attribute compared to another. This is useful for evaluating trade-offs between trip attributes (Holmes and Adamowicz, 2003). In terms of economic value of the trip attributes to visitors, since the trip cost attribute is denominated in dollars, then the monetary value of the other attributes can be calculated by dividing the other trip attribute regression coefficients by the coefficient on trip cost (Holmes and Adamowicz, 2003). For example, the monetary benefits of visiting an additional site attraction site is calculated as B2/B4. Separate trip attribute surveys and models would need to be estimated for the three primary activities (Glen Canyon day use rafting, Glen Canyon angling and Grand Canyon rafting).
Priority: Highest priority projects and clearly related to GCMRC.

3. Regional Economic Analysis of Tourism Related to Glen and Grand Canyon

Visitor spending related to commercial outfitters, guides, land and air shuttles, hotels, restaurants, etc. supports a substantial industry in northern Arizona, Utah, Las Vegas, etc. As part of a survey aimed at obtaining visitor satisfaction with trip attributes, the same survey can obtain information regarding visitor expenditures. This information would be by expenditure category and by geographic area of the spending. This information would be analyzed in a series of input-output models to calculate the multiplier effects in regions of varying size. Like past analyses, it can be done to reflect the multi-county income and employment in northern Arizona (Douglas and Harpman, 1995). However, the PEP felt that limiting the analysis to just this small geographic area did not fully reflect the extent of the outfitting and guiding industry and tourism related to Glen and Grand Canyons. As such PEP recommends that in addition to northern Arizona, that it was very appropriate to include an adjacent state regional model composed of Arizona, Utah, and southern Nevada. PEP suggests that a multi-state model reflecting the same geographic area as encompassed for the hydropower marketing (i.e., Western Area Power Authority area) also be used.
Priority: Highest priority projects and clearly related to GCMRC.

4. Monitor the Role of Agency Information Transfer and Influence on mitigating suboptimal flows/flow experiments.
This involves GCMRC and NPS developing information on the flow regimens and other experiments to be conducted and providing that information via alternative media to boaters and anglers prior to and during their trip planning. GCMRC would evaluate whether the information received improved visitors' planning and enjoyment of their trip. Part of the monitoring design would be how different people react to different flow regimes with and without the pre-trip information. The effectiveness of different information treatments and information delivery would be evaluated to design the best information transfer mechanism.

5. Understanding what visitors are experiencing particularly as it relates to trip attributes influenced by dam operations.
As noted earlier, scientific understanding of the nature of visitor experiences is poor. Consequently, the PEP recommends monitoring trip attributes assumed to influence visitor experiences rather than experiences *per se* (high priority study 1 above). While this seems acceptable in the near term, a better understanding of the nature of the visitor experience in Glen and Grand Canyons is necessary to be assured that the initial trip attributes chosen in the conceptual model are the ultimate determinants of the quality of the visitor experience. The rationale for this type of research is to improve our long term ability to monitor visitor experiences directly rather than relying on monitoring trip attributes which are proxies for visitor experience. This would likely involve diverse research methods, including qualitative work.

6. How does flow affect rate of travel and user discretionary time and the resulting personal benefits for visitor exploration and associated impacts on natural resources?
It has been logically asserted that higher flows lead to increased rates of travel and more user discretionary time for Grand Canyon rafters. With more discretionary time, users will either spend more time in camp or more time on side hikes and at attraction sites. Again, it is assumed that more discretionary time will provide more personal benefits for rafters but that there may be environmental costs resulting from increased exploration. More people will visit and trample more places, resulting in more impact to vegetation, soil, animal populations and archaeological sites. While these assumptions seem logical, they have not been tested and the magnitude of effect (both positive and negative) has not been quantified. Consequently, some management specialists conclude that more discretionary time (resulting from higher flows) is harmful, while others conclude that it is beneficial. Since these relationships are so strongly influenced by dam operations, we believe this is worthy of careful study, using some combination of trip dairies, participant observation, impact assessment and/or surveys of visitors and experts.

