Long Term Monitoring of Camping Beaches In Grand Canyon

Summary of Results for 2012 with Comparisons to Observations of the 1996 Beach Building/Habitat Flow

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

By
Paul Lauck[2]
June 12, 2012

Upper North Canyon Camp, RM 20.7 R, 4/3/12 (left) and 9/13/12 (right)
Documents erosion across beach front after summer fluctuating flows.

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Adopt – A – Beach:
Long-Term Monitoring of Camping Beaches in Grand Canyon
Summary of Monitoring Observations for Year 2012

By Paul Lauck[1]

Abstract

For the past seventeen years, the Adopt-A-Beach repeat photography program has been monitoring beaches along the Colorado River through Grand Canyon. Through comparative examination of photo series and on-the-spot observations contributed by the volunteer photographers, campsite conditions are evaluated. Factors considered which contribute to changes, both positive and negative, include: fluctuating river flows, aeolian action, vegetation increase/decrease, human introduced change, rain associated erosion or other actions, natural or anthropomorphic, that may have an effect on the camp. The resulting evaluations are also segregated and examined dependent upon which of the four primary river reaches in which the beach resides. The conclusions are presented as observational, monitoring data only.

For the time spanning the 2012 summer boating season, early April to late October, 32 of the 44 study beaches in the program had photographs and photographer comment sheets spanning a sufficient period of time to be evaluated. Of these 32 beaches, 31% were classified as Unchanged for the time period, 16% had Improved through the summer and 53% were considered as Degraded by the end of the season. Of the Unchanged beaches, 31% are located in the Marble Canyon reach, 60% in the Upper Granite Gorge reach, another 9% are contained in the Muav Gorge reach and none are in the Lower Granite Gorge. Forty percent of the Improved beaches are located in the Marble Canyon reach, another 20% in the Upper Granite Gorge and 40% are found in the Muav Gorge reach. Neither of the two beaches included in the study this year and located in the Lower Granite Gorge was considered to have improved. For the beaches classified as Degraded for this time period, 29% are from the Marble Canyon reach,18% are found in the Upper Granite Gorge, 41% in the Muav Gorge reach and two, or 12% are located in the Lower Granite Gorge reach. The primary factor cited as creating an Improved camp is an increase of sand on the beach front enlarging the beach and creating more favorable parking for boaters. Some of this occurred during late season when tributary floods increased sediment in the mainstem, which was subsequently deposited on nearby beaches. The predominant cause of beach degradation this season was the erosion and incision of camps by rain runoff. This was noticed particularly in the Muav Gorge reach from storms occurring the last week of July and first two weeks of August. One camp, at Upper National Canyon, was completely denuded of vegetation and sand and covered by debris. The Lower National Canyon camp was also devastated from this event, but had a very different outcome.

The comparison of the beaches from late season 2011 and early 2012 was conducted on a total of 36 beaches. Of the 36 camps, 69% did not show enough change to warrant a

classification other than Same. Of these 25 beaches, 17% are located in the Marble Canyon reach, and 28% are found in the Upper Granite Gorge and 19% are in the Muav Gorge reach. There are two beaches, or 5%, in the Lower Granite Gorge. Only 14% of the beaches considered showed an Improvement in camping condition at the end of the winter. This accounted for 5 beaches, 4 in the Marble Canyon reach and 1 in the Muav Gorge. In general the camps improved due to sand deposition along the beach fronts and because previously steep, cutbank-associated parking areas slumped to decrease the slope and improve access. Seventeen percent of the camps evaluated were classified as having been degraded during the winter months. The camps were divided between two reaches, with 2 located in Upper Granite Gorge and 4 in the Muav Gorge. The universal factor cited as evidence for this classification was sand loss across the beach front, with the accompanying cutbanks and exposed rocks.

When the season ending 2012 beaches were compared to the beaches immediately following the March 2008 HFE event, 20% of the 25 qualifying camps were considered to be the essentially the Same, another 20% were classified as Improved and the remaining 60% were considered as Degraded. Those beaches which did not have significant change were distributed from River Mile 98.7 downstream with 3 in the Upper Granite Gorge, and one each in the Muav Gorge and the Lower Granite Gorge. Beaches which were classified as having Improved also totaled 5 and were distributed with 3 in the Marble Canyon reach, and one each in the Upper Granite Gorge and the Muav Gorge. The remaining Degraded beaches were found in all reaches, with 16% in the Marble Gorge, 32% in the Upper Granite Gorge, 47% in the Muav Gorge and one beach located in the Lower Granite Gorge. Sediment deposition contributed from local recent upstream flooding events was the predominant factor for a beach having Improved. For the Marble Canyon beaches, this would presumably have been from the Paria drainage. Sand removed by wind above the normal fluctuating flow limit, exposing rocks, and erosion from variable river flows across beach fronts, were both primary factors for a beach classification of Degraded. Rain erosion as a factor was not cited as often, but the resulting degradation was usually more pronounced.

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Introduction and Background

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 camping area available for river parties and backpackers (Kearsley and Warren 1993, Kearsley and Quartaroli 1997).

The Grand Canyon Protection Act was passed by Congress in 1992 to ensure that ecological and cultural resources downstream of the dam would be monitored for changing conditions imposed by operation of the dam. The Act states that Glen Canyon 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).

In 1996, following completion of the "Operation of Glen Canyon Dam: Final Environmental Impact Statement" (EIS), a Record of Decision was signed and implemented which included provision for the use of "beach/habitat-building flows." Now referred to as High Flow Experiments (HFE), the EIS defined these events as "…scheduled high releases of a short duration designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels and provide some of the dynamics of a natural system" (U.S. Department of the Interior, 1995), with the added intent of restoring some of the dynamics that resulted from flooding in the ecosystem. Further, an HFE is defined as a flow release exceeding 31,500 ft^3/s. Sandbars 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). The first HFE was conducted in late March 1996, and consisted of a 7-day steady release of 45,000 ft^3/s that was preceded and followed by steady flows of 8000 ft^3/s for 4 days each (Melis, 2011).

Grand Canyon beaches form the substrate for communities of plants, invertebrates and vertebrates, including species such as riparian birds (Carothers and Brown, 1991). These beaches are also 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. Consequently, those who run the river are interested in observing the changes to camping beaches throughout the river corridor in the Grand Canyon. As a non-profit organization dedicated to protecting Grand Canyon and the Colorado River experience, Grand Canyon River Guides developed and implemented the Adopt-a-Beach (AAB) program prior to the initial flood event in 1996 in order to assess the evolving state of the recreational resource. AAB is a long term monitoring program that relies on systematic photograph replication to document and analyze changes in sand deposition and other physical attributes of an initial dataset of 44 camping beaches along the Colorado River corridor in Grand Canyon. A cooperative agreement with Grand Canyon Monitoring and Research Center (GCMRC), ensures that the extensive AAB photo archive and legacy data are incorporated into the GIS Campsite Atlas project to build a more complete and robust understanding of the status, trends and conditions of camping beaches in the river corridor affected by the operations of Glen Canyon Dam.

