Adopt – A – Beach:
Long-Term Monitoring of Camping Beaches in Grand Canyon

Summary of Results for Year 2008

Introduction and Methods

The Adopt-A-Beach (AAB) program has now completed its thirteenth year as a study that monitors camping beaches along the Colorado River in Grand Canyon. This program, sponsored by Grand Canyon River Guides, Inc., is implemented by a 100% volunteer group of river guides, scientists and NPS personnel. Results are submitted to various agencies such as the Cultural Resources Program of the Grand Canyon Monitoring and Research Center (GCMRC). Results are also presented to the Adaptive Management Program so that private and commercial recreational interests are represented as stakeholders in Colorado River management as reported to the Secretary of the Interior.

Methods implement repeat photography and observational comments that document a selected set of camping beaches in Grand Canyon. Data collection is usually conducted from April through October of the year, though data has been gathered in January and through December in some years. The selected beaches are categorized as belonging within one of four different critical reaches within the river corridor (Marble Canyon, the Upper Granite Gorge, the Muav Gorge and the Lower Granite Gorge). A critical reach is defined as an extended area in which camping beaches are sparse, small, and/or in high demand.

The program assesses visible photographs and first-hand, objective comments pertaining to changes to beaches, as influenced by regulated flow regimes, rainfall, wind, vegetation and human impacts. Volunteers for this program are unique in that many run the Colorado River more than once in one season, and are able to provide sets of repeat photographs and on-the-spot comments for each study beach. To date, river runners have produced more than 2300 repeat photographs and associated field sheets recording the sequential condition of beaches. Research results include reporting positive and negative or that no changes were found in beaches; longevity of the Beach Habitat/Building Flows (BHBF) and High Experimental Flow (HEF) deposits; and primary and secondary processes that cause change in camping beach area and quality.

Results and General Conclusions

Results of this study show that beaches, when compared to the Pre-1996 BHBF beaches, responded favorably to the 2008 BHBF. As of the end of 2008, 8 of 24 (33%) of the beaches reviewed were classified as being degraded compared to the same beaches examined from 1996. While 5 of 24 (21%) are reported as unchanged, 11 of 24 (46%) are currently considered more desirable in camp utility. The 46% reported as being in a condition preferable to the 1996 beaches is an increase over the past four years of analysis. Most importantly, this is the first time in at least the last four years that the BETTER rating has exceeded the WORSE classification (Thompson and Pollock, 2006, Lauck, 2007 and 2008).

The factor sited as being the primary contributor of long-term erosion is fluctuating flows that contain low sediment concentrations. This is especially evident for a period immediately following a BHBF or HEF event. This is followed by a decreased magnitude of change that 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 (Thompson, 2004, Lauck, 2008). The angle of repose is achieved as the beach recedes to a point static with the erosive force of the water. This recession is directly related to the amount of river flow and the geography of the surrounding canyon near an individual beach. While this remains true, beach front scour during the 2008 BHBF can be attributed as an important acerbating factor for perhaps three of the beaches considered as degraded since 1996.

Independent of low sediment concentration flows is the loss of camp area at a beach through the action of rain created gullies or flashfloods. Severe impact by rainfall funneled onto a beach by tributaries or the surrounding rock walls is recorded in at least 2 instances during 2008, and has been the second most often cited cause of erosion in the three previous years of study (Thompson and Pollock, 2006, Lauck, 2007). Unlike the decrease in magnitude of erosion from fluctuating flows, flash events are less predictable in their frequency and vary considerably in their effects. Any single event can prove devastating to a beach, as happened at Olo, RM 146.1L in 2008 and previously, and the erosion effects appear to be accumulative, as was experienced at Matkat Hotel, RM 148.9L in 2006, 2007 and 2008.

Vegetation encroachment is often a less dramatic and a less frequent factor in beach change, though reduced camp area and camp desirability due to vegetation, particularly arrowweed and camelthorn, are commented on by adopters. However, camp area lost to vegetation spread through 2008 was readily evident, particularly on beach deposition specifically related to the BHBF.

Changes in beaches due to eolian action is another of the lesser emphasized contributors to beach adjustment. Though not cited as a cause for change in beach classification during this study, sand removal and repositioning on beaches by wind was discernable. Dune buildup was noted with concern by volunteers on two beaches. Human impacts, specifically urine and trash found, were also more pronounced as secondary factors in comments from volunteers this year.

For the year 2008 specifically, the March BHBF resulted in beach improvement on 28 of 41 (68%) beaches examined, 5 (12%) showed no significant change, and 8 (20%) were reported as degraded compared to late 2007. Of the 44 beaches included in the AAB archive, 34 were analyzed throughout the year 2008, with 2 (6%) improving, 17 (50%) were found to be relatively unchanged, and 15 (44%) degraded between the first and final photos of the year.

The data accumulated for 2008 emphasize the need for continued BHBF events whenever the sediment load available in the system allows, followed by low fluctuating flows. The flows that exceed power plant capacity are vital in replacing beach areas above the normal dam release flow line where sand has been removed by flash floods and wind, for restoring beach fronts eroded by river and wave action and to help mitigate the effects of vegetation encroachment and human impacts.

For questions or comments please contact Paul Lauck or Lynn Hamilton at Grand Canyon River Guides, Inc., Flagstaff, Arizona (928)-773-1075.

INTRODUCTION

In 1981, the Glen Canyon Environmental Studies (GCES), under the administration of the Bureau of Reclamation, began to study the effects of controlled flow releases from the dam on the downstream river ecosystem (U.S. Department of Interior 1987). Included in this study were 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 the 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 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 power plant capacity (31,500cfs), whereas those above this discharge are described as Beach/Habitat Building Flows (BHBF) or High Experimental Flows (HEF). 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.