7. Use Levels, Encounters and Solitude.
There has been long-standing concern over rising use levels in parks and outdoor recreation areas and their impacts on the quality of the recreation experience (Manning 1999). This issue is often addressed under the topic of carrying capacity (Shelby and Heberlein 1986; Stankey and Manning 1986; Manning 1999). This issue may be especially relevant in wilderness and backcountry areas which are often valued by visitors for their opportunities for solitude and low rates of encounters with other recreation groups (Hendee and Dawson 2002). Research on the Colorado River in Grand Canyon has found that many visitors are sensitive to encounters with other groups in a number of contexts, including on the river, at campsites, and at attraction sites

(Hall and Shelby (2000) and Shelby and Whittaker (2005)). Other manifestations of high use levels include limited access to attraction sites, crowding at attraction sites, and competition among river runners for strategic campsites. All of these crowding-related attributes may impact the quality of the visitor experience. Moreover, at least some of these crowding-related attributes may be affected by Glen Canyon Dam releases and resulting river flows. Research is needed to determine the relationship between river flow and crowding-related attributes. **Relationships between new or experimental flow regimes and new NPS launch schedule on river encounters, site attraction encounters, camp encounters, and camp competition are an essential component of recreation monitoring and for estimating the statistical models derived from the conceptual model in Figure 3-1.**

8. Recreation Impact Monitoring

A critical component of maintaining high quality recreation opportunities along the Colorado River corridor is protecting the ecological integrity and the overall aesthetics of campsites, day use areas, and attractions. While human impacts on recreation sites have the potential to change the nature of a site, the amount of change tolerated on any site becomes a managerial decision. Informed managerial decisions, which are driven by data collection and on-going recreational impact monitoring, allow for the creation of sustainable recreation environments. A formalized monitoring program, which satisfies the criteria of both valid and reliable data, needs to be established to protect the quality of recreation experiences and integrity of the resources of GCNP and GCNRA.

The current NPS campsite impact monitoring program should be continued and coordinated with the GCMRC beach monitoring program (e.g., using some of the same beaches) to allow evaluation of how changes in beach size (especially in critical reaches) is affecting visitor impacts to beaches and corresponding aesthetic effects and ecological effects.

Recreation impact monitoring is not currently being implemented at GCNRA day use areas or GCNP attraction sites. It is highly recommended that a program similar to the GCNP campsite monitoring program, with site appropriate variables, be developed and implemented on a regular basis. While GCNP campsites are certainly receiving use and the monitoring program is a useful managerial tool, the GCNRA day use sites and GCNP attraction sites are impacted by recreational users at a much higher and consistent rate. Without the benefit of site data, the integrity of the resource base and the aesthetic quality of day use and attractions sites is in jeopardy.

3.2.2. MO 9.2 Visitor Safety

9.2 Maintain/improve the quality and range of opportunities in Glen and Grand Canyons in consideration of visitor safety, and the inherent risk of river-related recreational activities.

A major concern related to river use safety is focused on the flow levels of the Colorado River, especially daily fluctuations in flow. NPS maintains two data collection processes to help determine the relation of flow to injuries and accidents. The first process is an on-going study that assesses impacts and potential risks of whitewater boating during variable flows. Baseline data was collected in 1985-86 during high flows, then in 1990-91 during low and medium flows, during the experimental "flood" in 1996, and finally in 2000 for flows of 8,000 cfs. The process included week-long observations at a sample of rapids and the occurrence of accidents or incidents. During 2000, a total of 314 trips (1,025 boats) were observed over the course of 58 days. The data showed that the majority of accident variables were recorded at Hance Rapids

with the most common incident being "hitting the rocks". Overall, in 2000 there were 18 incidents with 9 injuries, 7 boat groundings, 4 short haul evacuations, and 3 trips terminated.

It is highly recommended that these flow studies continue on a regular basis to maintain a strong data base and also be coordinated with GCMRC and implemented during times of experimental flow regimes. Additional data collection is recommended for the upper reaches of the Colorado River, from Lee's Ferry to the Dam, especially related to daily fluctuations in flow and the occurrence of incidents/accidents.

NPS also maintains an on-going database of river related injuries and accidents. In this case, trip leaders are responsible for reporting incidents where over $500 damage is incurred to rafts/equipment. Additionally, all medical rescues on the river are reported in the data base. An annual report on river incidents is produced each year with the goal of decreasing injuries, accidents, and fatalities. This should be continued.

However, there are **additional** recommendations related to maintaining visitor safety and reducing risk factors on the Colorado River. First, there needs to be better public information related to flow regimes and how these flows may affect river users. A significant problem related to this communication, of course, is short term planning related to experimental flow opportunities. Nevertheless, communication with river users is essential in terms of flow level and the impacts to users and daily flow fluctuation and the impacts to users.