Since its inception in 1996, the Adopt-A-Beach program has utilized volunteer photographers to conduct repeat photography of these camps. 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 field season and between years. Volunteer photographers 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. With the end of the 2012 season, river runners have produced nearly 4300 replicate photographs on more than 3000 dates with associated field sheets recording the sequential condition of beaches.

Standardized comment forms completed by the volunteers at the time the photographs are acquired, assisting in the effort to document the beach conditions. The program assesses the visible photographs and first-hand, objective comments pertaining to changes to beaches, and reports on the conditions as influenced by regulated flow regimes, rainfall, wind, vegetation, human impacts or any other factors that may be present. 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 (Lauck, 2009).

Recently, the presence and impacts of the tamarisk beetle, *Diohabda spp*. have been included in these comments. This component of the analysis has been added not only for ecological monitoring reasons, but also because of related questions pertaining to the recreational experience: will the beetle remove valuable shade from camping areas, how will other vegetation respond to the impacts on the tamarisk and how does this affect the camp. Also, in what ways may defoliation of tamarisk affect aeolian or streamflow related erosion. These are examples of recreational concerns.

The purpose of this report is to present the results of the monitoring effort for the period between late 2011 and early September 2012. Also, after each of the HFE events, beaches were shown to have eroded at differing rates (Thompson, Burke and Potochnik, 1997, Lauck 2009). Hence, researchers are concerned with the longevity of bars and camping areas augmented by the HFEs, and a comparison of the 2012 beach conditions with those photographed both before and after the HFE conducted in March 2008 are included.

Research results include reporting positive "Improved" conditions, negative "Degraded" conditions or "Same" that no changes were found in beaches; longevity of these camps; and attributes the primary and secondary processes that cause change in camping beach area and quality. Specific research questions that are addressed by this report are:

- What changes, if any, are found at the beaches between early winter 2011 and early spring 2012?
- What changes, if any, are found at the beaches during the boating season of 2012?
- How do the beach conditions of late 2012 compare to those of spring 2008, after the High Flow Experiment?
- How are changes in the beaches, if any, distributed throughout the river corridor?
- Which processes resulting in a change of condition at a beach are most prevalent?

Methods

Study locations and beaches

Since 1996 the AAB program has studied an average of 38 beaches per year from within three of the five *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, 1996-2011. The reaches are as follows: 1) Marble Canyon, river miles 9-41; 2) Upper Granite Gorge, river miles 71-114; 3) Muav Gorge, river miles 131-165.

Two additional critical reaches were added during the 2003 monitoring season. The purpose was 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 has been collected for the Glen Canyon reach for a few years, but the Lower Gorge reach, which was been extended to include the 250 Mile Camp in 2009, is still being monitored.

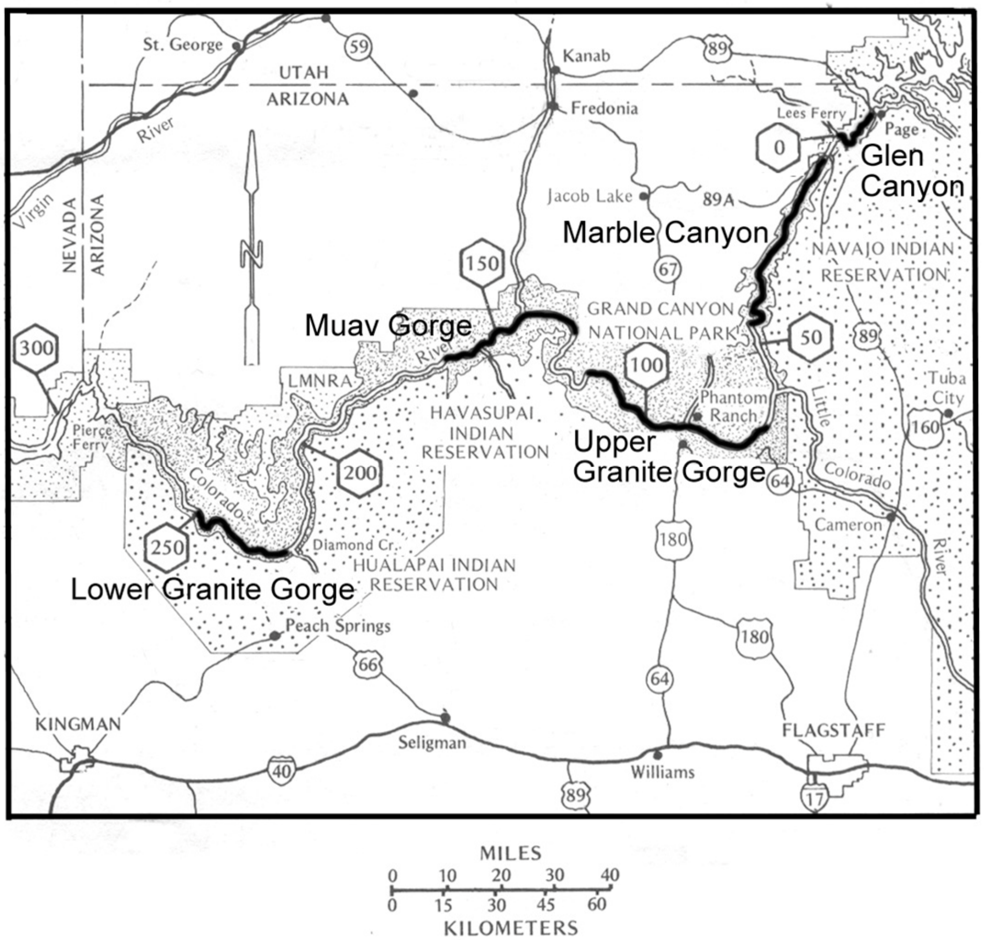

Figure 1. Locations of five critical reaches along the Colorado River in Grand Canyon National Park

Table 1 shows popular campsites (n = 44), 34 of which were originally inventoried in 1996, and includes beaches added in 2000, 2001 and 2009.

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 Canyon
		16.6	Hot Na Na	81.7	Grapevine	133.7	Talking Heads	250.0	250 Mile
		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	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	Nautiloid (Middle&Lower)	97.3	Boucher	144.0	Kanab Creek		
		37.9	Tatahatso	98.7	Crystal	146.1	Olo		
		38.6	Martha's (Bishop's)	100.2	Lwr Tuna	148.9	Matkat Hotel		
		41.2	Buck Farm	108.3	Ross Wheeler	150.9	Upset Hotel		
				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 the five critical reaches.