The Adopt-A-Beach Program (AAB) was begun in the Spring of 1996 as a means to monitor the condition of camping beaches along the Colorado River in Grand Canyon through repeat photography. Implemented by the Grand Canyon River Guides, Inc., (GCRG) a nonprofit, grassroots organization that represents the interests of the Grand Canyon river running community, this program is conducted by the volunteer efforts of river guides (including commercial, private and scientific groups) who travel by boat on the Colorado. Those who run the river are interested in observing how dam controlled flows, rain and wind created erosion, human use and other factors impact the camping beaches along the Colorado. These factors have been addressed throughout the continued period of this study, 1996-2008, as river runners have observed changes to the beaches and have recorded this information through repeat photography and written comments associated with each photograph.

Inception of Adopt-A-Beach was a result of the first BHBF of 45,000 cfs in the Spring of 1996. Specifically, the AAB program was launched by GCRG prior to the BHBF to document the effects of the high flow on camping beaches. River runners photographed and recorded information about changing conditions prior to the high flow, just after the high flow, and throughout the 1996 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 parties conducting trips through Grand Canyon. Both commercial and private river trips, as well as backpackers, rely on wide sandy areas for camping and recreation. 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 the Technical Work Group (TWG) board. Professional river guides and other river runners make the program possible, contributing 100% of the manpower, the entire dataset 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 through the commercial boating season of 2008.

A flow regime known as the Winter High Fluctuating Flow (WHFF), or Trout Suppression Flow (TSF) for one of its intended aims, was implemented from December 1, 2007 through February 1, 2008. This high fluctuating flow schedule was resumed in mid-April and daily release fluctuations gradually increased through September 1, with daily flows averaging between approximately 9000+ cfs and 17000+ cfs. Steady flow activities were conducted through September and October of 2008.

Specific research questions posed for the two years in the current study target:

- What changes in beaches occurred between the March Beach Habitat/Building Flow and late fall months of 2008?
- How did the beaches respond to the March Beach Habitat/Building Flow?
- How do the beaches compare between the end of 2008 and late 2007?
- How do the beaches compare between the end of 2008 and immediately preceding the 1996 flood?
- How does the beach response from different experimental high flows compare?
- Which processes resulting in change were most prevalent?
- Were there differences in these results per each critical river reach?
- 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 the guides, this report attempts to answer these questions.

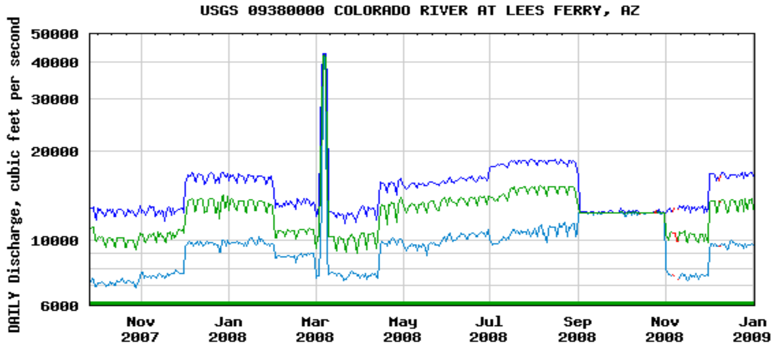
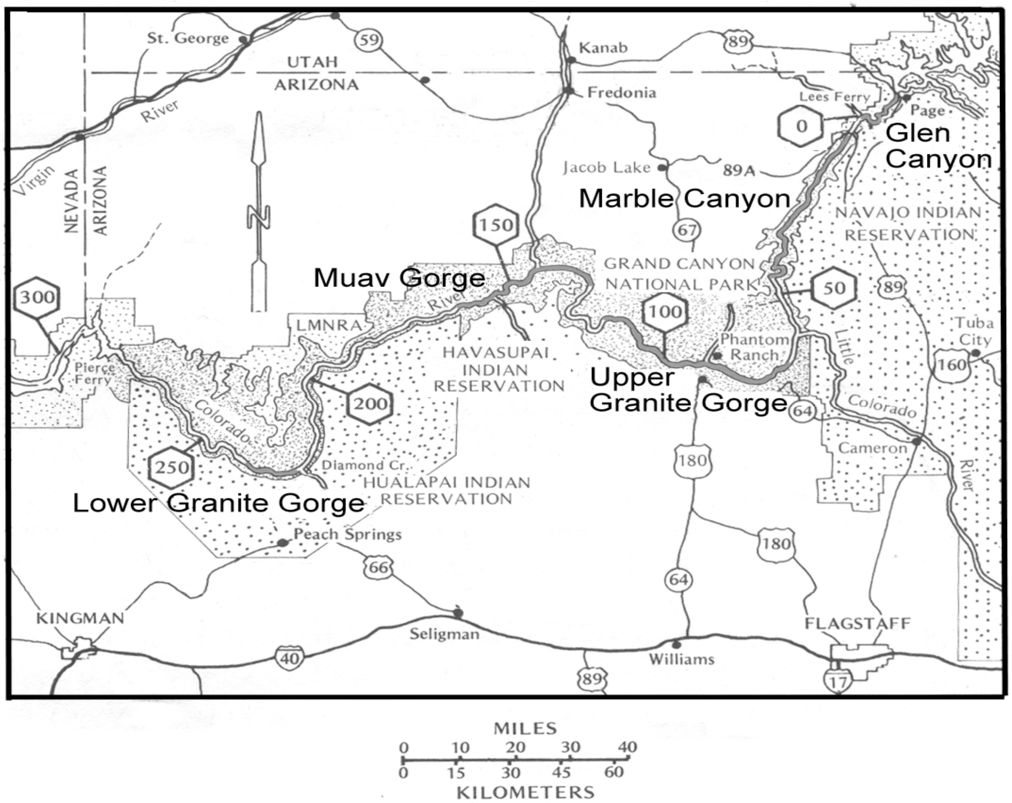


Figure 1. Streamflow graph for Lees Ferry, AZ, October 2007 to January 1, 2008 From USGS Real-time streamflow website.

Study Locations

Since 1996 the AAB program has studied an average of 38 beaches per year 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, 1996-2008. 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 were added for the 2003 monitoring season. The purpose is to 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 included 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). Unfortunately, no data was available for the Glen Canyon reach for this report, but the Lower Gorge reach is included.



