ADOPT-A-BEACH PROGRAM
Long-Term Monitoring of Camping Beaches in Grand Canyon

Summary of Monitoring Observations for Year 2015

By
Paul Lauck[1]

July 31, 2016


Examples of beaches with fluctuating flow cutbanks after HFE deposition.
Tatahatso Camp, RM 37.9 L (left) and Shinumo Wash Camp, RM 29.4 L (right).
Both photos taken 4/3/2015.

[1]Grand Canyon River Guides, Inc.
PO Box 1934, Flagstaff, AZ 86002

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Abstract

For the past twenty 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, conditions pertaining to the desirability of the beach as a camp for rafting parties are evaluated. Factors considered, which contribute to changes that may have an effect on the camp, 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,. Beginning at River Mile 11.3, as measured downstream from the United States Geological Survey gaging station at Lees Ferry, AZ, the 239 miles of river in the study are divided into four separate geomorphic reaches, and the resulting evaluations are also segregated and examined by reach. The conclusions are presented as observational, monitoring data only.

For the time spanning the 2015 summer boating season, early April to late October, 37 of the 44 study beaches in the program had photographs and photographer comment sheets deemed of a sufficient period of time to be evaluated. Of these 37 beaches, 19% were classified as Unchanged for the time period, only one, or 3%, had Improved through the summer and 78% were considered as Degraded by the end of the season. Of the Unchanged beaches, 14% are located in the Marble Canyon reach, 43% in the Upper Granite Gorge reach, and 43% are contained in the Muav Gorge reach. None of the Unchanged beaches were in the Lower Granite Gorge reach. Twenty-four percent of the Degraded beaches are located in the Marble Canyon reach, another 31% in the Upper Granite Gorge reach, 34% are found in the Muav Gorge reach and 10% were located in the Lower Granite Gorge reach. The single Improved beach was located in the Upper Granite Gorge reach. The primary factor cited for those camps classified as Degraded was the fluctuating flow releases from Glen Canyon Dam. This designation applied to 15 of the beaches. Twelve of the beaches have rain events cited as the primary cause. Wind erosion, vegetation increase and human impacts were also cited as present.

A comparison of the beaches from late season 2014, with photos obtained prior to the November High Flow Experiment (HFE), and early 2015 were conducted on a total of 29 beaches. Only 59% of the beaches appeared Improved in the spring of 2015. The photos indicate that many possible positive results from the HFE were undermined by a prolonged relatively high fluctuating flow regime from December 1, 2014 through January 2015. Still, only 14% of the beaches Degraded during the winter, and twice that amount, 28%, were considered Unchanged. A few of the Unchanged camps actually had some sand addition, but the shear cutbanks across the fronts of the beaches, indicative of a high fluctuating flow regime, precluded a more positive classification. Three of the 4 Degraded beaches had a shear much greater than found the previous year, and the other beach, Kanab, was practically eliminated by a flash flood during the winter.

[1] Grand Canyon River Guides, Inc., Flagstaff, Arizona (928) 773-1075

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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. The use of photographic duplication over time, and analysis of the differences between photo duplicates as a means of detecting change in the Grand Canyon landscape, has been demonstrated previously (Turner and Karpiscak 1980, Webb 1996). 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 2015 season, and the addition of new 1600 images, river runners have produced nearly 11000 replicate photographs on more than 3575 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 (see Appendix B). 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 and documented photographically. This component of the analysis was 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. Unfortunately, very few of the images acquired during the 2015 season provided information which allowed evaluation for the presence of the beetle, so it is not included in this year's analysis.

The purpose of this report is to present the results of the monitoring effort for the period between late 2014 and late October 2015. 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. A comparison of the spring 2015 beach conditions with those photographed after the HFE conducted in November 2014 are included.

Research results include reporting positive "Improved" conditions, negative "Degraded" conditions or "Unchanged" conditions, when no changes were found in beaches. Attributes of the primary and secondary processes that cause change in camping beach area and quality are also included. Specific research questions that are addressed by this report are:

- What changes, if any, are found at the beaches through the boating season of 2015?
- What changes occurred in beach conditions during the winter between the November 2014 High Flow Experiment and April 2015?
- 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 37 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, 1996-2015.