Unlike other established re-photography studies, both within and outside of the Grand Canyon, the AAB program does not adhere to a regime which includes matching photos per a specific time of day or date (Webb1996, Webb, Boyer and Turner, 2010). The photographs obtained here are much more opportunistic and acquired whenever a volunteer happens to pass their chosen camp. However, guidelines for the volunteer are provided to help regulate the consistency required to make adequate comparisons between the images. 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. However, the portion of the camp photographed at each beach, the relative photographic locations between beaches and the number of images acquired per beach are not all the same. This means that one beach may be evaluated through slightly differing information than another one, in that not every beach photo set contains the same 'clues.' The resulting evaluations can only be compared with results for camps using the same views. Most commonly, the photos are shot from the boat on the river, taken as a single image or series, to provide a full, upstream to downstream look at the beach. Photos taken from specifically designated locations on shore, looking across the front of the beach, usually from an elevated, oblique angle, are often acquired as well. Combined, these views provide a considerable amount of information for analysis.

A few beaches are photographed from the river only. Unfortunately, this often limits the visibility of the upper or rear part of the camp. Efforts are being made to expand these visits to include a shore based view, but this is completely up to the volunteer and their time available. Also, almost half of the beaches have photo locations toward the back of the camp, looking across the upper part of the beach or toward the river. While not always practical, these views are invaluable additions to the beach dataset.

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.

Figure 2 & 3. Upper North Canyon Camp, RM 20.7 R, 4/3/12 (left) and 9/13/12 (right) Documents erosion across beach front after summer fluctuating flows.

The time-series photos taken within study locations allow assessment of relative change over the course of each season and between monitoring years. The number of adopted beaches with useable season long data in 2012 totaled 32. Each record in the data base represents an individual visit to a beach where each beach usually has 1-5 photos associated with it. Adopters often take extra snapshots of various impacts such as flash flooding in Schist Camp (August 2002) and North Canyon (October 2010) and debris flows at National Canyon (July 2012). These documented events and data are available to any interested researchers through Grand Canyon River Guides or Grand Canyon Monitoring and Research Center and the images are currently available as part of the Adopt-A-Beach photo gallery, http://www.geanious.com/gallery/main.php. Part of the Adopt-A-Beach program is to provide photos of unusual natural events in Grand Canyon to interested parties.

Analysis

When a volunteer requests a camera and a beach assignment, they are asked to photograph a completed datasheet, identifying the beach name and mile, plus the photo date and time, immediately prior to photographing the camp. This information is included in the captioning of the image, and helps to correctly place the photo chronologically during analysis. While this practice occurs most of the time, occasionally the datasheet is photographed later or, rarely, not at all. Photos without a distinct date/time attribute in the photography sequence are examined by water color, shadowing on the surrounding walls, or other common elements such as guest attire when available, to help correctly identify the proper sequential placement of the image(s). It is possible that the date/time attributes are incorrectly applied to a very few images. With the increasing use of digital cameras to collect the images, a date/time stamp on the photo will help eliminate this issue.

When comparing the photos for evaluation, numerous criteria are used to gather the empirical data. After the images are sorted by camp and have been given a date and time caption, a consistent pattern of examination was conducted for every analysis. This began with the water level determination for the first image examined in any set. This was accomplished by consulting the flow graph of one or all of the following USGS gauges: Colorado River @ Lees Ferry, AZ (09380000), Colorado River Near Grand Canyon, AZ (09402500), Little Colorado River Above Mouth Near Desert View, AZ (09402300), Kanab Creek Above the Mouth Near Supai, AZ (09403850), Havasu Creek Above the Mouth Near Supai, AZ (09404115) or the Paria River @ Lees Ferry, AZ (09382000). See Figures 6 – 11. These graphs also helped determine when additional sediment may be entering the mainstem for possible deposition along beaches downstream. During comparison to each subsequent image, identification of a near-shore landmark or two and its proximity to the current shoreline was employed to help determine relative water levels. The flow graphs were also revisited if required, particularly when it appeared that the river volume and possible sediment load changed due to additional input from the Paria or Little Colorado tributaries.

The images were viewed for evaluation using Adobe Photoshop v7.0 on two Sony 19' monitors, side-by-side, with one image on each. Beginning at the front, or shoreline of the beach, the images were examined and compared. The presence/absence of rocks or debris, either hindering or enhancing boat parking, was noted. Due to the variety of river flow levels between the comparison photos, change in the 'parking' at a particular beach is often difficult to evaluate, and, when covered at higher flows, is considered only when recorded by the AAB observer. Any beach front cutbanks which would affect unloading/loading of boats at similar flow levels, or which indicated erosion of the beach by the river flow were also noted. Conversely, the absence of a cutbank or smoothing of an access slope helped determine the possible addition of sand by sediment augmentation or other river action that benefited the camping desirability of the beach.

The images being compared were then examined progressively from front to back to note the absence or addition of rocks or other debris which would impact the total area being used as a camp. The location and visual extent of emerging rocks can usually indicate the physical action which occurred to reveal the rocks. As an example, rocks which were covered in image "A" by sand, covered by river flow in image "B" and subsequently revealed as the water level receded, are noted as indicators of river flow erosion. Conversely, the reverse action would be noted as an indicator of sediment deposition.

Figure 4 & 5. Tuckup Canyon, RM 165.2 R. Photo on left taken 4/13/12, right taken 8/25/12. Documented defoliation of tamarisk tree.

The same kind of visual clues can also be used to determine aeolian action, particularly when the exposed or covered rocks and shelves are higher than any possible river flow level during the time period being examined. During the last HFE, some camp areas increased as a result of boulders and bedrock being covered by sand carried onto the beach at the higher flow. Since then, some of these have re-emerged as a result of wind scour, resulting in a decrease in camp area. The upper portion of Lower Tuna Camp is an excellent example of this action.

Determining whether a beach was uncomfortably steep for access was easily assessed if one of the photos was taken across the front, either looking up or downstream. But beaches with only head-on photos are more difficult to discern. Well-trodden paths, leading to and from obvious access points, creating easily eroded channels, are the primary clues. Human caused erosion is usually noted by the volunteer photographer and can be correlated with the images.

Beach images acquired from various viewpoints were the easiest to determine changes in vegetation. When this was not possible, such as head-on only shots, a systematic comparison from one end of the beach to the other was used. Baccharis species, arrow-weed (*Pluchea sericea*), Russian thistle (*Salsola tragus*), coyote willow (*Salix* species) and camelthorn (*Alhagi* species) were usually identifiable when noted moving into a previously open sand area, or were missing from subsequent images.

