Long Term Monitoring of Camping Beaches in Grand Canyon: A Summary of Results from 1996 – 2001

Annual Report of Repeat Photography
By Grand Canyon River Guides, Inc.[1]
(Adopt-A-Beach Program)

by
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INTRODUCTION

Adopt-a-Beach (AAB) is a program of repeat photography that monitors the condition of camping beaches from year to year. This program is conducted through volunteer efforts and implemented by Grand Canyon River Guides, Inc. (GCRG), a nonprofit, grassroots organization that represents the interests of the Grand Canyon river running community. River guides (including commercial, private, and scientific groups), who work throughout the summer months on the Colorado River, are interested in how controlled-flow releases from Glen Canyon Dam affect beaches that are used for campsites. Furthermore, factors other than controlled flows that might be affecting campsite change are addressed in this study. Throughout the continued period of this program, 1996-2001, guides have observed changes to beaches and have recorded this information through repeat photography and written comments associated with each photograph.

In 1981, the Glen Canyon Environmental Studies (GCES) began under the administration of the Bureau of Reclamation to study the effects of controlled flow releases from the dam on the downstream river ecosystem (U.S. Department of Interior 1987), including effects on sediment supply and recreational resources. Studies of sediment dynamics showed that fluctuating flow releases from the dam have had a degrading effect on sand bar deposits (Hazel and others 1993, Schmidt and Graf 1990) since the closure of the dam. However, beaches can also be replenished by high flows adequate to entrain bedload sand and cause deposition to high elevation areas of beaches (Parnell and others 1997, Wiele and others 1999). Studies of campsite resources demonstrated that impact to sand bars due to erosion decreases the carrying capacity and campable area available for river parties and backpackers (Kearsley and Warren 1993, Kearsley and Quartaroli 1997).

In 1992, the Grand Canyon Protection Act was passed by Congress to ensure that ecological and cultural resources downstream of the dam would be monitored for changing conditions imposed by operations of the dam. The October, 1996 Record of Decision for operation of the dam states that the dam:

> "….must be managed in such a way as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park….were established, including, but not limited to, natural and cultural resources and visitor use" (U.S. Department of Interior 1996).

The Grand Canyon Dam Environmental Impact Statement recommends that scheduled, high-flow releases of short duration be periodically implemented (U.S. Department of Interior 1995). Sand bars form when sediment carried by the river, either from bed load or suspended load, is deposited by the action of eddy currents in recirculation zones. This occurs primarily on the downstream end of debris fans, but also in areas along the river's channel margin (Schmidt 1990). Habitat maintenance flows (HMF) are within powerplant capacity (31,500 cfs), whereas those above this discharge are beach/habitat building flows (BHBF). The former were intended to maintain existing camping beaches and wildlife habitat; the latter to more extensively modify and create sand bars, thus restoring some of the dynamics that resulted from flooding in the ecosystem.

Inception of Adopt-a-Beach was a result of the first scheduled BHBF of 45,000 cfs scheduled for spring 1996. Specifically, the AAB program was launched by GCRG to document the effects of the high flow on camping beaches. Guides photographed beaches and recorded information about changing conditions prior to the high flow, just after the high flow, and throughout the 1996 commercial river season. The overall conclusion of that study demonstrated that the BHBF was highly effective in depositing new high-elevation sand, but that the post-BHBF high steady summer flow schedules caused rampant erosion of sand bars (Thompson and others 1997).

Camping beaches are an important resource for river guides conducting trips through Grand Canyon. Both commercial and private river trips, as well as backpackers, rely on wide sandy areas for camping and recreating. As a way to contribute to resource management, AAB now submits annual results to the Adaptive Management Program. The results and conclusions are synthesized through a representative that serves on Technical Work Group (TWG) board. River guides make the program possible, contributing 100% of the manpower, the entire data set of repeat photographs, and valuable input about the condition of beaches throughout each season and between years. Monitoring includes information on natural and human-induced impacts to beaches such as cutbank retreat, wind erosion and dune formation, rain gully formation and the effects of visitation and camping. The purpose of this report is to present the cumulative findings of data specific to this program up through the commercial boating season of 2001. Furthermore we summarize documented observations by professional river guides.

The river season of 2001 saw only medium and low fluctuating flows with no habitat maintenance f lows or other test flows. Therefore, specific research questions imposed this year only target the longevity of deposits from previous high flows. These questions are as follows:

- How long do small spike flow deposits help maintain beaches and campable area?
- How does the quality of camping compare during Low Steady Summer Flows (LSSFs) to that during medium fluctuating flows?
- What are the main processes causing decreased beach size throughout the summer?
- Is the 1996 flood deposit of 45,000 cfs still present and how has it changed on beaches over time?
- Based on these results, what does the AAB program conclude about future resource management of campsite beaches?

Through analysis of photos and data sheets completed by guides, this report attempts to answer these and other research questions.