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.

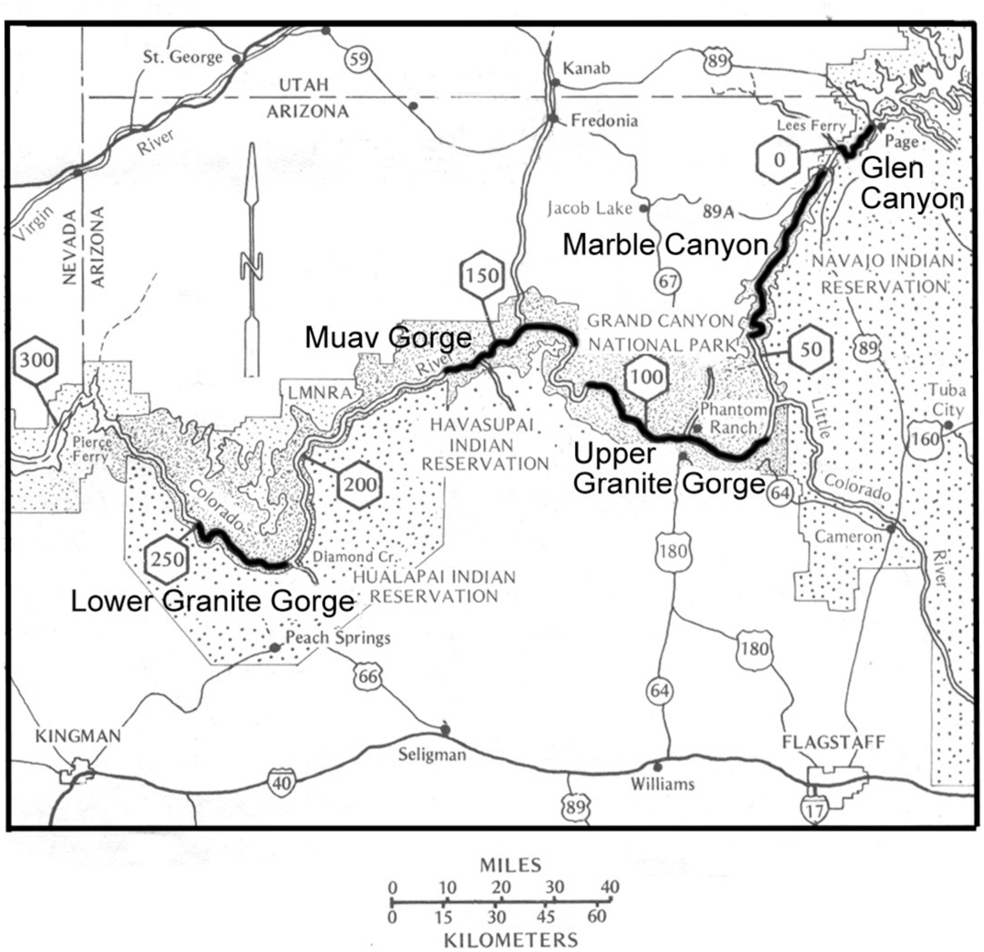

Figure 1. Locations of five critical reaches along the Colorado River in Grand Canyon National Park

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. Examples of beaches with fluctuating flow cutbanks after HFE deposition. Tatahatso Camp, RM 37.9 L (top) and Shinumo Wash Camp, RM 29.4 L (bottom). Both photos taken 4/3/2015.

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 2015 totaled 37. 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, http://www.gcmrc.gov/ 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.

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 at 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) and Colorado River Above Diamond Creek near Peach Springs, AZ (09404200). See Figures 4 – 12. 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.