For those beaches where one or more tamarisk trees, or partial trees, are clearly visible in a photo, the percent of green, leafy branches were noted early in the season. If the same plant appears to have leaf loss in subsequently dated photos, and particularly if the same plant produces more foliage later in the summer, then the presence of *Diohabda spp.* is assumed and recorded. This method of analysis may need to be adjusted as the effects of the beetle on the trees changes.

Knowledge of the study sites by this investigator was also considered, though this did not determine the final classification used for any particular beach. Using these analysis criteria, the beaches are given classifications indicating desirability as camping beaches, stated as Improved, Degraded or Same. While the designations of Same, Improved and Degraded are inherently subjective, the results are reflective of the stated evaluation purpose of determining the beach as a useable camp for river trips. No photogrammetry techniques were employed and this should not be interpreted in any way that results were obtained using anything other than objective evaluation.

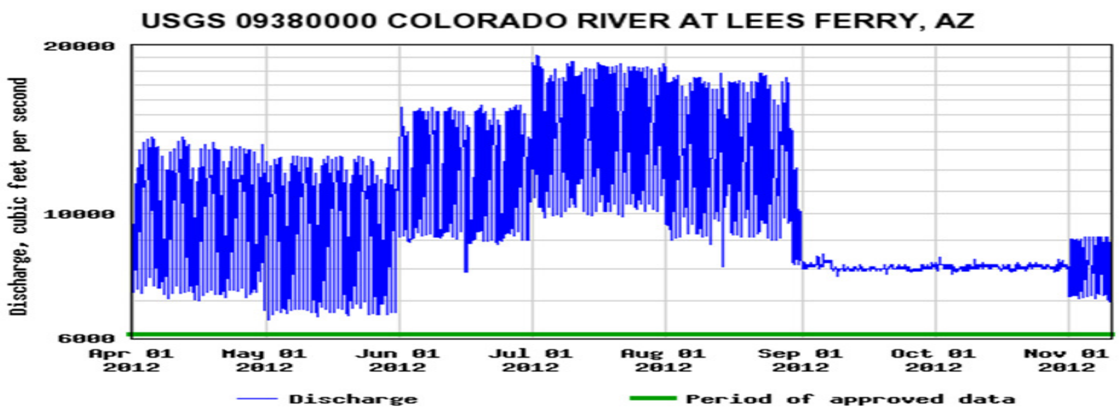

Figure 6. Flow graph for Colorado River at Lees Ferry, AZ., season of 2012

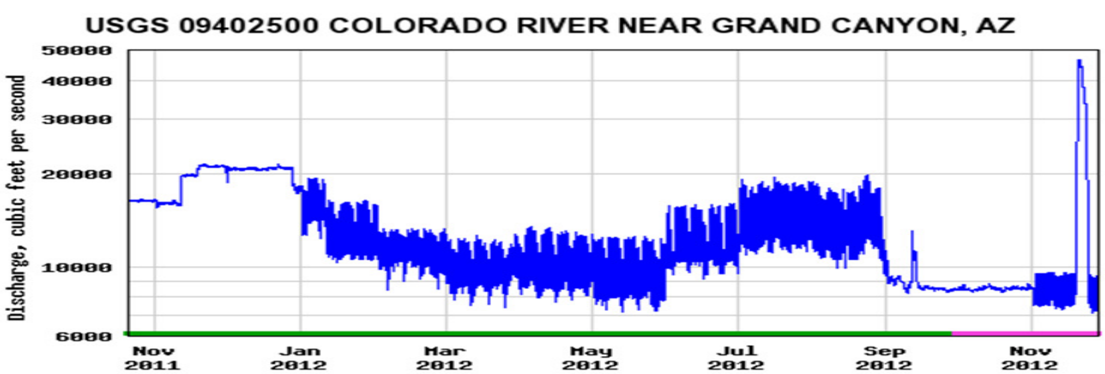

Figure 7. Flow graph for Colorado River near Grand Canyon, AZ., late 2011 to late 2012.

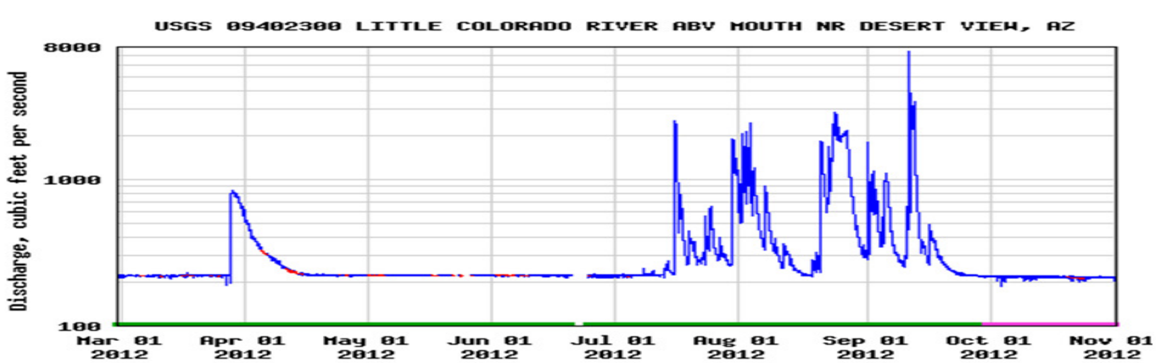

Figure 8. Flow graph for Little Colorado River above mouth near Desert View, AZ ., 2012