Defines a critical reach for campsite beaches along the Colorado River

Figure 2. Locations of five critical reaches in Grand Canyon National Park.

Table 1 shows popular campsites (n = 44), many of which were originally inventoried in 1996, and include beaches added in 2000 and 2001. 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.

The number of adopted beaches with useable data in 2008 totaled 41. 2007 had a 100 % adoption rate, with 44. Each record in the data base represents an individual visit to a beach where each beach 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 Schist Camp (August 2002) and 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. Part of the Adopt-A-Beach program is to provide photos of unusual natural events in Grand Canyon to interested parties.

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 highest average fluctuating flow of the season and to a zone of 20,000 cfs when comparing 1996 photos (determined by Kaplinski and others 1994).

From year to year GCRG assesses the number of beaches that change in size and evaluates campsite space up to the 45,000 cfs zone, the level of the 1996 BHBF.

Glen Canyon		Marble Canyon		Upper Granite Gorge		Muav Gorge		Lower Granite Gorge	
Mile	Camp	Mile	Camp	Mile	Camp	Mile	Camp	Mile	Camp
-13.0	Dam Beach	11.3	Soap Creek	76.0	Nevill's	131.7	Below Bedrock	230.6	Travertine
-8.0	Lunch Beach	12.4	12.4 Mile (Salt Water Wash)	77.1	Hance	132.5	Stone Creek	236.1	Gneiss
		16.6	Hot Na Na	81.7	Grapevine	133.7	Talking Heads		
		19.4	19.4 Mile	84.6	Clear Creek	134.2	Race Track		
		20.7	North Cyn	85.0	Zoroaster	134.5	Lower Tapeats		
		22.7	Indian Dick (23 Mile)	92.1	Trinity Creek	135.2	Owl Eyes		
		29.5	Shinumo Wash (Silver Grotto)	96.6	Schist	137.8	Back Eddy		
		35.0	(Middle) Nautiloid	97.3	Boucher	144.0	Kanab		
		35.1	(Lower) Nautiloid	98.7	Crystal	146.1	Olo		
		37.9	Tatahatso	100.2	Lwr Tuna	148.9	Matkat Hotel		
		38.6	Martha's	108.3	Ross Wheeler	150.9	Upset Hotel		
		41.2	Buck Farm	109.0	Lwr Bass	156.3	Last Chance		
				110.0	110 Mile	165.2	Tuckup		
				114.9	Upper Garnet	167.0	Upper National		
				115.1	Lower Garnet	167.2	Lower National		

Table 1. Sample set of camping beaches inventoried that lie within five critical reaches.

Analysis

Data are analyzed according to the particular research questions asked for that year. For this study, the data are grouped into five temporal categories, the first beginning immediately after the March BHBF and ending in October 2008. The second category considered the beach response as a direct result of the March 2008 BHBF, and compared the initial 2008 data to the latest images and comments acquired in 2007.
The third category of analysis compared the last photo date of the years 2008 and 2007. The fourth category of analysis utilized the final photo data collected in the year 2008 and compared it to the earliest data available in 1996. And finally, a fifth category analyzed the relative affects of different high-flow events.

When comparing the photos for evaluation, 8 criteria were used to gather the empirical data used. These included estimating the river flow in each of the photos, usually confirmed by flow data available through the Grand Canyon Monitoring and Research Center (GCMRC) website, and standardizing the beach configuration to the highest dam release summer flow, just over 16,000 cfs. Also considered was any evidence of any flattening, mounding or scouring of sand in the photos, a change in area of sand cover between photo dates, vegetation cover, rocks covered/uncovered by the flow changes or wind action that would indicate a change in camping area, a change in the loading/unloading areas used by river parties who stop to lunch or camp at the beach, and comments made by the AAB photographer on the datasheet when the photo is taken. Due to the variety of river flow levels between the comparison photos, change in the 'parking' at a particular beach was usually difficult to evaluate, and often was considered only when recorded by the AAB observer. Knowledge of the study sites by this investigator were also considered, though this did not determine the final classification used for any particular beach. Using these criteria, the beaches were given classifications indicating sand deposition as Increase, Decrease or No Change. If 2 or 3 of the criteria, depending on the significance of the observation, indicated a change in the beach condition between the photos, the beach was classified as either “Better camping”, or “Worse camping”. Otherwise, a classification of “Same” was used for that beach. While the designations of Same, Better and Worse are inherently Subjective, the results are reflective of the stated evaluation purpose of determining the beach as a useable camp for river trips. This should not be interpreted in any way that results were obtained using anything other than Objective evaluation.

Results of this classification process are presented in tabular format. See Tables 2 & 3 in the Appendix B

RESULTS

Analysis of Beach Stability Through the 2008 Season

Of the 44 beaches currently considered in the AAB Project, 34 (77%) were photographed both early and late enough in the year to be included in the analysis for change throughout the 2008 boating season. Almost all of these beaches were photographed in the two weeks immediately following the end of the March BHBF, and most had photographic and written data gathered into September.

Two (6%) of the 34 were designated as having improved by the end of the 2008 analysis period. The beach at Grapevine Camp (RM 81.7, Reach 2) was considered BETTER because of slumping sand banks that improved the upstream boat parking area, and some rocks at the Upper National Camp (RM 167,Reach 3) beach parking were covered, possibly by a late season sediment flow. Also, a non-BHBF related sediment flow partially improved the beach at Soap Creek (RM 11.3, Reach 1), but not sufficiently to garner a BETTER status rating.

Of the 34, 15 (44%) degraded through the summer enough to receive a WORSE rating. There were 3 (20%) located in Reach 1, 5 (33%) in Reach 2 and 7 (47%) are in Reach 3. All 3 beaches designated as WORSE in Reach 1 had fluctuating flows as the primary degradation factor, with one vegetation increase and one rain caused erosion each mentioned as secondary factors. In Reach 2, the primary reason for the WORSE rating was again river fluctuation, at 4 beaches. Vegetation encroachment was sited as the primary reason at Nevill’s (RM 76, Reach 2). Rain events, vegetation, fluctuating flows and human impact were all noted as secondary factors, and, while human waste, trash and vegetation destruction did not suffice to change any camp rating in the study, it was listed as a contributing degradation factor at least twice. Note that the human impacts at the beaches could only be accounted for through the comments made by the volunteer photographer on site. Reach 3 had 4 beaches affected mostly by fluctuating flows, 1 beach was designated as WORSE due to vegetation increase, and 2 received WORSE ratings primarily due to rain erosion impact. Rain and fluctuating flows were also noted as secondary factors at more than half of the Reach 3 beaches.