METHODS

Data Collection

The primary method of assessing camping beaches in this study is through analysis of repeat photography. During the summer months (April 1-October 31) volunteers (river guides, scientists, GCNP personnel) photograph a specific "adopted" beach every time they pass through the river corridor. Disposable waterproof cameras and data sheets, provided by GCRG, are distributed to all adopters of beaches. At the end of the commercial season (October), guides mail cameras and data sheets back to GCRG for analysis. A qualified scientist, who is active in Grand Canyon issues and is very familiar with AAB study sites, is contracted from year to year to analyze photographs and data, draw up results and offer conclusions to resource managers concerned with recreational and cultural interests in Grand Canyon.

This project allows each participant to take stewardship of a site, and enables him or her to detect ongoing changes over the course of a season. During each visit, guides photograph their adopted beach from pre-established photo locations that provide different views of the beach: specifically, the beachfront and an overview of the camp. In sites where overviews are impossible, a photo location is selected to reveal as much of the camp as possible. In the last 5 years, however, thick tamarisk encroachment has led to recent re-establishment of many photo locations. Re-establishment of photo locations will be on-going as needed, in order to obtain the necessary photo angles.

A data sheet (Appendix A) accompanying each photographed visit allows the adopter to comment on changes to the condition of the beach and the possible causes of changes that are visible. Also included are site location, date, time, and approximate river flow. Photographed visits for each beach average 4 per season. The number of visits for each beach can range from one to eight. Many guides take the initiative to also photograph different episodic events such as debris flow or flash flooding that recently occurred on or near their beach. Such photos can be highly beneficial to many different researchers concerned with monitoring a particular resource at a given area.

The photographs for all beaches of all years have been carefully labeled and are archived at the Grand Canyon River Guides office. Photographs from year 2001 have been archived digitally onto compact discs. Copies of any of these discs can be obtained from the GCRG office.

Information gleaned from photographs and from data sheets are entered into a master database using Access 2000. A crosscheck of the two different sources of information help to fill gaps in data and help to standardize changes from one visit to the next. For instance, if the guide comments do not provide enough information about the site at the time a photograph was taken, the photo is used to assess the site for that visit. If the photo shows very little or no change in the appearance of the beachfront but the guide's data sheet provides enough descriptive information about conditions throughout the site, the comments receive priority. The current Access database contains about 935 records of assessed changes and guide comments for the monitoring years 1996-2001.

Study Locations

Since 1996 the AAB program has studied 43 beaches from within three *critical reaches* of the river corridor (Figure 1). The practice of assessing camping beach resources within critical reaches was first developed by Kearsley and Warren (1993), and modified for the 1996 Adopt-a-Beach study by Thompson and others (1997). A critical reach is defined as a section of the river where camps are in high demand and few in number. The same reach system has been in use for all years of study, 1996-2001. They are as follows: 1) Marble Canyon, river miles 9-41; 2) Upper Granite Gorge, river miles 71-114; and 3) Muav Gorge, river miles 131-165.

Two new critical reaches have been added for the 2002 monitoring season. The purpose is increase the sample set of beaches in order to more widely represent the effects of beach erosion and building throughout the whole river corridor below Glen Canyon Dam. These new reaches now include Glen Canyon, from the dam to Lees Ferry (river mile 0), and Lower Granite Gorge, from Diamond Creek (river mile 226) to Gneiss Canyon (river mile 236). Results from these reaches will be included in the 2002 Annual Report.

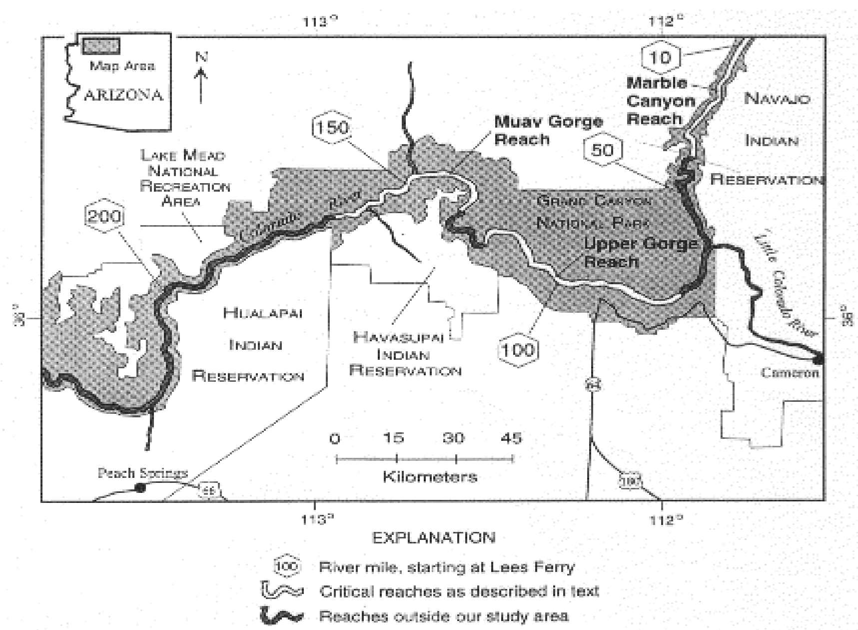


Figure 1. Locations of the three critical reaches in Grand Canyon National Park (after Thompson and others 1997). Each reach contains a sample set of between 12 – 16 beaches.