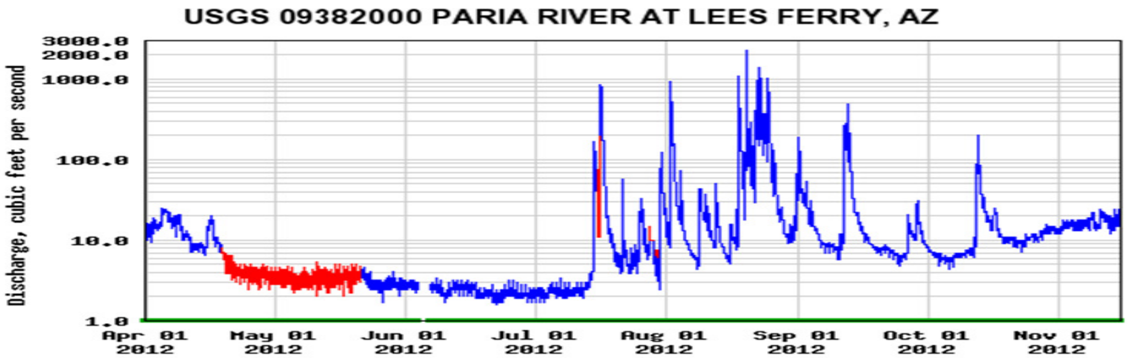

Figure 9. Flow graph for Paria River at Lees Ferry, AZ., 2012

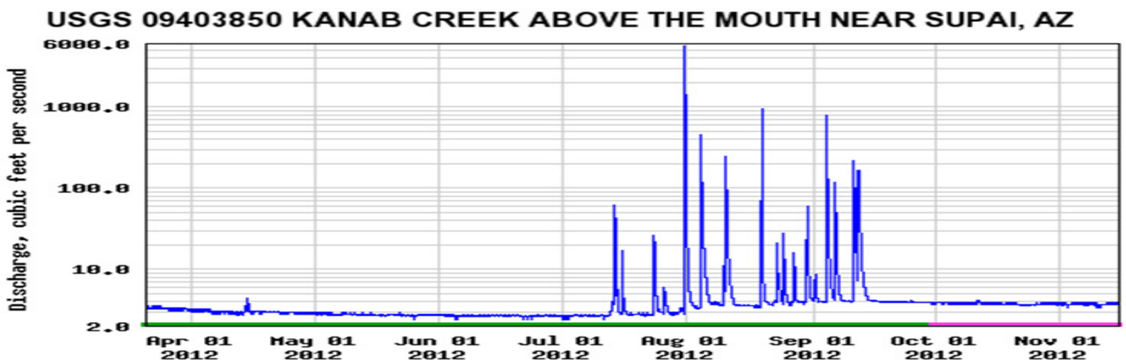

Figure 10. Flow graph for Kanab Creek above the mouth near Supai, AZ., 2012

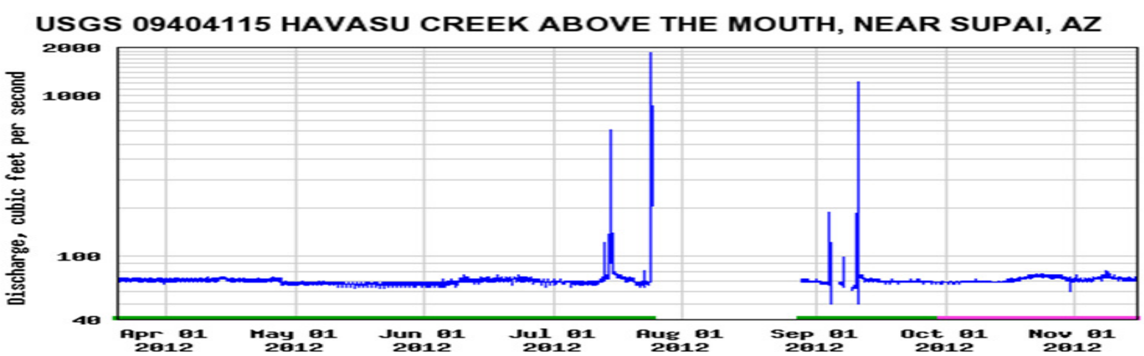

Figure 11. Flow graph for Havasu Creek above the mouth near Supai, AZ., 2012

The data are compared and analyzed according to the research questions that are most applicable for the time period being studied. For the season of 2012, evidence of change between April 1 and the latest photo acquired for the year, but before the November HFE, was evaluated. The majority of the ending date photos were taken from mid-September into November. Five of the beaches which had early season information were not included in this portion of the study because the last photo of the beach was taken on or before August 1. Another analysis conducted with this data set compared the early April photographs to the end of season 2011. Finally, the end of 2012 season images were compared to April photos taken subsequent to the 2008 HFE event to evaluate a rate of change.

Figures 12 & 13. Owl Eyes Camp, RM 135.2 L June 3, 2012 (left) and September 21, 2012 (right)
A beach that was nearly the same from early in the season and again when the flows declined.

Results

Through 2012 boating season

For the time spanning the 2012 summer boating season, early April to early September, 32 of the 44 study beaches in the program had photographs and photographer comment sheets spanning a sufficient period of time to be evaluated. Only three of the beaches were orphaned after the initial April photo set, but 9 were not recorded late enough to be considered for a complete season. The change of the flow regime beginning in early September was chosen as the optimal time to conclude the season for evaluation, but evidence of change was included if noted in mid-late August. Of these 32 beaches, 31% were classified as Unchanged for the time period, 16% had Improved through the summer and 53% were considered as Degraded by the end of the season. Of the Unchanged beaches, 10, or 31% were located in the Marble Canyon reach, 60% in the Upper Granite Gorge reach, another 9% are contained in the Muav Gorge reach and none were located in the Lower Granite Gorge. Forty percent of the Improved beaches are located in the Marble Canyon reach, another 20% in the Upper Granite Gorge and the remaining 40% are found in the Muav Gorge reach. Neither of the two beaches located in the Lower Granite Gorge included in the study this year was considered to have improved. For the beaches classified as Degraded for this time period, 29% are from the Marble Canyon reach, 18% are found in the Upper Granite Gorge, 41% in the Muav Gorge reach and two, or 12% were located in the Lower Granite Gorge reach.

The primary factor sited as creating an Improved camp is an increase of sand on the beach front enlarging the beach and creating more favorable parking for boaters. Some of this occurred during late season when tributary floods increased sediment in the mainstem, which was subsequently deposited on nearby beaches. The predominant cause of beach degradation this season was the erosion and incision of camps by rain runoff. This was noticed particularly in the Muav Gorge reach from storms occurring the last week of July and first two weeks of August. One camp, at Upper National Canyon, was completely denuded of vegetation and sand and covered by debris. The Lower National Canyon camp was also devastated from this event, but had a very different outcome.

While the previous camp was completely lost, evaluation criteria concluded that the new beach, located 40-50 meters downstream, is an improvement from the early season camp. More campable area, easier parking, a flat, low level grade across the beach, less obstruction by vegetation and more accessible kitchen are the result. It would not be an acceptable camp if you were looking for privacy, as much of the vegetation is well back from the beach front. Beach front erosion and cutbanks as a result of the higher seasonal fluctuating flows are the second most readily evident cause of Degradation.