There needs to be more consistent reporting of accidents and incidents on the river. While NPS maintains an on-going database, users are only required to report incidents and accidents if there is a loss of equipment greater than $500. In some cases, medical incidents may not be reported at all if the river trip takes care of their own injured party or evacuation. Everyone's safety on the river is improved through reporting of incidents and accidents in a consistent manner. In addition, with comprehensive incident/accident reporting, NPS will be able to communicate more effectively with the river users regarding the impacts of flow level and flow fluctuation.

Another data collection tool that is recommended by NPS and would be very useful in helping to control visitor safety and risk management would be a flow related trip leader survey (private and commercial). This survey would consider flow regimes on the river and the assessment by trip leaders of the following issues: (a) trip incidents, and (b) trip accidents. Again, sharing information among and between leaders is an efficient and effective manner for decreasing future incidents/accidents.

Importantly, the issue of safety and risk management needs to include the upper reaches of the river corridor from Lees Ferry to the Dam. In this case, health and safety risks are focused on two primary issues: (1) sanitary waste and the flushing of beaches with large flows and (2) daily fluctuations and the impacts on boaters. In terms of sanitary waste, the large number of users concentrated in a narrow corridor with limited resource base to handle sanitary waste disposal in a proper manner is a problem. While toilets have been located at common day use sites and some camp areas, there are still many sites which are impacted by human waste. The recommended day use/campsite monitoring program for the river corridor from Lees Ferry to the Dam (see section 9.l #8) would assist in documenting serious incidents of sanitary waste disposal which could then be mitigated. One form of mitigation may be the flood level flows from large releases. Large daily fluctuations for the boaters above Lees Ferry can be particularly troublesome, especially if the users are uninformed about the flow regime. It is recommended that additional data collection be targeted for the upper reaches related to types of incidents/accidents and number of users impacted with high daily fluctuations in flow. In

addition, the trip leader survey (mentioned above) would be a valuable tool to use with commercial guides on the river section above Lees Ferry.

Finally, there needs to be research to determine if high flow conditions improve sanitary conditions at camping beaches.

3.2.3 Management Objective 9.3 Beaches and Campsites

1. Assemble Inventory of Current Campsites in the Form of a Campsite Atlas

Past studies of campsites have used different techniques, creating the current situation where it is difficult to identify trends and impossible to link changes in beaches with insight into trends in carrying capacity. A first step in rectifying this situation would be development of an inventory of all current campsites, as well as all sites that have been identified in earlier studies. Some of the information that might be compiled in the inventory includes: location, capacity, campsite boundaries on orthophotos, information from historic studies, and site attributes such as shade, boat mooring, etc. Such an inventory might need to be updated about every 10 years. There would be multiple benefits of such a study. It would consolidate current information and provide an objective baseline for future monitoring. It would provide insight into the entire system of beaches in Grand Canyon, clarify which beaches in critical stretches most limit carrying capacity and also provide a basis for developing a representative sample of beaches for other monitoring purposes (CMIN 9.3.2).

High Priority

2. Trends in Beaches and Their Carrying Capacity.

The camp area beach monitoring work of Kaplinski et al. (2005) should be continued but improved. We recommend three changes. First, field time can be reduced by adopting the orthophoto mapping techniques that have been developed. We suggest that there be some consideration given to using multiple slope criteria or slope criteria more stringent than the current 8% slope screen (e.g. 1% slope). Second, the nature of the sample of beaches should be more carefully examined. The purpose of the sample should be to represent what is happening generally on Grand Canyon beaches. Therefore, the sample should ideally be random or systematic. Selecting such a sample would be facilitated by the campsite inventory (CMIN 9.3.1).

The most profound and important recommended change to existing monitoring is the incorporation of evaluative judgments of the capacity of each beach, particularly those in critical reaches. This social perspective provides the means for linking physical changes in beach area to carrying capacity. Various methods might be used for collecting such data. Much could be learned by tracking which beaches commercial groups of various sizes camped on. Guides could be surveyed and asked to make a judgment regarding the maximum number of people that could comfortably camp at each beach. Continuation of the Adopt-A-Beach program, with the inclusion of capacity judgment on the form, could also contribute. Whatever is done, it is important to develop methods that are precise. While this effort might be considered separate from the physical measurements of camp area, we have combined this work with the orthophoto work to emphasize the need for these related efforts to be integrated and complementary.