Seventeen (50%) of the 34 beaches received a SAME designation. These beaches did not display enough detectable change to be considered either BETTER or WORSE. These were fairly equal in Reach distribution, with 4 in Reach 1, 6 in both Reaches 2 and 3, and one (the only beach with data) of the two beaches in Reach 4.

From a different and perhaps more important perspective, 9 of the 17 beaches receiving a rating of SAME at the end of 2008 are still considered BETTER or IMPROVED as a result of the March BHBF. Put another way, of the 28 beaches considered to be BETTER due to the high flow, 32% maintained or improved in this status through the 2008 season. This will be further explained in a following section.


Figures 3 & 4. ***Mid-April and Mid-October views of the camp at Shinumo Wash, RM 29.5 L***

Analysis for Pre Summer Seasonal Flows for 2008

No photos were acquired for 2008 which pre-dated the March BHBF. As a result, no analysis of the impacts from the Winter High Fluctuating Flows was attempted.

Analysis of the Effects of the March 2008 Beach Habitat Building Flow

The effects of the March 2008 BHBF of 41,000 cfs were pronounced on all but 5 (12%) of the 41 beaches included in this analysis. Only three of the 44 AAB beaches could not be considered in this portion of the study, two which were not adopted in 2008 and one because it was not photographed in 2007.

So, 5 received a rating of SAME after the BHBF was concluded. Two each are in Reaches 2 and 3, with one, Travertine Falls (RM 230.6) located in Reach 4.

A total of 8 (20%) were given a WORSE rating as a result of the high water. The primary reason for the degradation was equally divided between beach-front scour exposing rocks at the boat landing area and removing camp area, and the resulting severe steep grade of the beach both at the landing area and in camp. An increase of sand in a camp, without an increase in camp area or utility, was usually offset by these overriding factors. Four of these beaches were located in Reach 1, with 2 each in Reaches 2 and 3.

Figure 5. Low flow parking at Crystal shortly after 2008 BHBF.

In counterpoint to the WORSE designations, 28 (68%) of the 41 beaches were improved enough by the BHBF to be regarded as BETTER by this study. The most common result of the BHBF was an increase in camp area and improved boat parking through sand deposition, with vegetation being covered or removed also noted. Between one quarter and one half of the beaches sited with camp area increase were attributed to rain erosion gullies being filled and smoothed. Of the 28, 7 were located in Reach 1, 9 in Reach 2, a total of 11 were found in Reach 3 and one, Gneiss (RM 236.1) was located in Reach 4.

As noted in a previous section, 8 (29%) of these beaches maintained a stable condition through the 2008 season, while one (4%), Grapevine (RM 81.7, Reach 2) increased as a desirable camp after already receiving a BETTER rating.

Comparison Analysis of Late 2008 beaches with Late 2007

Another perspective of longevity is through comparison with photos of the same beaches acquired in late 2007. The photo records allowed this analysis to be conducted for 31 beaches.

Of these 31 locations, 11 (35%) appeared to be less desirable as camps at the end of 2008 than in late 2007. Six, or just over half of these beaches, were negatively impacted by the March BHBF. Four of the remaining beaches had been designated as having been IMPROVED as a result of the BHBF, and may have degraded more significantly through the 2008 season. The other beach, Ross Wheeler (RM 108.3, Reach 2) showed no change as a result of the BHBF, and was actually marginal in being rated as WORSE compared to 2007. By Reach, 3 of the WORSE rated beaches were located in Reach 1, 2 were found in Reach 2 and, alarmingly, 6 were from Reach 3. This Reach also contained the 4 beaches that had been rated as BETTER following the March 2008 BHBF.

Conversely, of the 31 beaches in the comparison, 15 (48%) qualified as BETTER than the same beaches one year previous. All but 2 of these camps were designated as BETTER following the March 2008 BHBF, so 13 showed immediate improvement from the high flow. The remaining 2, Lower Bass Camp (RM 109, Reach 2) and Last Chance (RM 156.3, Reach 3) improved in camp desirability through the 2008 season as the sand graded and resulted in better parking or increased camp area. Reach 1 contained 3 of these beaches and 6 each were located in both Reach 2 and Reach 3.

There were 5 (16%) camps that received a SAME designation when compared to the 2007 photos. Of these, 3 had been rated as BETTER following the March 2008 BHBF. The breakdown for these camps included 1 in Reach 1, 3 in Reach 2 and the last located in Reach 3. When combined with the 11 beaches receiving a WORSE designation, a total of 16 camps degraded or showed no significant improvement from 2007.


Figures 6 & 7. Upper National camp, RM 167.0 L at similar river levels. The photo on left is from late 2007, the right was taken in August 2008.

Comparison Analysis of late 2008 beaches with 1996 Pre-BHBF event

Perhaps the most important question considered throughout the thirteen years of annual snapshots examined by the AAB program is; how do the current beaches compare to those photographed prior to the 1996 BHBF event. The results from this year are encouraging.

For 2008, 25 beaches had sufficient data to be examined. Of the 20 beaches listed by AAB but not used this year, 8 were not photographed prior to the 1996 event, and 11 were not photographed in 2008 or, more likely, did not have any views taken after July 2008, and so were not considered representative for this comparison. One beach was photographed from a different location in 1996 and could not be reasonably compared. Neither of the beaches located in Reach 4 were photographed in 1996.