Table 1 shows all popular campsites (n = 43), inventoried in 1996, that lie within the three critical reaches. Every beach in the inventory has an established photographic location that shows an optimum view of the beachfront and as much of the actual camping area as possible. Each year, GCRG motivates guides to adopt as many beaches as possible. To encourage a relatively complete data set from year to year, GCRG encourages adoption of high-priority beaches (n = 27) first. These beaches have been adopted for most of the study years. Usually, they are camps that can be used year after year by the river community, and thus are continually in high demand. The remaining beaches are adopted once high-priority beaches have been claimed. Low priority beaches have undergone much change and are presently somewhat undesirable for camping. Therefore, these beaches fail to be consistently adopted through the period of study, and have been given lower priority for continued study.

The time-series photos taken within study locations allow assessment of relative change over the course of each season and between monitoring years. Assessment is standardized according to the average fluctuating flow zone of 20,000 cfs (determined by Kaplinski and others 1994). From year to year GCRG assesses change to beach area and campsite space above the 20,000 cfs zone up to the 45,000 cfs zone, the level of the 1996 BHBF. Should any flows exceed 45,000 cfs in the future, GCRG would analyze beach change up to the height of the new deposit or scour line.

Table 1. Original beaches inventoried in 1996 that lie within the three critical reaches. Beaches adopted in 2001 are in bold type (n = 33).

Marble Canyon		**Upper Gorge**		**Muav Gorge**	
Mile	**Camp**	**Mile**	**Camp**	**Mile**	**Camp**
8.0	Badger	**76.6**	**Hance**	**131.1**	**Below Bedrock**
9.0	**Soap Creek**	**84.0**	**Clear Creek**	132.0	Stone Creek
12.2	**Salt Water Wash**	84.5	Above Zoroaster	**133.0**	**Talking Heads**
12.3	**Hot Na Na**	**91.6**	**Trinity**	**133.5**	**Race Track**
19.1	**19 Mile**	92.2	Salt Creek	133.6	Tapeats
19.9	20 Mile	**96.1**	**Schist Camp**	**133.7**	**Lower Tapeats**
20.4	**North Cyn**	**96.7**	**Boucher**	**134.6**	**Owl Eyes**
23.0	23 mile	98.0	Crystal	**137.0**	**Back Eddy**
29.3	Silver Grotto	**99.7**	**Lower Tuna**	**143.2**	**Kanab**
34.7	**Nautiloid**	102.7	Shady Grove	**145.6**	**Olo**
37.7	**Tatahatso**	**107.8**	**Ross Wheeler**	**148.5**	**Matkat Hotel**
38.3	**Bishop**	**108.3**	**Bass**	**155.7**	**Last Chance**
41.0	**Buck Farm**	**109.4**	**110 Mile**	**164.5**	**Tuckup**
75.6	**Below Nevils**	**114.3**	**Upper Garnet**	**166.4**	**Upper National**
		114.5	**Lower Garnet**	166.6	Lower National

Each year, data are grouped according to the particular research questions asked for that year. For each year, data are grouped into two time periods: (1) summer season, beginning on April 1st and ending October 31st; and (2) winter season, the intervening period that begins November 1st and ends March 31st. Data are also categorized according to critical reach in order to rank which reaches show more change over time. In order to determine longevity of the BHBF flood deposit, beach area at the end of summer season is compared to its pre-BHBF area. Finally, an attempt was made to summarize guide comments about the changing quality of campsites into a rudimentary camp quality index. However, most guides neglected to comment consistently on vegetation encroachment, boat parking, steepness of slope for camp access, and rockiness. Therefore an overall qualitative assessment was determined from photographs.

Relative changes as seen either in the photos or written on field data sheets were categorized according to increase, decrease, or no change with respect to the previous visit. Changes pertain to the whole beach as delimited in the photo frame, using individual physiologic features of that beach as references for comparison. Individual factors (see Appendix A) affecting camp quality changes are recorded as better, worse, or the same.