Priority: Highest priority projects and clearly related to GCMRC.

3. Extrapolate Campsite Capacity Trends Back to the 1970s

By repeating and reanalyzing portions of the Weeden et al. (1975) campsite survey, conducted in 1973, it should be possible to extend campsite capacity monitoring data back to the 1970s, giving a longer-term and more complete picture of trends. This would entail repeat photography on the sample of campsites that Weeden photographed. Changes apparent on the photographs could be analyzed. The magnitude of change in photographs could be compared with differences in capacity estimates, calibrating the beach capacity estimation procedures that Weeden used with those used in current inventory and monitoring efforts. Insights gained could be used to adjust Weeden's capacity estimates such that they are more comparable to current estimates.

3.2.4 Management Objective 9.4 Wilderness Experience

If management actions are taken to assure that the nature of whitewater rafting experiences in Grand Canyon is protected, then we believe that wilderness experiences will generally be protected as well. The most obvious exception to this statement is that travel on motorized rafts and helicopter exchanges are inconsistent with wilderness experiences (Hendee and Dawson 2002). However, decisions regarding the appropriateness of these means of travel are outside of the purview of GCMRC. Therefore, we conclude that there are no unique monitoring or research needs related to this objective that are not included in MO 9.1.

3.2.5. Management Objective 9.5 - Maintain and enhance visitor experience affected by GCMRC activities.

The PEP believes that the first priority is to minimize the impact of GCMRC activities on visitor experiences. To accomplish this, the NPS administrative process (updated in 2002) for approving all science related trips within GCNP needs to continue with a few suggested improvements such as having NPS modify Research Permit to include explicit procedures to minimize GCMRC impacts to visitor experience, i.e., being outside of main recreation season for non-recreation sampling whenever possible, not stopping non-essential attraction sites, avoid competing with visitors for prime camping areas, and use least intrusive scientifically valid tools.

There are also several additional on-going issues which need to be addressed in terms of minimizing impacts related to GCMRC trips:

First, it is important to add questions to any future social research on river users regarding their interaction and perceptions of research or education trips. At this point, little data has been collected about the visitor encounters, types of encounters, and overall impressions related to science trips. While GCNP acknowledges that complaints are received from visitors, the extent of visitor impacts is not currently documented.

Second, there needs to be better communication between the agencies and the guides/visitors related to the need and purpose of research related river trips. Many visitors have no understanding of why research on the Colorado River might be beneficial to the ecological integrity or to their experience on the river. Third, GCNP and GCMRC need to work together to address visitor perception of research and education trips. In particular, GCMRC should provide quarterly research updates to GCNP for educational outreach to river users. This information could be published in a newsletter format and distributed to river trips prior to their launch. This simple communication could enable river users to be prepared for any research/recreation interactions and provide users with some insight to the importance of research.

Finally, GCMRC and GCNP should work to facilitate joint river trips as much as possible to minimize the total number of administrative trips per year. This could be accomplished through an annual coordinating meeting between agency staff to determine where such dual purpose trips might occur.

Chapter 4. Integration with Other Agencies and Programs

The broad goals of the GCDAMP and GCMRC overlap with those of other agencies, most notably the National Park Service and Arizona Game and Fish. In identifying information needs, we have not attempted to delineate the responsibilities of these respective agencies beyond noting high priority information needs as those critically important needs that are most directly related to dam operations. We strongly suggest that GCMRC cooperate with these other agencies to develop monitoring and research programs that are as efficient as possible. For example, monitoring of beach size is strongly related to dam operations, while monitoring of human impacts of camping is more indirectly related to dam operations but of high interest to the National Park Service. It might be most efficient to conduct both types of monitoring simultaneously, following a negotiated agreement on responsibilities and funding.

There also is need for more integration between recreation and other resource areas within GCMRC. Cooperation between recreation and sediment work is evident in the work of Kaplinski et al. (2005) and we recommend that even more cooperation and integration occur. It is also important that there be more cooperation between recreation and programs working on terrestrial biology and on cultural resources.