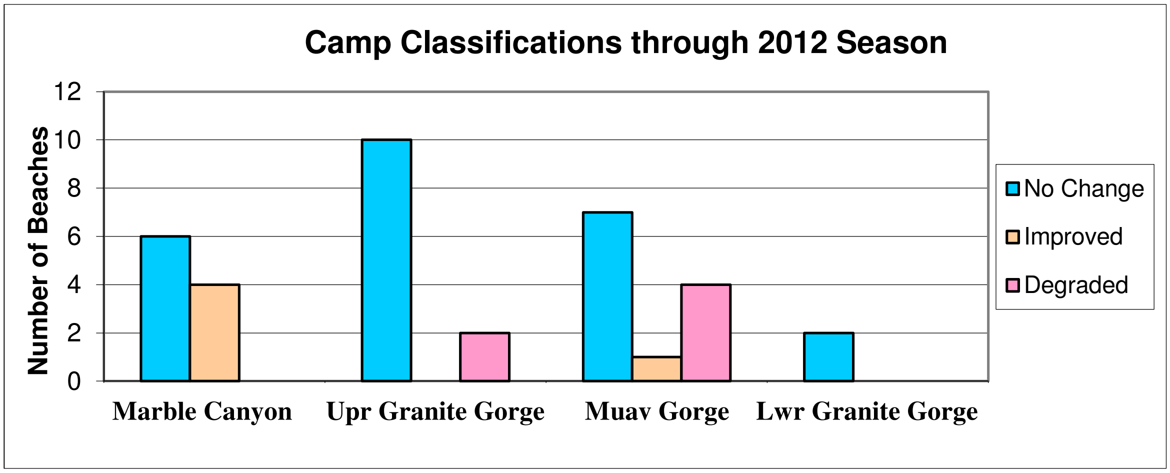

Figure 14. Graphic illustration for 2012 seasonal evaluations

Winter of 2011 - 2012

For this portion of the analysis, 36 of the beaches were included. Each had photos taken between September 5, 2011 and April 15, 2012. Almost all of the 2011 images were acquired between mid-September and mid-October. All of the 2012 images were taken during the first two weeks of April. Beaches in all 4 reaches were well represented.

Of these 36 camps, 69% did not show enough change to warrant a classification other than Same. Of these, 17% are located in the Marble Canyon reach, 28% are found in the upper Granite Gorge reach and 19% in the Muav Gorge reach. There were two beaches in the Lower Granite Gorge reach rated as Same or 5%.

Only 14% of the beaches considered showed an Improvement in camping condition at the end of the winter. This accounted for 5 beaches, 4 in the Marble Canyon reach and 1 in the Muav Gorge. In general the camps improved due to sand deposition along the beach fronts and because previously steep, cutbank associated parking areas slumped to decrease the slope and improve access. Seventeen percent of the camps evaluated were classified as having been degraded during the winter months. The camps were divided between two reaches, with 2 located in Upper Granite Gorge and 4 in the Muav Gorge. The universal factor cited as evidence for this classification was sand loss across the beach front, with the accompanying cutbanks and exposed rocks.

The flow regime release from Glen Canyon Dam during the winter of 2010-2011 began with an increase to steady flows near 20,000 cfs in November and December and included considerable daily fluctuations from January 1, 2012 through early Aril. This has proven in the past to be a cause of beach front erosion and a reduction in both camp size and preferability (Hazel et al, 1993).

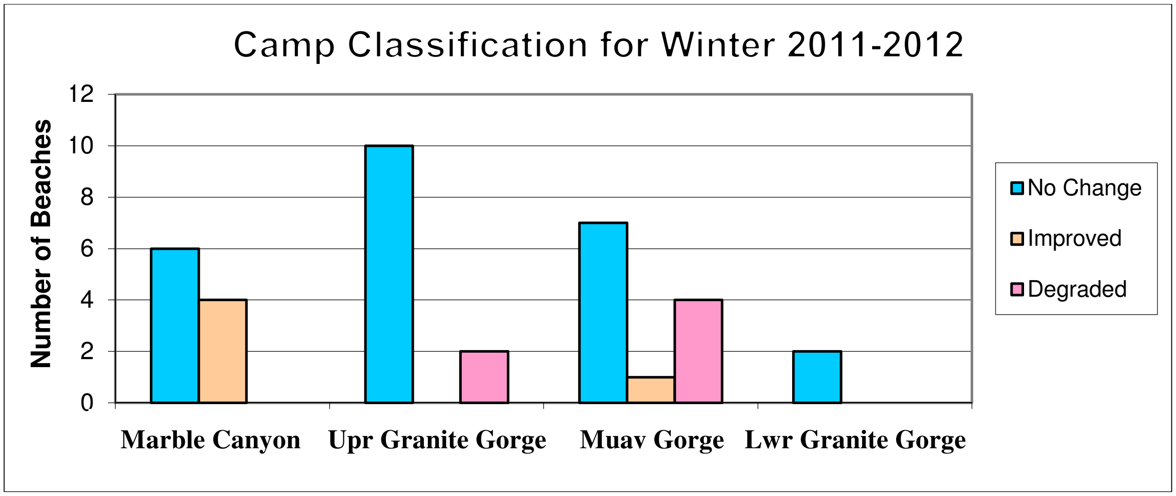

Figure 15. Graphic illustration for winter 2011-2012 seasonal evaluations

Changes since 2008 High Flow Event

The March 2008 HFE resulted in increased camping areas and improved boat parking at many of the beaches. To help evaluate the longevity of these results, comparison was conducted between photos acquired in April or early May of 2008 and photos taken late in the season of 2012. With one or two exceptions, the 2012 photos were all acquired after the end of the Summer higher flows on September 1. Twenty five beaches were analyzed in this segment of the evaluations. The other beaches either did not have images available for early 2008 and/or late 2012. One beach, 250 Mile camp, had not yet been included in the AAB beach database in 2008.

Four of the five camps displayed slight changes, if any, between comparisons. These camps were usually somewhat elevated and protected by vegetation from fluctuating flows and wind erosion. One camp, 110 Mile, was classified as Same because, while considerable driftwood and trash had been removed from the camp, vegetation increase had reduced the useable area, offsetting the results. Another 5 camps were considered as Improved in the 2012 images. Three of these camps are located in the Marble Gorge reach and were expanded by seasonal deposition from local upstream tributary flooding, presumably the Paria drainage. Another camp had improved simply because a huge cutbank at the beach edge and duning of sand in the interior of the camp had taken many months to flatten and provide a more comfortable area for camping. The remaining beach, Lower National, was completely rearranged by a late July flash flood/debris event, but was subsequently replaced by another tributary sediment contribution, presumed to be Kanab Creek, soon afterward.

Of the remaining 19 beaches classified as Degraded, most displayed combined effects of erosional forces. Removal of beach front sand, exposing rocks in boat parking/loading areas, combined with rock exposure in camp interiors from aeolian action, were the two most common interactions. Rain events which created everything from incised gullies through camps to total beach removal were also factors of high importance. Vegetation increase was also noted, but played a far lesser role in the classification results.

Tamarisk beetle tracking

This is the second season that the AAB program has been noting and recording the presence of *Diohabda spp.*, and the first time the records have been included in the annual report. As observed in the images, the effects of the beetle present as trees that go from green foliage and full form early in the season, then appear leafless and/or burnt orange in early July, and finally return to partial green again later in the summer.