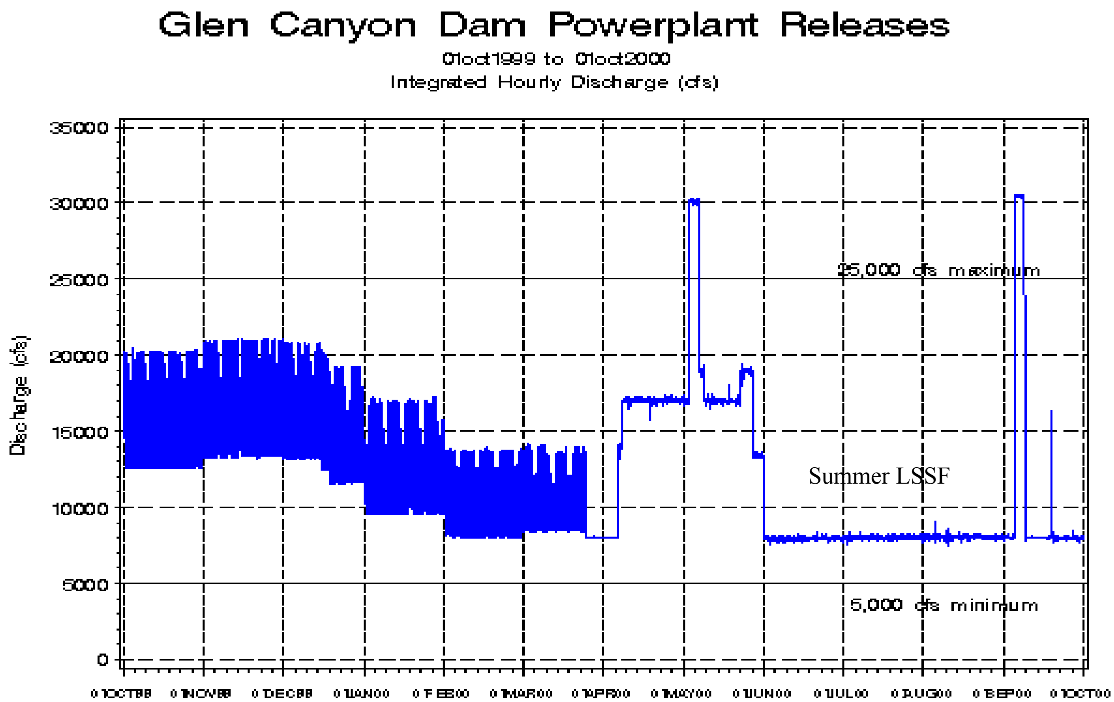


Figure 2. Hourly flows released from Glen Canyon Dam for water year 2000 (October 1, 1999 – September 30, 2000). Graph shows the LSSF bracketed by the spring and fall HMFs.

For the river season of 2000, photos of beaches that immediately preceded and followed each HMF (Figure 2) were assessed for changes. During the LSSF, changes were assessed separately. Since n values were different for each category, percent of beaches were used. Therefore, comparisons between time periods and between critical reaches could be standardized.

Water year 2001 showed medium fluctuating flows, with no high flow spikes in the hydrograph (Figure 3). Any beach change through 2001 was assessed along with this hydrograph along with average daily flows.

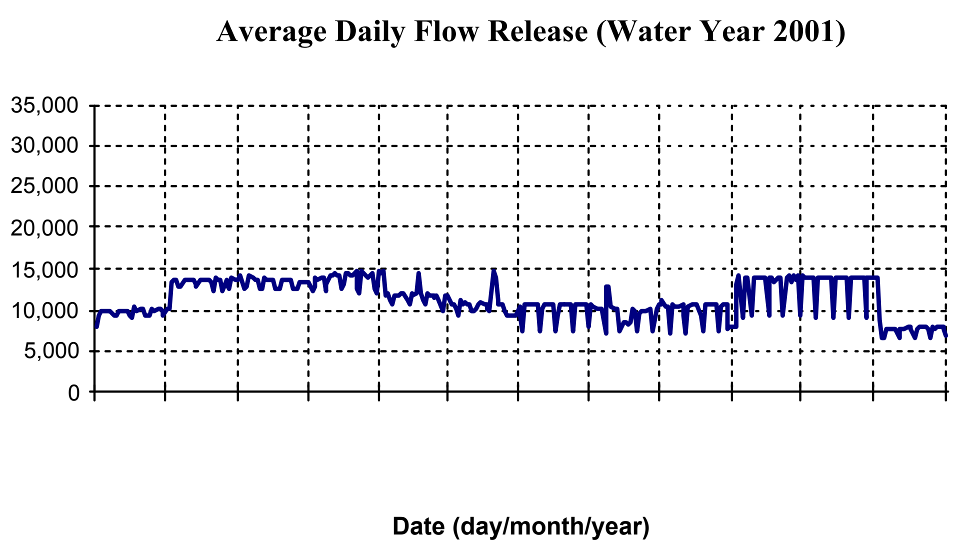


Figure 3. Average daily discharge from Glen Canyon Dam for water year 2001 (October 1, 2000 – September 30, 2001).

RESULTS

The number of adopted beaches with useable data totaled 33 out of the 38 beaches that were originally adopted for the river season of 2001. This number is similar to that in year 2000, for which 34 beaches were analyzed. The number of records entered in the database for the river season of 2001 totaled 132, which is a slight decrease in monitoring participation compared to year 2000.

Each record represents an individual visit to a beach and has 1-5 photos associated with it. As encouraged by other Grand Canyon researchers, several adopters took extra snapshots of various episodes such as flash flooding in Last Chance Camp (August 2001) and debris flows at Hot Na Na (July 2000). These documented events and data are available to any interested researchers through Grand Canyon River Guides or Grand Canyon Monitoring and Research Center.

Results of the Winter Season (November 1, 2000 to March 31, 2001).