The recreation and biology programs need to work together to understand the ecological significance of human impacts on vegetation and wildlife around campsites, on side hikes and at attraction sites. Impact inventories are needed to describe the distribution and magnitude of human impact. However, to assess the significance of these impacts there needs to be a simultaneous description of the "value" of the biological resources being impacted. Cooperation between these two programs is also needed to assess the prevalence of vegetation encroachment on campsites and the effects of encroachment on carrying capacity. Similar cooperation is needed with the cultural resources program. Impact inventories describe disturbance of archaeological sites but, to evaluate the significance of impact, these data need to be combined with descriptions of the "value" of the cultural resources being impacted.

Cooperation among resource areas is also needed to identify and evaluate trade-offs among the effects of dam operations on multiple resources. Ideal dam operations for one resource may be detrimental to other resources and *vice versa*. The search for optimal dam operations will require more coordination and cooperation among resource areas.

Chapter 5 Conclusions

Recreation monitoring is critically important. It is a legal requirement of the Grand Canyon Protection Act of 1992. Recreation is one of the dual mandates of Grand Canyon National Park, and Glen Canyon is a National Recreation Area. The need for recreation and nonmarket economics monitoring has been previously pointed out in Behan (2000) and by the National Research Council (1999).

While there have been limited efforts to engage in recreation monitoring within GCMRC, the recreation monitoring program is not funded nor conducted with the same thoroughness that characterizes physical and biological resources. There is no systematic or comprehensive monitoring of several key elements that affect the quality of a river recreation experience in the Grand Canyon. Very little monitoring of recreation use or visitor experience occurs in the Glen Canyon reach. Economic valuation studies of river recreation have not been updated since the EIS and do not reflect the current flow regimes or flow experiments. Thus GCMRC is not adequately meeting Goal 9.1 set out by AMWG to "Maintain or improve the quality and range of recreation opportunities in Glen and Grand Canyons…".

GCMRC's existing recreation monitoring program only sporadically addresses some of the core monitoring information needs (CMIN's) associated with each of the five goals for recreation: maintaining quality of the visitor experience (9.1), visitor safety (9.2), camping beaches (9.3), wilderness experience (9.4) and maintaining the visitor experience in the face of GCDAMP research and monitoring activities in the canyon (9.5).

Although these five objectives are appropriate, the PEP believes that many identified information needs are problematic. The PEP believes that the most efficient way to achieve the goal of maintaining quality visitor experiences is to develop a model that: (a) identifies the recreation resources conditions and trip attributes (such as rapids and beaches) that are most important to a high quality experiences and (b) estimates how different flow levels affect these important recreation resource conditions and trip attributes. By monitoring flow and how recreation resources and trip attributes change with new flow regimes and flow experiments as well as changes in NPS and AZFG regulations, GCMRC can infer how the quality of the recreation experience and economic value of that recreation experience changes over time.

The consistent theme of many of these recommendations is for GCMRC to move away from viewing recreation as primarily monitoring physical resources (e.g., beaches), and to include social and visitor evaluative aspects of recreation not only in Grand Canyon but also in Glen Canyon. With the increasing rafting use in Grand Canyon National Park being proposed by the National Park Service, the PEP believes it is incumbent on GCMRC and NPS to redouble their efforts to develop a coordinated recreation monitoring program along the lines suggested in this report.

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Appendix A Biographies of PEP Members

David Cole

David N. Cole is Research Biologist with the Aldo Leopold Wilderness Research Institute, Forest Service, Rocky Mountain Research Station, located in Missoula, MT. His research has focused on the management of recreation in wilderness, with particular emphasis on the ecological impacts of recreation use. His numerous publications on monitoring visitor impacts to wilderness appear in a wide range of publication outlets.

Pam Foti

Pam Foti, professor in Parks and Recreation Management, Department of Geography, Planning, and Recreation, at Northern Arizona University, Flagstaff, AZ (January, 1988-Present), received her Ph.D. in Land Resource Management from the Institute for Environmental Studies at the University of Wisconsin, Madison (1987). Her research focuses on the physical impacts of recreational use.

John Loomis

John Loomis began his career as an economist in the BLM, and worked as an economist for the U.S. Fish and Wildlife Service. Dr. John Loomis is currently a professor in the Department of Agricultural and Resource Economics at Colorado State University. He served on the Science Advisory Board for the Grand Canyon Monitoring and Research Center for two years. He is the author of three books as well as over 100 journal articles dealing with economic valuation of non-marketed natural resources such as recreation, fishing, wilderness, and endangered species. Prior to coming to Colorado State University, Dr. Loomis was an Associate Professor at University of California-Davis in Division of Environmental Studies.