Of the 25 beaches considered, 4 (17%) are rated as being in essentially the same condition as in 1996. In fact, they looked almost identical, with the primary difference being the addition of foliage on the vegetation. Two of these were located in Reach 2 and the other 3 in Reach 3. There were 9 (37%) beaches rated as WORSE than their 1996 counterparts. Reaches 1 and 2 each contained two of the beaches, and 4 were located in Reach 3. In 5 beaches, vegetation encroachment was sited as either the primary or as a secondary factor. This factor was often cited in conjunction with decreased beach size, but should not be inferred as the cause for less camp area, as reduction from erosion was just as likely. Rockier parking areas and steeper, less user accessible beaches were also common reasons for the less desirable rating. This can be attributed to the 2008 BHBF in two or more instances. Dune creation associated with the 2008 BHBF, reducing the usable camp area, was also pronounced at 2 beaches.

Finally, 11 (46%) of the beaches compared received a BETTER status. These were located in all three Reaches containing camps in consideration, with 2, 4 and 5 in Reaches 1, 2 and 3, respectively. Beside the finding of more camp area in general, it's most important to note that this was due largely because of the increase in sand found toward the rear of the beaches, usually above the 20K cfs flow level. Although some eolian action is evident on a very few of these beaches, the deposition can be almost unequivocally attributed to the BHBF and/or HFE flows from 1996, 2004 and 2008. This increase in camp area was usually more significant than any negating factors, and therefore was the determining reason given for the BETTER rating.

Comparison Analysis of the Relative Effects of the March 2008 BHBF and 1996 BHBF

The 2008 BHBF was substantially better in building beaches than the 2004 BHBF. However, this comparison is somewhat biased, since the 2004 BHBF was represented by 2005 photographs, in which beaches had undergone 4 months of winter season impacts.

The effects from the 2008 BHBF showed more extensive building of the upper level of beaches (above the high flux zone) than the 1996 BHBF. Hypothetically, upper levels of beaches benefited from cumulative effects of previous BHBFs (1996, 2000, 2004) where sediment redistribution clearly covers more boulders and rocks in the 2008 photo set. About 1/3 of beaches appeared slightly more difficult to access after the 2008 BHBF compared to the 1996 BHBF. Steep rises and cutbanks impede ease of boat unloading and kitchen setup. Generally, over-steepened beachfronts find equilibrium after a season of fluctuating flow and commercial use. End of season or 2009 photos would show if this hypothesis was true.

Vegetation encroachment does not appear to hinder campsite access. Rather, vegetation may help stabilize beachfronts and anchor sand from being transported by wind.

Compared to pre-BHBF conditions of 1996, the present high volume of sand and extended beach area of all (but one beach) has improved campsite quality and access tremendously. The one beach, North Canyon, is estimated to be about the same in campsite quality compared to pre-BHBF conditions of 1996, as the upper beach has grown in elevation at the expense of a lower beach area.

Both the 1996 and 2008 BHBF benefited a majority of beaches in the study by covering rocks and boulders in both upper and lower beach areas, extending the upper beach area toward the river, and carving out submerged sandbars rendering easy boat (particularly motor boat) access to camps. Beachfronts appeared too high and steeply sloped for decent access to camp, and more boulders and rocks were exposed in the boat parking area.

The numbers show that not all BHBF results area equal. When specifically compared to the 1996 BHBF, the 2008 event was twice as successful. Of the 33 beaches which could be compared, 6 (18%) did not look appreciably different. This included 1 in Reach 1, 3 in Reach 2 and 2 in Reach 3. Nine (27%) of the beaches did not respond as well as their 1996 counterparts. The primary reason for the differences was a more rocky parking area, and increased slope or cutbanks at the beach front. These occurred twice in both Reaches 1 and 2, with 5 beaches in Reach 3 that looked better after the 1996 event. Finally, 18 (55%) of the beaches proved to be rejuvenated more successfully in 2008. These were equally distributed between the three reaches considered, with 5 in Reach 1, 7 in Reach 2 and 6 located in Reach 3. In almost all cases, the sand deposition that occurred during the 2008 BHBF covered more rocks in all areas of the camps, from front to back.

Overall, the 2008 BHBF has been the most successful flow in terms of rebuilding beaches and maintaining a somewhat resilient deposit. The longevity and resilience of the 2008 BHBF should be tested by comparing end of season photos of 2008 (or 2009) to those of 1996 BHBF.

CONCLUSIONS

The results of this study since 1996 are generally consistent with those presented by other authors and agencies in the past. Following BHBF and HEF events, beaches have continued to decrease in size and acceptability as time passes. Degradation of beaches occurs throughout the year, with the greatest impacts closely following a BHBF or HMF event (O'Brien, 2000; Lauck, 2007). The annual magnitude of beach loss and degradation of camps (Hazel and others, 2002) appears to apply primarily to erosion associated with fluctuating flow patterns. It may still be too soon following the 2008 BHBF to fully justify that sentiment, but results for the few months used in this study do indeed point in that direction.

It is unfortunate that beach front scour was witnessed at a few of the beaches following the March BHBF. As demonstrated throughout the 13 years of this project, most beach fronts, regardless of reach, become static and beach front erosion becomes almost mute. Once the sand has achieved an angle of repose at the landing areas, the effects of dam release flows appear to be minimal. However, as demonstrated at Lower Tapeats camp, erosion from fluctuating flows can severely impact beaches in a very short time period.

Figures 8 & 9. Lower Tapeats beach, RM 134.5 R. Left photo 4/08, right photo 9/08.

Vegetation encroachment into camp areas, eolian action and human impacts are usually slower to produce noticeable changes. However, for 2008 and in previous years, the frequency of flash events and the sudden, not usually subtle results, generated considerable concern. Most importantly, major rain events are not limited to a particular reach and cannot be regulated by dam releases. Without BHBF events to help rework and 'restore' the areas scoured or incised by flash floods, these beaches would require long periods to recover, if at all.

The results of this years AAB study concur with this statement by Dennis Kubly of the Bureau of Reclamation, "Sediment – triggered floods (in Grand Canyon) temporarily improve beach building and improve sediment retention, long term sustainability may require additional flow modification or augmentation" (Kubly, 2009). This investigator would change that statement slightly to " ….WILL require additional flow modification and augmentation".