Of the 44 beaches photographed in early April 2012, 27 had enough photographic evidence to evaluate the presence or absence of the beetles. Of these, 8 beaches were considered as having beetle infestation and beetles were not observed at 19. Six of the beaches did not contain trees identifiable as tamarisk and 11 did not have images covering a sufficient time span to evaluate. Of the 6 without tamarisk trees to track through the season, the 2 National Canyon camps had trees and showed evidence of beetles in the images recorded immediately before a monumental debris flow and flood removed the trees from the scene, preventing complete evaluation.

The images indicate that the beetle is active in the Marble Canyon reach, with 5 beaches, and is not well established in the Upper Granite Gorge, as no beetle activity was noted. The beetle reappears in the Muav Gorge at Kanab Creek, RM 144.0, was not found at Matkatamiba Hotel camp, and reappears at Tuckup Canyon RM 165.2 and, probably National Canyon, RM 167. There was also evidence of beetle activity in the Lower Granite Gorge at 250 Mile camp.

Conclusions

While this analysis is limited to reporting monitoring observations and presumptive factors affecting change, it does provide evidence of changes in the beaches and the effects on associated recreational camping. Both natural and manmade actions contribute to the acceptability of a beach as a desired recreational camp area.

Subsequent analysis using the results accumulated during the past seventeen years of observations could perhaps consider the hierarchical role of these factors of change. Another direction for evaluation could be the way in which individual beaches react to the multiple HFE events, or how these results are distributed through the different reaches in the system.

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 sixteen 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.

Special thanks also to the members of the Prescott College Grand Canyon semester course, November 2011. Participating students and staff took the time to photograph more than a dozen beaches during their river trip and made many 2011 – 2012 winter evaluations possible.

Thanks also to our contributors over the years: the Grand Canyon Fund, established and managed by the commercial outfitters in Grand Canyon; the Public Outreach Ad Hoc Committee of the Glen Canyon Dam Adaptive Management Program; the Grand Canyon Monitoring and Research Center; and, finally, to those individual GCRG members who believe that the Adopt-A-Beach project worthy of their support.

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Web

Geanious, Chris. Website gallery for Adopt-A-Beach images
http://www.geanious.com/gallery/main.php

Appendix A

Results of Analysis in Tabular Form

Page 1 Results of evaluations, winter season, late 2011 to April 2012

Camp name	Rvr mile	Late 2011	to	Early 2012	reason
		Same	Improved	Degraded	
Soap Creek	11.3 R	X			
12.4 Mile	12.4 L	X			
Hot Na Na	16.6 L	X			
19.4 Mile	19.4 L	X			
Upper North Canyon	20.7 R	X			
23 Mile	22.7 L				No late season 2011
Shinumo Wash	29.5 L		X		More sand on lower end, rocks covered
Nautaloid	35 L	X			
Tatahatso	37.9 L		X		Cutbank slope at front has softened
Martha's	38.6 L		X		Rocks covered at parking
Buck Farm	41.2 R		X		More sand area in general
Total above	11	6	4	0	
Nevills	76 L	X			
Hance	77.1 L	X			
Grapevine	81.7 L	X			
Clear Creek	84.6 R			X	Less camp area, beach front erosion
Zoroaster	85 L	X			Hard to tell due to water level difference
Trinity Creek	92.1 R	X			Slightly more camp area
Schist	96.6 R	X			
Boucher	97.3 L	X			
Crystal	98.7 R	X			
Lower Tuna	100.2 L	X			
Ross Wheeler	108.3 L				No late season 2011
Bass	109 R				No late season 2011
110 mile	110 R				No late season 2011
Upper Garnet	114.9 R			X	More rocks exposed at parking
Lower Garnet	115.1 R	X			
Total above	15	10	0	2	
Below Bedrock	131.7 R	X			
Stone Creek	132.5 R			X	Less sand, more rocks at lower end
Talking Heads	133.7 L	X			
Racetrack	134.2 R	X			
Lower Tapeats	134.5 R			X	Sand loss across beach area
Owl Eyes	135.2 L	X			
Backeddy	137.8 L				No late season 2011
Kanab	144 R	X			
Olo	146.1 L			X	Less sand across front
Matkat Hotel	148.9 L				Water level difference prevents eval
Upset Hotel	150.9 L			X	Less sand, more rocks at parking
Last Chance	156.3 R	X			
Tuckup	165.2 R		X		Cutbank mid beach has softened
Upper National	167 L	X			
Lower National	167.2 L				No late season 2011
Total above	15	7	1	4	
Travertine Falls	230.6 L	X			
Gneiss	236.1 R				Water level difference prevents eval
250 Mile	250.0 R	X			
Total above	3	2	0	0	
Totals	44	25	5	6	
	36				
% of beaches	82	69.4	13.8	16.6	

Page 2 Results of evaluations, through 2012 season

Camp name	Rvr mile	2012	thru	season	reason
		Same	Improved	Degraded	
Soap Creek	11.3 R		X		Slight improvement - sand input late season
12.4 Mile	12.4 L				No late season photos
Hot Na Na	16.6 L				No late season photos
19.4 Mile	19.4 L			X	Slight degradation - late season erosion
Upper North Canyon	20.7 R			X	Beach recession, cutbank, aeolian depletion
23 Mile	22.7 L				No late season photos
Shinumo Wash	29.5 L			X	Sand loss along front, more rocks visable
Nautaloid	35 L		X		Slightly better for parking/off loading
Tatahatso	37.9 L	X			Guide says same, no late season photo
Martha's	38.6 L			X *	More rocks in parking area (* Late July eval date)
Buck Farm	41.2 R			X	Lots of sand loss, though front slope decreased
Total above	11	1	2	5	
Nevills	76 L				No late season photos
Hance	77.1 L				No late season photos
Grapevine	81.7 L	X *			(* Late August evaluation date)
Clear Creek	84.6 R	X			Slight veg increase
Zoroaster	85 L				No late season photos
Trinity Creek	92.1 R			X	Increase in drainage gully size
Schist	96.6 R			X	Sand recession, more rocks at beach front
Boucher	97.3 L				No late season photos
Crystal	98.7 R	X			No change evident
Lower Tuna	100.2 L				No late season photos
Ross Wheeler	108.3 L		X		It appears people and wind have helped
Bass	109 R	X			No change evident
110 mile	110 R	X			No beetles evident
Upper Garnet	114.9 R	X			Positives and negatives equal
Lower Garnet	115.1 R			X	Sand loss across front, gully
Total above	15	6	1	3	
Below Bedrock	131.7 R				No late season photos
Stone Creek	132.5 R			X	Less sand in camp, more rocks
Talking Heads	133.7 L	X *			* Early August eval, still water covered
Racetrack	134.2 R	X			Loss of sand at parking, but slope softened
Lower Tapeats	134.5 R				No late season photos
Owl Eyes	135.2 L	X			Maybe slight decrease in camp
Backeddy	137.8 L			X	Gully exposed rocks at parking, veg increase
Kanab	144 R			X	Flood sheared off side of beach
Olo	146.1 L			X *	Sand loss from flash (* Late July eval date)
Matkat Hotel	148.9 L			X	Huge rain gullies in camp
Upset Hotel	150.9 L		X		Slight increase in sand deposition across parking
Last Chance	156.3 R				No late season photos
Tuckup	165.2 R			X	Rain gully, cutbank, tammy beetle noted
Upper National	167 L			X	Loss of camp from flash flood
Lower National	167.2 L		X *		* Old camp removed by flash, new camp is bigger!
Total above	15	3	2	7	
Travertine Falls	230.6 L				No late season photos
Gneiss	236.1 R			X *	Lots of beach loss (* Early August evel date)
250 Mile	250.0 R			X	Rain gully through lower camp area
Total above	3	0	0	2	
Totals	44	10	5	17	
Reported	32				
% of beaches	73	31.3	15.6	53.1	