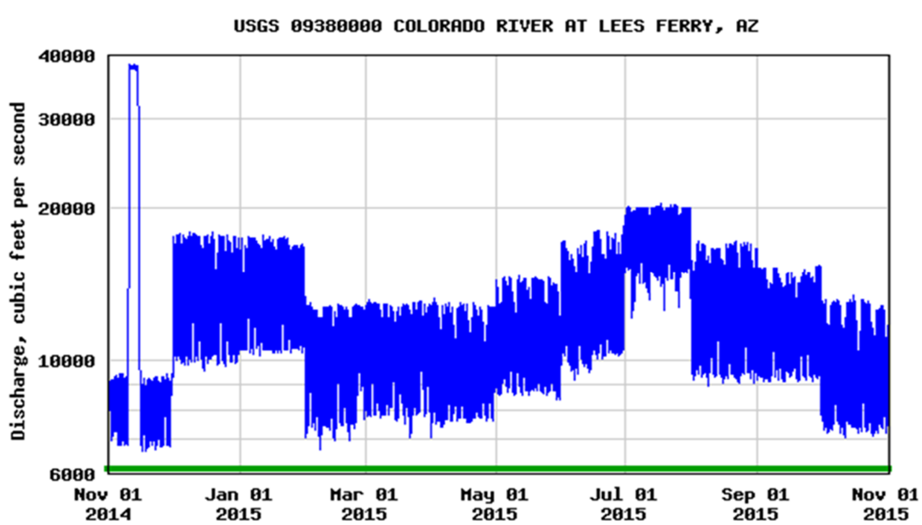

Figure 4. Flow graph for Colorado River at Lees Ferry, AZ., late 2014 through Oct 2015

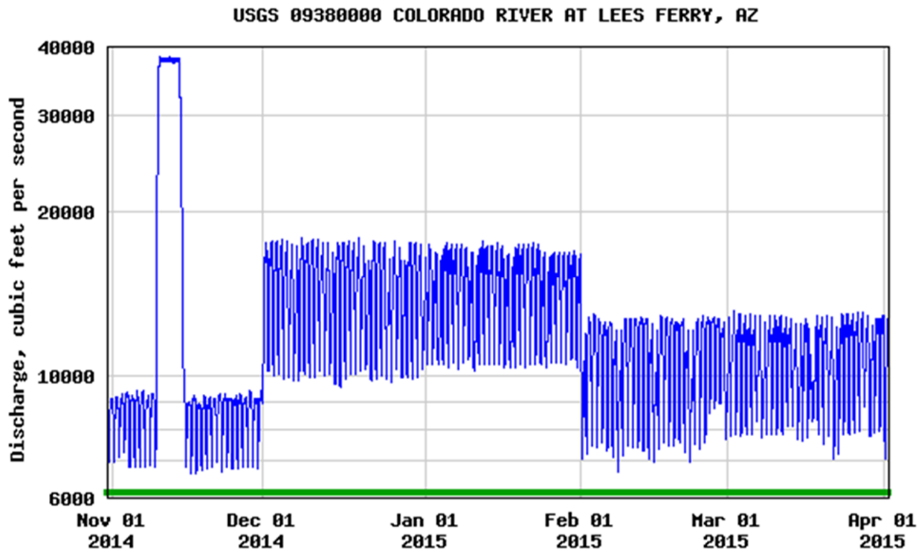

Figure 5. Flow graph for Colorado River at Lees Ferry, AZ., November 1, 2014 through March 2015