It has also been proposed that photographs from the 2008 BHBF be used to form a new baseline of data. The photos from 1996 are outdated and are inconsistent in showing the lower and upper beach areas. Photo locations have had to be adjusted to account for vegetation intrusion and other factors, rendering incomplete data using 1996 comparisons.

ACKNOWLEDGEMENTS

Grand Canyon River Guides, Inc. would like to thank all of the adopters for volunteering the time to pull over and photograph their beaches and for their valuable observations and written comments. It takes time and effort to do this, and the dedication shown by guides has literally kept this program alive for ten plus years. The result is the most comprehensive collection of repeat photographs of critical camping beaches in the Grand Canyon. An added benefit is the public outreach fostered by the volunteers' actions. By taking time to include guests as active participants and by answering their questions, volunteers can further explain how our resource in Grand Canyon is enhanced, degraded or maintained by the influence of man and technology.

Special thanks to Lynn Hamilton for exhaustive work in support of this project; Andre Potochnik for his continued hard work as GCRG's (and therefore, this project's) representative of recreational interests in the Adaptive Management Program of Glen Canyon Dam.

Thanks also to our contributors, the Grand Canyon Conservation Fund, established and maintained by the commercial outfitters in Grand Canyon, the Grand Canyon Monitoring and Research Center and, finally, to those contributions from individual GCRG members who believe that the Adopt-A-Beach project worthy of their support.

REFERENCES CITED OR REVIEWED

Hazel, J.E. Jr., Kaplinski, M.A., Beus, S.S., and Tedrow, L.A., 1993. Sand bar stability and response to interim flows after a bar-building event on the Colorado River, Arizona: implications for sediment storage and sand bar maintenance: EOS Fall Meeting Abstracts, vol. 74. p. 43

Hazel, J.E. Jr., Kaplinski, M.A., Parnell, R.A., and Manone, M.F., 2001. Monitoring the effects of spring 2000 habitat maintenance flow on Colorado River ecosystem sand bars: Northern Arizona University, Department of Geology, Sand Bar Studies Fact Sheet. 2 p.

Hazel, J.E. Jr., Kaplinski, M.A., Parnell, R.A., and Manone, M.F., 2002. Colorado River ecosystem sand bar conditions in 2001: results from 12 years of monitoring: Northern Arizona University, Department of Geology, Sand Bar Studies Fact Sheet. 4 p.

Kaplinski, M.A., Hazel, J.E. Jr., and Beus, S.S., 1994. Monitoring the effects of interim flows from Glen Canyon Dam on sand bars in the Colorado River corridor, Grand Canyon National Park, Arizona: Report for Glen Canyon Environmental Studies, Northern Arizona University, Department of Geology. 62 p.

Kaplinski, M.A., Hazel, J.E.Jr., and Parnell, R.A., 2006. Campsite Area Monitoring from 1998 to 2005: The Effects of the November 2004 High Experimental Flow on Recreational Resources in the Colorado River Ecosystem. Report for Grand Canyon Monitoring and Research Center. 22 p.

Kearsley, L.H., and Warren, K.W., 1993. River campsites in Grand Canyon National Park: inventory and effects of discharge on campsite size and availability: National Park Service Division of Resource Management, Grand Canyon National Park, Grand Canyon. 65 p.

Kearsley, L.H., and Quartaroli, R., 1997. Effects of a beach/habitat building flow on campsites in Grand Canyon: Final Report of Applied Technology Associates for the Glen Canyon Environmental Studies. 18 p.

Kubly, Dennis, 2009. Reclamation: Managing Water in the West. Presentation at CAMNet Rendezvous, March 8-10, 2009, Kearney, Nebraska.

Lauck, Paul, 2007. Long Term Monitoring of Camping Beaches In Grand Canyon: A Summary of Results from 1996 – 2005, with an Emphasis on the Results of High Experimental Flow of November 2004

Lauck, Paul, 2008. Long Term Monitoring of Camping Beaches In Grand Canyon: A Summary of Results for Years 2006 – 2007 with Comparisons to Pre 1996 Beach Building/Habitat Flow and the Pre 2004 High Experimental Flow Beaches

Lucchitta, I., and Leopold, L.B., 1999. Floods and sandbars in the Grand Canyon: GSA Today, vol. 9, No. 4 p. 1-7.

Melis, T.S., Topping, D.J., Rubin, D.M., and Wright, S.A., 2007. Research Furthers Conservation of Grand Canyon Sandbars, U.S. Department of the Interior Fact Sheet 2007-3020, 3 p.

O'Brien, G.O., Burke, K.J., and Hamilton, L., 2000. Effects of natural flow and controlled flow releases from Glen Canyon Dam on Grand Canyon beaches, 1999: a continuation of a repeat photography study by Grand Canyon river Guides, Inc. (Adopt-A-Beach Program). Administrative report for Grand Canyon Monitoring And Research Center by the Grand Canyon River Guides Adopt-A-Beach program, 22 p.

Parnell, R.A., Dexter, L., Kaplinski, M.A., Hazel, J.E. Jr., Manone, M.F., and Dale, A., 1997. Effects of the 1996 controlled high flow release from Glen Canyon Dam on Colorado River sand bars in Grand Canyon: Final report for the beach habitat building flow: submitted to Glen Canyon Environmental Studies by Northern Arizona University, Department of Geology, 22p.

Rubin, J.M., Topping, D.J., Schmidt, J.C., Hazel, J.E.Jr., Kaplinski, M.A., and Melis, T., 2002. Recent sediment studies refute Glen Canyon Dam hypothesis: EOS Transactions, AGU, Washington, D.C., p 273 & 277.

Schmidt, J.C., 1990. Recirculating flow and sedimentation in the Colorado River in Grand Canyon, Arizona: Journal of Geology, vol 98, p. 709-724.

Schmidt, J.C., and Graf, J.B., 1990. Aggradation and degradation of alluvial sand deposits, 1965 to 1985, Colorado River, Grand Canyon National Park, Arizona: U.S. Geological Survey Professional Paper 1493, 74 p.