In order to fill gaps between time periods of each river season, we assessed winter season change. The visible change to beaches is documented by comparing the last photo of the previous river season (usually in October) with the first photo taken the following spring (usually in April or May). Processes, such as erosion from rainfall or fluctuating flow, are often visible in the first new photo of the river season. Erosion from camping is either non-existent or minimal due to the "off-season" of river traffic. The category "Don't Know" is recorded for those beaches whose photos or data could not be interpreted.

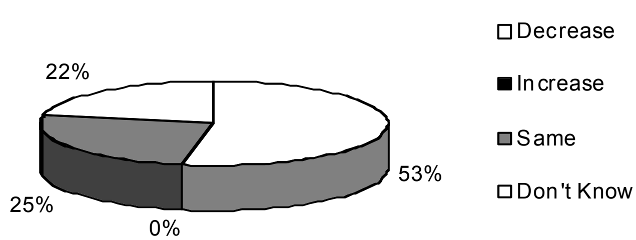
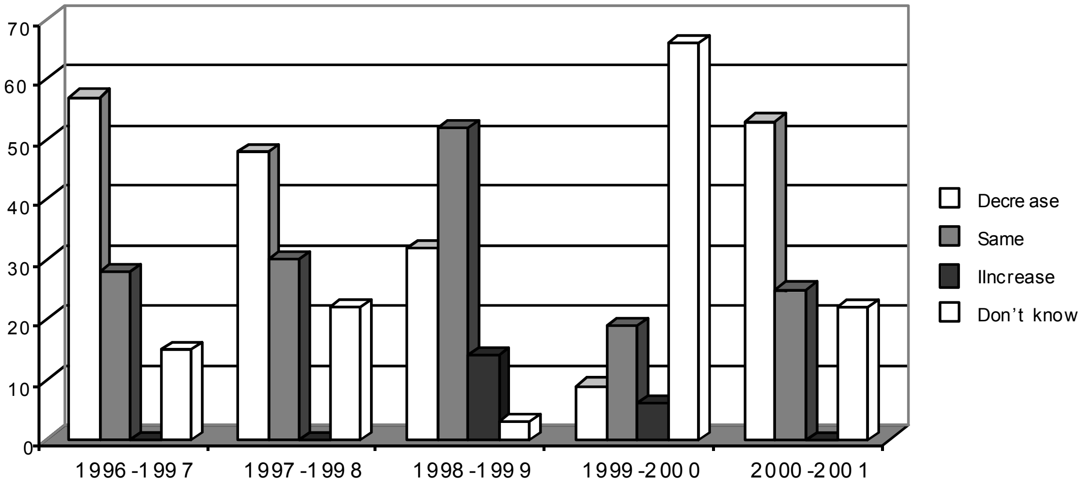


Figure 4. Percent of beaches (n=32) showing change over the 2000-2001 winter season.

Out of 32 beaches for which data was recorded, 53% showed a decrease, 0% showed an increase, and 22% showed no change (Figure 4). Over 25 sampled beaches showed a series of cutbanks at the beachfronts in the first set of 2001 photos. These same beaches lacked the extent of cutbank erosion as seen in the fall 2000 photos. This implies that most change to beach area was due to a changing flow regime over the winter months. Figure 3 shows a 5,000-cfs increase in fluctuating flow from November 2000 through March 2001. This small increase in flow for over 4 months was enough to scour away most of the fall 2000 HMF deposit at the beachfront. Higher elevation sand (above the 30,000 cfs line) appears to have been reworked by wind and incorporated into the 1996 BHBF deposit. Only 4 beaches showed effects from rainfall, but their beach sizes remained the same. Process of erosion could not be determined for two of the



beaches.

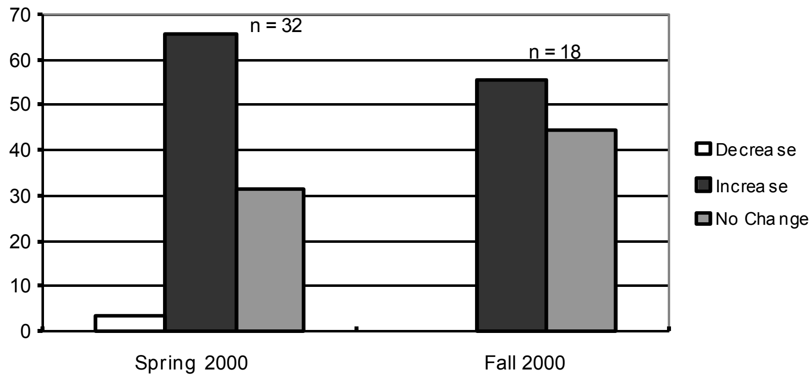
Figure 5. Comparison of change observed after each winter season, 1996-1997 through 2000-2001.

Figure 5 compares the percent of beaches that changed for each of the study years during the winter period. The trend demonstrates that the number of beaches decreasing in size from winter events, whether a result of fluctuating flow or rainfall, has continually fallen off until the spring 2000 HMF. The declining rate of decrease exemplifies the initial rapid adjustment of newly aggraded bars to relatively normal dam releases following the 1996 BHBF. This data agrees with that of Hazel and others (2001), where sand bar thickness has been decreasing every year since 1996, but at a decreasing rate.