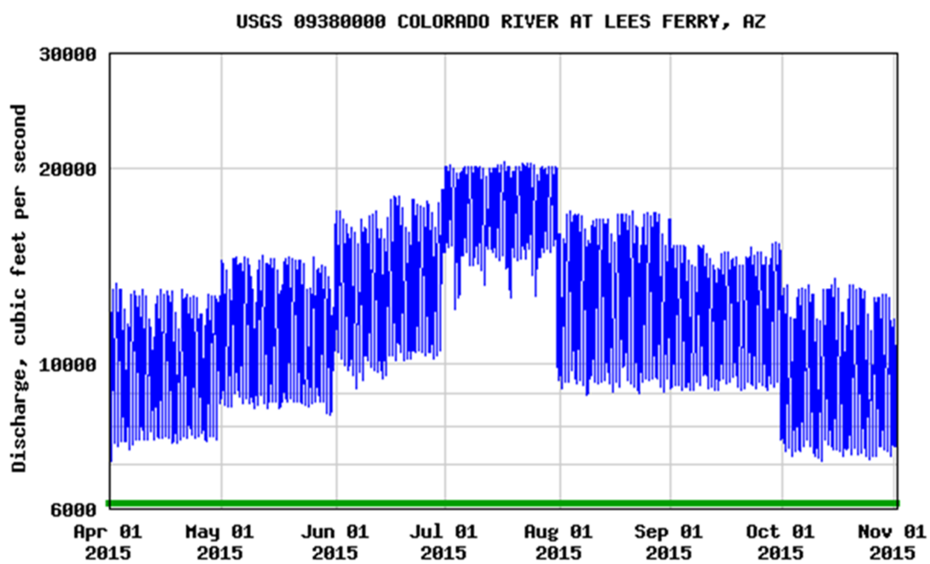

Figure 6. Flow graph for Colorado River at Lees Ferry, AZ., April 1 through October31, 2015

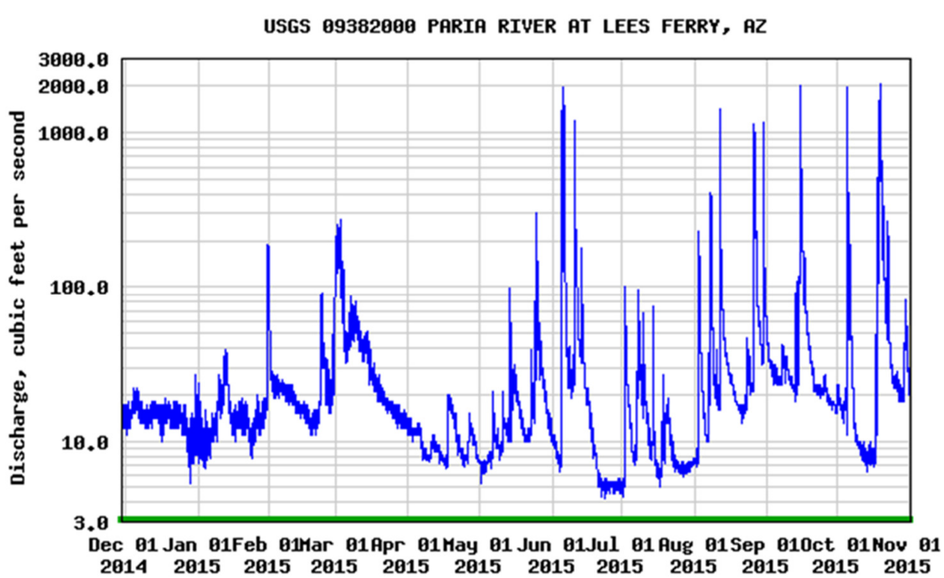

Figure 7. Flow graph for Paria River at Lees Ferry, AZ. December 1, 2014 through October 31, 2015