Robert Manning

Robert Manning is Professor and Chair of the Recreation Management Program at the University of Vermont. He is also Director of the University's Park Studies Laboratory. He teaches and conducts a program of research on the history, philosophy and management of parks, wilderness and related areas. Dr. Manning has published widely on topics related to park and outdoor recreation management, and is the author of Studies in Outdoor Recreation published by Oregon State University Press. He has spent three year-long sabbatical leaves with the National Park Service, including one year at Grand Canyon National Park.

R. Neil Moisey

R. Neil Moisey, is an Associate Professor in the Recreation Management and Tourism Program in the College of Forestry and Conservation, at The University of Montana. His research focuses on river management issues and the role of the private sector in natural resource management and planning. Dr. Moisey was previously on the faculty at the University of Wyoming and the University of Missouri.

Robert Ratcliffe

As Deputy Chief for Bureau of Land Management's National Recreation and Visitor Services Division Mr. Ratcliffe oversees a broad range of national recreation and visitor services policies and programs. He is also responsible for oversight of a $75 million agency budget. He has served on oversight committees in the development of the Department of Interior's strategic

plan. He served as a Congressional Fellow in the US Senate advising on environment and natural resource issues. Mr. Ratcliffe has been active in natural resources, public lands and recreation management for almost 30 years. He has an M.S. in Resource Recreation Planning and Management and has worked for a number of public agencies, universities and private organizations in outdoor adventure education, river and recreation management, and natural resource planning in the west. Besides BLM, his agency experience includes, U.S. Forest Service and National Park Service. His background incorporates a of public and private sector experience as a river guide and outfitter, adjunct professor, and backcountry ranger.

Appendix B Conduct of the PEP

1) Questions Asked of the PEP Panel

A. Program focus and scope

Questions: Does the current recreation monitoring program address the stated management objectives and core monitoring information needs identified in the Glen Canyon Dam Adaptive Management Program?

What are the strengths and deficiencies of the current program relative to the Management Objectives and Core Monitoring Information Needs for recreation?

Are we monitoring the most critical recreational parameters relative to dam operations, and if not, what are the most critical parameters that the GCD-AMP should be monitoring on a routine basis?

How can the current monitoring data and information resulting from past research be most usefully applied to evaluating effects of current and proposed experimental dam operations on visitor use values and experiences (e.g., backcountry hiking/camping, angling, whitewater rafting below Lees Ferry, day rafting in Glen Canyon, etc.) in the Colorado River Ecosystem?

2) There are a number of important attributes of "visitor use values" potentially affected by dam operations that GCMRC monitors inconsistently, or not at all. These include: 1) angler and boating safety under different flow regimes; 2) changes in visitor perceptions of experiential values relative to various flow regimes; 3) effects on recreation-based economics; and 4) issues related visitor capacity/crowding (among others).

Questions: What methods/approaches could be developed and implemented to address these issues within the framework of the Glen Canyon Dam Adaptive Management Program?

Are there existing methods that have been developed elsewhere that would be appropriate for this setting and could be transferred to this program for implementation in the near future? If so, then what are they?

B) Campable Area Monitoring and Sampling

Questions: How would you evaluate (rate) the adequacy of this approach for characterizing changes in campable area? What other methods, if any, would you recommend to measure this parameter?

Would there be more utility/value in obtaining camping site inventories for change throughout the entire system below the dam, even if the data were only available on a quadrennial basis?

Is the existing campable area mapping program adequate with respect to the location, distribution, and number repeat mapping sites and the frequency of measurements?

C) Monitoring effects of experimental actions on recreational parameters

Questions: Have past research and monitoring of experimental flows been adequate for evaluating effects on recreation?

What additional science elements might be required as part of a future experimental design (BHBF tests for sand bar building, relaxed fluctuating flow operation test, and possibly, steady flows) that would integrate changes in available recreational resources and visitor experience?

D) Program Management

Questions: Is there adequate scientific direction, program management, and budget to ensure the most efficient and scientifically credible recreation monitoring and research program?

If so, then what are the most critical elements?
If not, then what critical elements are missing?

E) Prioritization of Research and Monitoring Activities

Question: In the face of potential (and likely) funding limitations, how would you prioritize elements of the Recreation program between and within the following broad categories: 1) important and essential to implement and/or maintain immediately; 2) highly desirable and important, but not critical to implement immediately (should implement within 2-5 yrs); 3) desirable but not essential for the program in the near term.