The number of beaches decreasing in size then rose again dramatically in winter of 2001, 7 months after the fall 2000 HMF. This repeated pattern is a testament to widespread erosion that follows a bar-building episode.

Longevity of the Habitat Maintenance Flows

Two spike flows of 30,000 cfs were released from Glen Canyon Dam for four days in early May 2000 and again in September 2000 (Figure 2). Both flows showed similar results where an average of 60% of beaches increased in size (Figure 6). The Spring HMF increased area to a few more beaches, probably because antecedent long-term erosion had created more accomodation space for deposition compared to antecedent conditions for the Fall HMF. Most beach area was gained at the beachfront for both HMFs. Deposition from the HMFs increased beach elevation at most by approximately 0.1 meters on the higher elevation bars up to the 30,000 cfs line. When the two HMFs were compared by reach, most beaches in Muav Gorge benefited over the other reaches. The net increases to Muav Gorge beaches may be a result of greater sediment supply due to two factors: (1) distance below the Little Colorado River (Schmidt 1990, Webb 1996) where cumulative inputs from this tributary benefit downstream



reaches in Grand Canyon; and (2) upstream erosion of beaches in Marble Canyon and Upper Gorge that ultimately benefit beaches located further downstream (Hazel and others 2002).

Figure 6. Number of beaches showing change due to the spring and fall HMFs.

Photos taken in fall 2001, compared to those taken shortly after the fall 2000 HMF event, show little to no evidence of the HMF deposit remaining. Only 11% of beaches showed evidence of this deposit. It appears that either the deposit had been mostly scoured away or the deposit is now too insignificant in size to be detected in many of the photos. This evidence supports the preliminary conclusion that the HMF deposits only last as long as flows remain very low (Thompson 2001, Hazel and others 2002). Otherwise, the HMF deposit is eroded away within a few months to a year after its emplacement.

Longevity of Beaches Since the 1996 Beach/Habitat Building Flow

The success of the Beach/Habitat Building Flow of 1996 demonstrated the need for periodic beach building for maintaining the campsite beaches in Grand Canyon. Over 25,000 river runners and backpackers to the Colorado River in Grand Canyon rely on these campsites for recreation. In March 1996, Glen Canyon Dam released a flow of 45,000 cfs in order to suspend sediment stored in eddies, and deposit it to high elevation sand bars. While this test flood flow benefited a large majority of campsites in Grand Canyon (Kearsley and Quartaroli 1997, Thompson and others 1997), it mined out lower elevation bars and sediment in the river channel due to its long duration (Topping and others 2000). A multitude of sediment studies determined that future BHBFs can be extremely beneficial if the duration of the high flow release is limited to 48 hours and if the Colorado River has received recent sediment inputs from the major tributaries (Rubin and others 2002, Lucchitta and Leopold 1999, Topping 1997).

Today, the persistence of this deposit is of great interest to resource managers and users of these high elevation bars. Each year, end-of-season photos are compared to pre-BHBF photos (taken in March 1996) to determine if any sites have returned to their original pre-BHBF condition. In a few cases, sites appear to have lost more area compared to its pre-BHBF condition.

Figure 7 shows a trend in which the percentage of beaches returning to the pre-BHBF condition have continually increased until year 2000, when the HMF of 30,000 cfs was imposed. This increase is especially prevalent in 1999, at which point 58% of beaches had returned to the pre-BHBF condition. The HMFs in year 2000 improved area for 80% of beaches. However, sand replenished to this deposit mostly affected low-elevation bars, as the spike flows were limited in stage height. By fall 2001, erosion had progressed to the point that 45% of beaches had returned to their pre-BHBF condition.

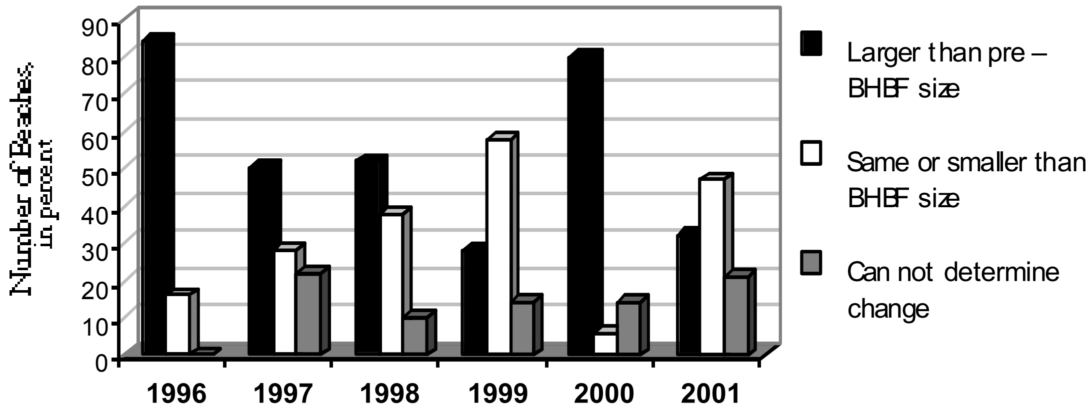


Figure 7. Relative size of beaches for each year compared to their pre-BHBF 1996 size. Comparisons were made using end-of-season photos for each year compared to February 1996 photos.