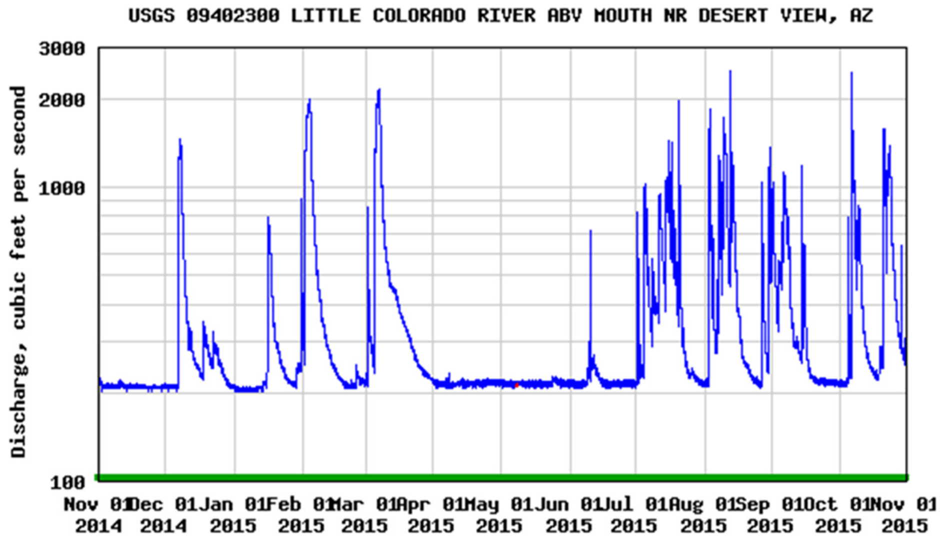

Figure 8. Flow graph for Little Colorado River above mouth near Desert View, AZ., November 1, 2014 through October 31, 2015

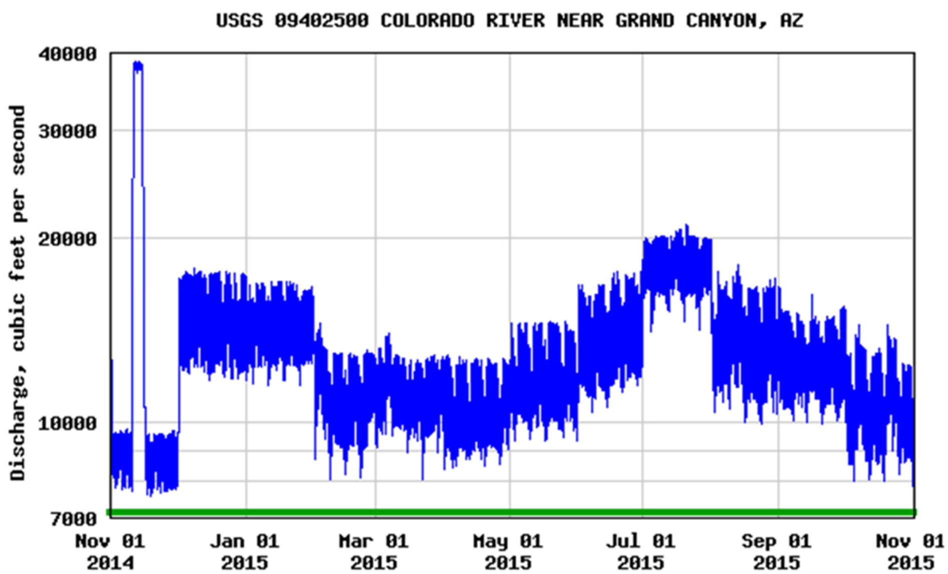

Figure 9. Flow graph for Colorado River near Grand Canyon, AZ. November 1, 2014 through October 31, 2015