Thompson, K.S., 2004. Long Term Monitoring of Camping Beaches in Grand Canyon: A Summary of Results from 1996 – 2003. Annual Report of Repeat Photography By Grand Canyon River Guides, Inc. (Adopt-A-Beach Program), 14 p.

Topping, D.J., Rubin, D.M., Nelson, J. M., Kinzel, P.J., and Corson, J.C., 2000. River sediment transport 2: systematic bed elevation and grain size effect of sand supply limitation: Water Resources Research, vol. 36, p. 543-560.

Topping, D.J., Rubin, D.M., Schmidt, J.C., Hazel, J.E. Jr., Melis, T.S., Wright, S.A., Kaplinski, M.A., Draut, A.E., and Breedlove, M.J., 2006. Comparison of sediment transport and bar response results from the 1996 and 2004 controlled flood experiments on the Colorado River in Grand Canyon, Proceedings of the 8th Federal Interagency Sedimentation Conference, April 2-6, 2006, 7 p.

U.S. Department of the Interior, 1987. *River and Dam Management*: A review of the Bureau of Reclamation's Glen Canyon Environmental Studies: National Academy Press, Washington, D.C., 203 p.

U.S. Department of the Interior, 1996. Record of Decision (ROD) on the Operation of Glen Canyon Dam Final Environmental Impact Statement (EIS): Bureau of Reclamation, Salt Lake City, Utah.

Webb, R.H., 1996. *Grand Canyon, A Century of Change.* University of Arizona Press, Tucson, 320 p.

Wiele, S.M., Andrews, E.D., and Griffin, E.R>, 1999. The effect of sand concentration on depositional rate, magnitude and location in the Colorado River below the Little Colorado River: in *The Controlled Flood in Grand Canyon:* Geophysical Monograph Series, vol. 110, p. 113-145.

Appendix A

Adopt-A-Beach Data Sheet
Used by Volunteers to Record Comments

Adopt a Beach Data Entry Form

Guide s Name ______________________

Camp Name ______________________

Camp Mile ________________

Date ________________

River Flow (circle one) Low (5-12K) Med (12-18K) High (18-25K)

Photo Numbers: ____________ (remaining)

Any Comments about Beach Change? (describe in this space)

Change in Beach Size from Previous Visit (circle one): Increase Decrease Same

---

Dominant Cause of Change (circle one):

Spike	Daily/Monthly Flow	Rain	Wind	People	Don't Know

Supporting Observations for Dominant Cause (check any that are appropriate):

- New cutbank
- Change of slope
- Bench in eddy
- Gully
- Trib/Debris flow
- Scour from wind or people
- Mounded sand

Secondary Cause of Change (circle one):

Spike	Daily/Monthly Flow	Rain	Wind	People	Don't Know

Supporting Observations for Secondary Cause (check any that are appropriate):

- New cutbank
- Change of slope
- Bench in eddy
- Gully
- Trib/Debris flow
- Scour from wind or people
- Mounded sand

Campsite Quality Compared to Last Visit (circle one): Same Better Worse

Supporting Observations for Campsite Quality (check any that are appropriate):

- Boat parking
- Rockiness
- Vegetation encroachment
- Steepness
- Trail erosion
- Open sand area
- Human impacts- ants, pee spots, litter (circle those that apply)

Any Comments about Campsite Condition? (describe in this space)

Appendix B

Results of Analysis in Tabular Form

2008 Season	GCMRC	Compare								2008		1996	
Camp name	River mile	early 2008	to	2007	reason	2008	all	year	reason	BHBF	to	BHBF	reason
		same	better	worse		same	better	worse		same	better	worse	
Soap Creek	11.2R			x	scoured at front, cutbank	x			slight improve, late season sed?				no photos to compare
12.4 Mile	12.4L		x		gully filled, bigger camp area	x			slight degrade	x			no change
Hot Na Na	16.6L				not adopted in 2008				not adopted in 2008				no photos to compare
19.4 Mile	19.4L		x		better parking, human impacts				only early season photos				no photos to compare
Upper North Canyon	20.7R			x	steep parking, more rocks	x			very little change			x	less beach front, more veg
Indian Dick	22.7L		x		more sand in camp area			x	lots of rw erosion, cutbank			x	rockier parking
Shinumo Wash	29.5L		x		much improved, bigger, better	x			new small rain gully		x		more camp area
Middle Nautaloid	35L		x		gully filled, rocks covered				only early season photos		x		more beach front
Lower Nautaloid	35.1L		x		rocks covered at beach				only early season photos		x		more beach front
Tatahatso	37.9L			x	steep parking, severe cutbank			x	even steeper, cutbank		x		more beach front, camp area
Martha's	38.6L		x		more sand in back, better park				only early season photos				no photos to compare
Buck Farm	41.2R			x	scoured, lots of exposed rocks			x	even less sand, more veg		x		slightly better, more sand
Total above	12	0	7	4		4	0	3		1	5	2	
Nevill's	75.1L		x		more sand overall			x	veg (arrowweed) took over		x		rocks covered, more camp
Hance	77.1L				not adopted in 2008				not adopted in 2008				no photos to compare
Grapevine	81.7L		x		less veg, more high sand		x		landing improved				no photos to compare
Clear Creek	84.6R		x		more sand, less veg			x	river erosion, cutbank, veg		x		more rocks covered
Zoroaster	85L		x		better all around, more sand			x	cutbank, rocks exposed			x	less sand, more slope
Trinity Creek	92.1R		x		much bigger camp area			x	rw erosion, gully from flash				no photos to compare
Schist	96.5R	x			not much change found	x			slight cutbank started		x		more camp, better parking
Boucher	97.2L		x		more camp area, better parking			x	serious loss of parking	x			no change
Crystal	98.7R			x	steeper landing, same rocks	x			no change		x		more high sand
Lower Tuna	100.2L				not adopted in 2007	x			slight veg increase		x		more high sand
Ross Wheeler	108.3L	x			possibly more rocks at landing	x			slight gully in camp	x			more veg, same camp area
Bass	109R			x	cutbank again, camp scoured	x			landing better, but human impacts	x			no change
110 mile	110R		x		more sand overall	x			some veg increase at landing		x		more camp, better parking
Upper Garnet	114.9R		x		better overall				only early season photos			x	less sand in camp area
Lower Garnet	115.1R		x		better overall				only early season photos		x		more high sand
Total above	15	2	9	2		6	1	5		3	7	2	
Below Bedrock	131.0R		x		lots of rocks covered	x			no significant change		x		more camp, less rocky
Stone Creek	132.5R		x		huge beach, good parking	x			lots of fluctuation thru season	x			no change
Talking Heads	133.7L		x		more camp area			x	cutbank, big loss from rw erosion				no photos to compare
Racetrack	134.2R	x			possibly more sand in camp				only early season photos		x		more high sand
Lower Tapeats	134.5R		x		huge deposition, great camp			x	river erosion removed all			x	less sand, rocky
Owl Eyes	135.2L		x		wider beach, less veg	x			camp area narrowing	x			no change
Backeddy	137.0L		x		gully filled			x	new gully from rain, cutbank			x	huge cutbank, steep camp
Kanab Creek	144R		x		nice deposition, veg scour	x			stable, no change found		x		more camp area
Olo	146.1L		x		HUGE camp area, good landing			x	flash flood removed all		x		much bigger camp
Matkat Hotel	148.9L		x		gully filled, looks great			x	cutbanks started, new gully		x		more camp, but more veg
Upset Hotel	150.7L		x		better parking	x			rocks exposed from rw erosion				no photos to compare
Last Chance	156.3R	x			more sand, but steep	x			camp area better but parking loss		x		more high sand
Tuckup	165.1R		x		better parking			x	sand loss at landing, rw erosion			x	rockier beach front
Upper National	167L			x	scoured at front		x		rocks covered - no late photos			x	rockier beach front
Lower National	167.1L			x	less camp, more parking area			x	veg, cutbank, rain gully			x	steeper beach front
Total above	15	2	11	2		6	1	7		2	6	5	
Travertine Falls	230.7L	x			slight improvement	x			no change				no photos to compare
Gneiss	236.1R		x		totally new beach				only early season photos				no photos to compare
Total above	2	1	1	0		1	0	0		0	0	0	
Totals	44	5	28	8		17	2	15		6	18	9	