Processes Causing Decreased Beach Size

In order to determine primary causes of erosion, various processes causing beach change, whether erosional or depositional, were recorded via guide comments and analysis of photographs. Morphological characteristics were recorded as outlined on the data sheet in Appendix A. One primary and one secondary cause were identified for each visit per site.

Figure 7 shows all identifiable processes that contribute to change on beaches. No depositional processes occurred throughout the 2001 river season. Erosional processes were primarily from medium fluctuating flows throughout the months of July-August and secondarily flash flooding from rain during the monsoon season. Beaches impacted by fluctuating flows showed progressive cutbank retreat through the month of August. Beaches impacted by rain showed loss in area due to gullies or rock and gravel influx. Erosion from people and wind were less significant, although impacts were seen on most beaches.

In isolating processes from reach to reach, impacts from fluctuating flows were most evident in Muav Gorge. This reach contained the most beaches that benefited from the HMFs of 2000 and therefore showed the most change during the 2001 season. Conversely, Marble Canyon did not benefit as much from the HMFs and therefore showed little relative change,.

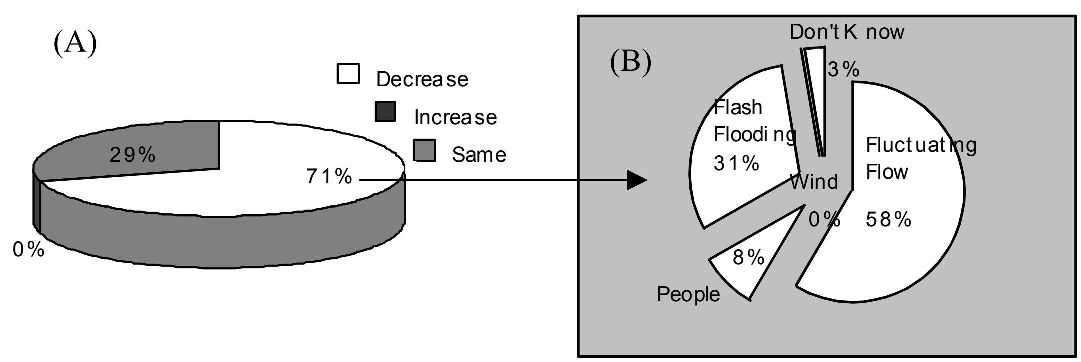


Figure 7. (A) Percent of beaches showing change throughout the 2001 river season. (B) Percent of beaches negatively impacted by a dominant process.

Camping Quality

During the Low Steady Summer Flows (LSSFs) of year 2000, guides responded that many small new beaches, upstream and downstream of their adopted beach, became available for camping. Also, adopted beaches such as Clear Creek, Olo, and Talking Heads (all of which are mostly under water at higher flows), again became useable camps under the LSSF. Available campsite space and ease of using a beach for camping, a collective term referred to as "campability," was assessed for change throughout the season. With the onset of the LSSF after the spring HMF (Figure 8(A)), 51% of beaches showed "much improved" campability, according to guide responses. These camps contained more sandy beachfront property, decreased rockiness for better boat parking, or a relatively flat bench for kitchen set-up and camping. The rest of the sampled beaches remained either the same for useable space or became more inaccessible due to increased rockiness for boat parking.

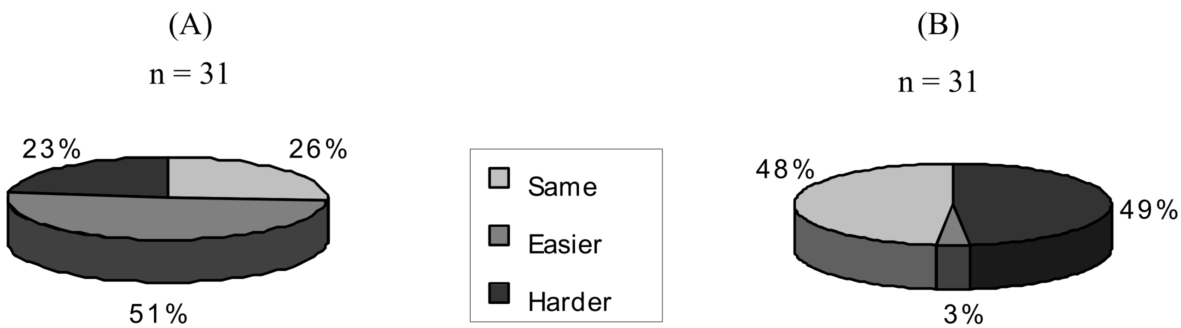


Figure 8. Campability during: (A) the LSSF- first response by guides with the onset of the LSSF; and (B) river season 2001 – the first response of the season by guides

Campability throughout the 2001 season was much harder compared to the 2000 season, according to guide responses (Figure 8(B)). Flows during the summer of 2001 fluctuated between 7000 and 14,000 cfs, which decreased camping area and rendered the lower benches useless. Several complaints were recorded that beaches had returned to their previously rocky state as that before the HMFs.