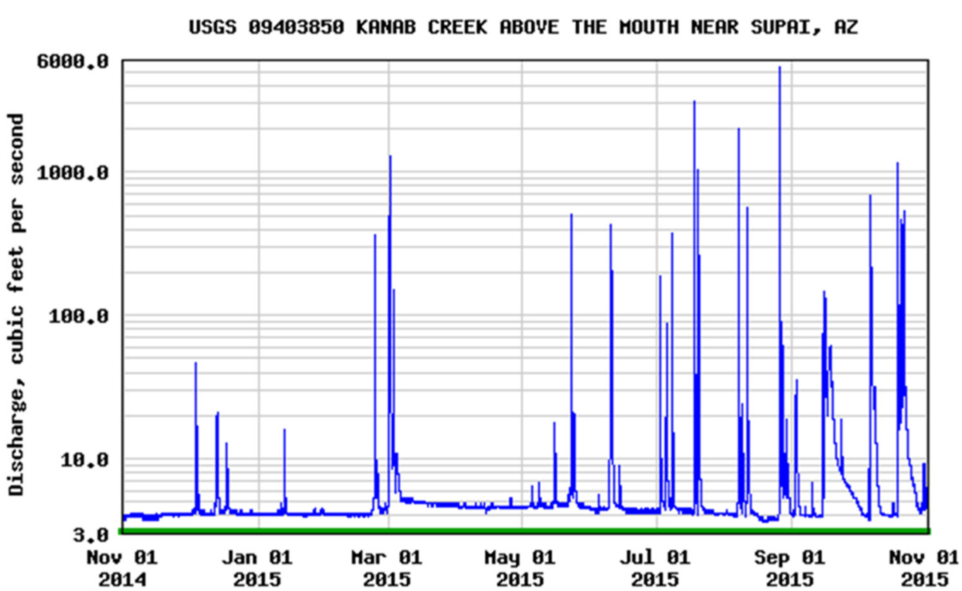

Figure 10. Flow graph for Kanab Creek above the mouth near Supai, AZ. November 1, 2014 through October 31, 2015

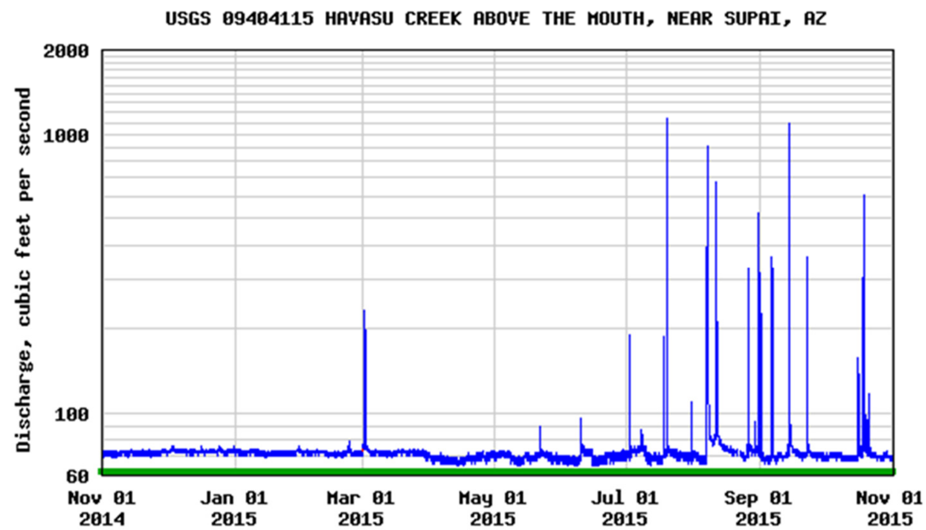

Figure 11. Flow graph for Havasu Creek above the mouth near Supai, AZ. November 1, 2014 through October 31, 2015