Page 3 Results of evaluations, end of 2012 season to post-2008 HFE

Camp name	Rvr mile	2012	to post	2008 HFE	Reason
		Same	Improved	Degraded	
Soap Creek	11.3 R		X		refilled from 2008 scour, new sand covers rocks
12.4 Mile	12.4 L				No late 2012 images
Hot Na Na	16.6 L				No early 2008 images
19.4 Mile	19.4 L		X		larger camp due to appearance of sand spit in eddy
Upper North Canyon	20.7 R			X	front scoured, cutbank and more rocks in camp
23 Mile	22.7 L				No late 2012 images
Shinumo Wash	29.5 L			X	sand loss due to fluctuating flow erosion
Nautaloid	35 L			X	fluctuating flow, wind and rain erosion removed sand
Tatahatso	37.9 L				No late 2012 images
Martha's	38.6 L				No late 2012 images
Buck Farm	41.2 R		X		sand replaced from 2008 scour, mostly upstream end
Total above	11	0	3	3	
Nevills	76 L				No late 2012 images
Hance	77.1 L				No early 2008 images
Grapevine	81.7 L			X	definative signs of wind and fluctuating flow erosion
Clear Creek	84.6 R			X	veg increase and less sand in camp
Zoroaster	85 L				No late 2012 images
Trinity Creek	92.1 R			X	fluctuating flow and rain erosion
Schist	96.6 R			X	slight change, river and wind erosion at exposed areas
Boucher	97.3 L				No late 2012 images
Crystal	98.7 R	X			very slight change, both river and rain effects noticed
Lower Tuna	100.2 L				No late 2012 images
Ross Wheeler	108.3 L	X			very similar
Bass	109 R		X		cutbank is gone, interior is flatter, better parking
110 mile	110 R	X			less driftwood and trash in camp, but more veg
Upper Garnet	114.9 R			X	wind and some fluctuating flow erosion
Lower Garnet	115.1 R			X	rain, river and wind erosion evident
Total above	15	3	1	6	
Below Bedrock	131.7 R				No late 2012 images
Stone Creek	132.5 R			X	much smaller due to river, wind erosion
Talking Heads	133.7 L				No early 2008 images
Racetrack	134.2 R	X			very slight change with some veg increase
Lower Tapeats	134.5 R				No late 2012 images
Owl Eyes	135.2 L			X	similar, but medium/high water would now flood camp
Backeddy	137.8 L			X	veg increase, rain gully and some river erosion
Kanab	144 R			X	rain erosion and veg increase
Olo	146.1 L			X	devastated by rain with some river erosion
Matkat Hotel	148.9 L			X	fluctuating flow and rain erosion
Upset Hotel	150.9 L			X	fluctuating flow erosion and veg increase
Last Chance	156.3 R				No late 2012 images
Tuckup	165.2 R			X	fluctuating flow and rain erosion
Upper National	167 L			X	devastated by rain erosion, 2008 also hurt camp
Lower National	167.2 L		X		larger, flatter due to rain event and subsequent deposition
Total above	15	1	1	9	
Travertine Falls	230.6 L	X			very similar
Gneiss	236.1 R			X	fluctuating flow erosion and veg increase
250 Mile	250.0 R				Not included in 2008 monitoring
Total above	3	1	0	1	
Totals	43	5	5	19	
	25				
% of beaches	58	20	20	60	

 Results of tamarisk beetle observations, end of 2012 season

Camp name	Rvr mile	2012	Beetle	Observations
		Yes	No	
Soap Creek	11.3 R	X		
12.4 Mile	12.4 L			No mid-late season photos
Hot Na Na	16.6 L			No mid-late season photos
19.4 Mile	19.4 L	X		
Jpper North Canyo	20.7 R		X	
23 Mile	22.7 L			No mid-late season photos, probable
Shinumo Wash	29.5 L	X		
Nautaloid	35 L	X		
Tatahatso	37.9 L			No mid-late season photos
Martha's	38.6 L		X	
Buck Farm	41.2 R	X		
Total above	11	5	2	
Nevills	76 L		X	
Hance	77.1 L		X	
Grapevine	81.7 L			No tamarisk evident to eval
Clear Creek	84.6 R		X	
Zoroaster	85 L			No mid-late season photos
Trinity Creek	92.1 R		X	
Schist	96.6 R		X	
Boucher	97.3 L			No mid-late season photos
Crystal	98.7 R		X	
Lower Tuna	100.2 L			No mid-late season photos
Ross Wheeler	108.3 L		X	
Bass	109 R		X	
110 mile	110 R		X	
Upper Garnet	114.9 R		X	
Lower Garnet	115.1 R		X	
Total above	15	0	11	
Below Bedrock	131.7 R			No mid-late season photos
Stone Creek	132.5 R		X	
Talking Heads	133.7 L		X	
Racetrack	134.2 R		X	
Lower Tapeats	134.5 R		X	
Owl Eyes	135.2 L		X	
Backeddy	137.8 L			No mid-late season photos
Kanab	144 R	X		
Olo	146.1 L			No tamarisk evident to eval
Matkat Hotel	148.9 L		X	
Upset Hotel	150.9 L			No tamarisk evident to eval
Last Chance	156.3 R			No mid-late season photos
Tuckup	165.2 R	X		
Upper National	167 L			Probably, but removed by flash flood
Lower National	167.2 L			Probably, but evidence removed
Total above	15	2	6	
Travertine Falls	230.6 L			No mid-late season photos
Gneiss	236.1 R			No tamarisk evident to eval
250 Mile	250.0 R	X		
Total above	3	1	0	
Totals	44	8	19	
	27			
% of beaches	61	29.6	70.4	

Appendix B

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)