Several factors that contribute to campsite quality were included as questions on the 2001 data sheets (Appendix A). Unfortunately, most guides neglected to report on the changing quality of camping throughout the season. Only a few remarks were recorded regarding increasing tamarisk encroachment and the increased presence of red ants at some campsites. Increasing vegetation can be clearly seen at most campsites in the photos from year to year. However, further analysis and funding would be needed to determine the relative rates of vegetation encroachment on campsite area over time. This could be accomplished using the existing AAB photo archive that covers years 1996 to present.

CONCLUSIONS

Results of this study since 1996 show that beaches have continued to decrease in size, system-wide even after the HMFs of 2000. Over years 1996-1999, the net effect of controlled flow releases from Glen Canyon Dam resulted in the continued winnowing of beachfronts, cutbank retreat, and loss of camping areas. Most negative impacts from fluctuating flows were reported in 1997 (O'Brien and others 2000). Erosion to beaches through years 1998-1999 continued, but effects were not as profound. This decreased magnitude of change through the years since 1996 reflects two geomorphic processes: (1) the increased stability of beach fronts as they attain an angle of repose, and (2) decreased amounts of sediment that can be eroded from beaches (O'Brien and others 2000, Hazel and others 2002). By fall 2001, most beaches that had initially gained area from the HMFs of 2000 had returned to their 1999 condition.

Many factors are contributing to long-term erosion of these beaches. Primarily, erosion from medium and high fluctuating flows that contain low sediment concentrations have resulted in conditions that are similar to those before the BHBF of 1996. Secondary processes contributing to erosion are listed here ranked according to magnitude of impact: (1) gullying and flash-flooding from rainfall; (2) beachfront erosion from campers; and (3) wind deflation. Some campsite area loss is due to encroachment of vegetation, mostly tamarisk.

Campsite area and quality can be greatly enhanced by implementing BHBFs well above power plant capacity, given there is available sediment inputs from the Paria and/or Little Colorado Rivers (Lucchitta and Leopold 1999, Hazel and others 2002, written responses by Grand Canyon river guides 2001). Over 80% of guides agreed that camping (useable space and quality) had improved dramatically during the LSSF that followed the spring HMF 2000. Moreover, camps that would normally be under water became available for use. By spring 2001, most guides reported worse camping conditions. This is attributed to relatively higher fluctuating flow zones on beaches, rendering the lower camping area useless, and eroded beachfronts that presently expose rocks.

The results of 6 years from this monitoring program show that the BHBF of 1996 was the most beneficial management action for replenishing and rebuilding beaches for campsite use. All other subsequent test flows produced small new deposits that only lasted for 7-12 months, at most. These results suggest that any newly deposited sand within power plant capacity will be quickly eroded if followed by medium or high fluctuating flows released from Glen Canyon Dam. This was evidenced by 3 events: (1) High fluctuating flows (of about 27,000 cfs) following the 1996 BHBF eroded much of the new deposit at all beach sites through the summer of 1996 and 1997; (2) High fluctuating flows following the fall HMF of 1997 stripped away the new deposit entirely by spring 1998; and (3) Medium fluctuating flows following the fall HMF of 2000 eroded most of the new deposit by spring 2001. To date, about 30% of beaches show evidence of high-elevation sand (above 30,000 cfs line) deposited by the 1996 BHBF. However, the amount of sand appears to be diminishing year after year.

Annual implementation of HMFs in spring and in fall would help preserve camping beaches by maintaining the beachfront. A regimen of BHBFs that exceed power plant capacity followed by low fluctuating flows is needed periodically to rebuild campsite areas above the 30,000 cfs line. However, future BHBFs need to have enough sediment in the system so as to preserve Marble Canyon beaches and lessen impacts on lower beach areas (below the 20,000 cfs line) systemwide.

Acknowledgments

Grand Canyon River Guides, Inc., would like to thank first and foremost the adopters for volunteering the time to pull over and photograph their beaches trip after trip and year after year, and for their valuable written observations and comments. It takes time and effort to do this, and the dedication shown by guides has literally kept this program alive for six years. The result is the most comprehensive collection of repeat photographs of critical camping beaches in existence for Grand Canyon. An added benefit is the outreach to the public about this effort, and how our resource in Grand Canyon is affected, degraded or maintained by the influence of man and technology. Special thanks go to Lynn Hamilton for exhaustive work in support of this project; Abigail Sullivan for her persistence in scanning photos and helping to re-establish new photo sites in Grand Canyon; Andre Potochnik for his continued hard work as GCRG's (and therefore, this project's) representative of recreational interests in the Adaptive Management process; Matt Kaplinski for sharing results and playing advisor to the Technical Work Group. Finally, big thanks go to our contributors: the Grand Canyon Monitoring and Research Center and the Grand Canyon Conservation Fund.

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