Table 2

2000 Season	GCMRC	late 2000	to	2007	reason	late 2000	to	pre 96	reason
Camp name	River mile	same	better	worse		same	better	worse	
Soap Creek	11.3R			x	much less sand				not in original dataset
12.4 Mile	12.4L		x		less veg, more sand				not in original dataset
Hot Na Na	16.6L				no photos for 2000				not in original dataset
19.4 Mile	19.4L				too few photo dates				photos not comparable
Upper North Canyon	20.7R	x			no change found		x		more camp, less rocks
Indian Dick	23.7L		x		better parking, more camp				no late 2000 photo
Shinumo Wash	29.5L		x		much bigger		x		beach is twice the size
Middle Nautiloid	35L				too few photo dates				no late 2000 photo
Lower Nautiloid	35.1L				too few photo dates				no late 2000 photo
Tatahatso	37.9L			x	worse cutbank			x	more sand, huge cutbank
Martha's	38.6L				too few photo dates				no late 2000 photo
Buck Farm	41.2R			x	less sand, more veg			x	less camp, more veg
Total above	12	1	3	3		0	2	2	
Nevills	75.5L		x		still better, MORE veg			x	more veg, slight add sand
Hance	77.1L				no photos for 2000				no late 2000 photo
Grapevine	81.7L		x		held up well				not in original dataset
Clear Creek	84.6R	x			loss of sand from rec		x		more veg, but more camp
Zoroaster	85L		x		going downhill				no late 2000 photo
Trinity Creek	92.1R		x		but trib flash affected				not in original dataset
Schist	96.5R	x			slightly better		x		camp bigger
Boucher	97.2L		x		hanging in there		x		much larger camp area
Crystal	98.7R			x	still steeper				no late 2000 photo
Lower Tuna	100.7L				no photos for 2007		x		camp area larger
Ross Wheeler	108.3L			x	worse parking			x	camp area same, more veg
Bass	108R		x		better landing, graded	x			almost identical
110 mile	110R	x			no change found			x	camp area same, more veg
Upper Garnet	114.9R				too few photo dates				no late 2000 photo
Lower Garnet	115.1R				too few photo dates				no late 2000 photo
Total above	15	3	6	2		1	4	3	
Below Bedrock	131.0R		x		sand held		x		more camp, less rocks
Stone Creek	132.5R		x		rec erosion, but still bigger	x			slight beach loss
Talking Heads	133.7L	x			back to same from rec flux				no late 2000 photo
Racetrack	134.2R				too few photo dates				no late 2000 photo
Lower Tapeats	134.5R			x	all eroded away, veg grown		x		more high sand in camp
Owl Eyes	135.2L			x	dune covers fat beach			x	new dune reduced camp
Backeddy	137.0L		x		still better with new gully	x			almost identical
Kanab Creek	144R				no photos for 2007		x		more camp, less veg
Olo	145.1L			x	steeper at parking	x			removed by flash
Matkat Hotel	148.9L		x		camp area bigger			x	camp same, more veg
Upset Hotel	150.7L		x		parking same, bit more camp				not in original dataset
Last Chance	156.3R		x		still more camp area		x		more high sand in camp
Tuckup	165.1R			x	erosion, rocks exposed		x		slight more sand
Upper National	167L			x	much less sand			x	smaller, worse parking
Lower National	167.1L			x	new gully, veg, dune			x	less camp, more veg
Total above	15	1	6	6		3	5	4	
Travertine Falls	230.7L				too few photo dates				not in original dataset
Gneiss	236.1R				too few photo dates				not in original dataset
Total above	2	0	0	0		0	0	0	
Totals	44	5	15	11		4	11	9	

Table 3