F) Collaboration

Questions:

How can these various programs work most effectively in a collaborative (synergistic?) manner to enhance products and outcomes for all the agencies with responsibilities for monitoring visitor use and satisfaction?

Which elements of the current (or proposed) NPS and AZGF recreation monitoring programs are essential (or important) to integrate and analyze within the GCMRC recreation program framework to meet established information needs of the Glen Canyon Dam Adaptive Management Program?

Similarly, what elements of the current (or proposed) GCMRC monitoring program are critical (or important) to integrate within the Grand Canyon National Park recreation monitoring program to meet management goals/LACs for recreation management established under the CRMP?

G) Effects of recreational activities on other aspects of the ecosystem

Question: What are the best and most appropriate methods (within the context of Grand Canyon National Park proposed wilderness) for capturing, measuring, tracking, and evaluating effects of human activities on the Colorado River ecosystem?

H) Integration with other GCMRC program areas

Questions: What recommendations can be offered with regards to data management guidelines and use of analytical tools that will further promote integrated analyses?

I) Data Management and Analysis (general)

Questions: What recommendations can be offered with regards to data management guidelines (including data storage and dissemination protocols), statistical analyses and/or use of other analytical tools to help ensure the credibility, validity, reliability, and long-term utility of the recreation monitoring and research data collected by the program?

2) Pre-trip literature give to panel members

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3. Presentations on the River

The background reading materials were supplemented by briefings:

- Flagstaff the night before by the trip by Helen Fairley, Ted Melis, and Barb Ralston of GCMRC.

During the first several days of the river trip there were several daily briefings related to the location of the trip:

- The first field briefing was given at Lee's Ferry regarding the day use rafting and angling taking place in the Glen Canyon reach of the Colorado River.
- The second briefing was by Matt Kaplinski (GCMRC) on the GCMRC beach area surveys, and comparison to the GIS maps. The campsite monitoring is done as an add on to the sandbar survey in October. Matt indicated there is no complete inventory of all the beaches in the Grand Canyon.
- The second briefing was by Jeff Behan on defining the recreational resources of the Grand Canyon and the legal mandates to monitor them. Jeff indicated there has been little systematic recreation research on a par with sediment or biology.
- A briefing on the new Grand Canyon National Park River Management Plan was presented by Linda Jalbert of the National Park Service. The discussion focused on managing visitor use in relation to river and camp encounters. The camp encounters are related to beach area available.
- Bo Shelby and Doug Whittaker presented a summary of the research on important attributes of visitor experience such as river encounters, camp encounters, and camp competition. Doug Whittaker stressed the importance of understanding the relative

importance of the many attributes that contribute to high quality overall recreation experience.

- Bo Shelby and Doug Whittaker gave a briefing on important management information needs that could be addressed by a recreation monitoring program. These included integration of data from past visitor experience studies and beach studies, as well as encounter data.
- Helen Fairley provided several briefings including a discussion and tour of the effect of visitor use on protection of cultural resources. She also presented the structure and inter-relationship of GCMRC, AMWG, and TWG.
- A briefing on the adopt a beach program was provided.
- Bill Stewart provided a briefing on the 1997 Grand Canyon boaters attitude and preference study. His research included an analysis of trade-offs of beach attributes of shade, beach size and beach vegetation using a paired comparison approach.
- Matthew Brown of NPS provided a briefing on the NPS Human Impact Monitoring at 46 beaches. He handed out the four page form used by student coders to inventory the site impacts (e.g., litter), campsite capacity and impacts on any cultural resources present at the site.
- Linda Jalbert of NPS discussed the few available studies on visitor safety and boater safety that have been performed of past accident rates and in relation to experimental flows.

The PEP had several independent work sessions during afternoons to sketch out an overall conceptual framework to guide a comprehensive recreation monitoring program, develop a tentative outline, and begin to develop initial priority monitoring recommendations. These were discussed with the entire group and further refined. The PEP also spent one day in Flagstaff to more fully develop the initial recommendations and overall structure of the PEP report. After returning each PEP member researched and expanded their respective sections and provided these to other PEP members to review. The entire document was reorganized and rewritten several times to improve the flow via PEP member rewrites, reviews and conference calls. Once a consensus was reached on the key elements, the executive summary and conclusions were written.