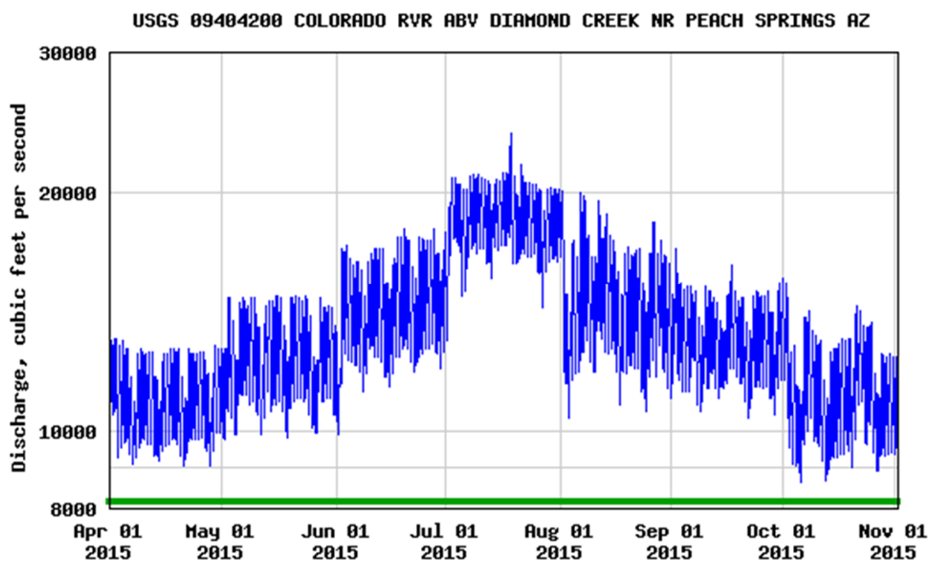

Figure 12. Flow graph for Colorado River above Diamond Creek near Peach Springs, AZ. April 1, 2015 through October 31, 2015

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, were 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.

The same kind of visual clues can also be used to determine aeolian action, particularly when the exposed and/or covered rocks and shelves are higher than any possible river flow level during the time period being examined. During the November 2013 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 rocks 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.

Because of varying photo locations from one beach to the next, some agents of change are more readily apparent than others. Deposition/erosion across a beach front at waterline is always more prominent in the images than perhaps vegetation incursion or loss. Aeolian activity on a beach is more apparent when the photograph is acquired from an angle slightly higher than the beach itself, and vegetation changes are more readily denoted when there are images of the beach in addition to the beach front itself. Not all beach photos include areas where human impacts would most likely be found.

While every effort is made to ensure an even, consistent analysis of the beaches, the patterns of photo acquisition on any particular beach may bias the evidence of an agent of change. Conversely, some bias towards a No Change determination may be present in other photo acquisition sets. The final determination is sometimes dependent on the patterns of photo acquisition established for a particular beach and, to a lesser extent, the effort exerted by the volunteer photographer.

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 Unchanged. While the designations of Unchanged, 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.

The data are compared and analyzed according to the research questions that are most applicable for the time period being studied.

Figures 13 & 14. Matkatamiba Camp, RM 148.9 L April 11, 2015 (top} and October 8, 2015 (bottom). Documented loss of camp area due to rain erosion through beach.

Results

Through 2015 boating season

Per Classification

For the period covering the 2015 summer boating season, photos were used which spanned from April 1 to late November20, with the earliest fall season ending date being July31, the latest being November 20. Thirty-nine of the 44 study beaches in the program had photographs and photographer comment sheets spanning a sufficient period of time to be evaluated, and, thanks to the generous effort by the Prescott College Grand Canyon Semester course, 19 of those beaches were photographed in November. The highest release flows during the season started July 1 and continued through that month. In order to include this factor in the analysis, the earliest season ending date considered was July 31. All 44 of the beaches were adopted for the 2015 season, but 5 were not photographed late enough in the year to be considered for a complete season analysis. Of the 39 beaches included in this portion of the analysis, 7 (19%) did not show significant changes, and were classified as Unchanged through the season. Twenty-nine of the beaches (78%) had Degraded through the summer, and one (3%) of the beaches evaluated was considered Improved by the Fall of 2015. This was the beach at Tatahatso Camp, RM 37.9 L and Improved only because slumping and human traffic created easier access to the beach, which had a severe shear cutbank face at the beginning of the season.

The most often cited cause of beach Degradation this season was the erosion by fluctuating flows, particularly noticed after the higher flows during July. Rain events were a close second and generally had more of an impact per beach than did the fluctuating flows. These impacts occurred as both flash flooding from an associated tributary or as more localized erosion from hillside runoff at the camp. Wind deflation of camps was frequently present, easily perceived as rocks became exposed above waterline.

Per Reach

Those beaches classified as Unchanged were not distributed evenly through the four reaches, with 1 in the Marble Canyon reach, 3 in the Upper Granite Gorge reach, 3 residing in the Muav Gorge reach and none of the beaches located in the Lower Granite Gorge. The 29 Degraded beaches were located in all four reaches, with 7 in Marble Canyon, 9 in the Upper Granite Gorge, 10 distributed through the Muav Gorge and all 3 of the beaches located in the Lower Granite Gorge. The Improved beach was located in the Marble Canyon reach.

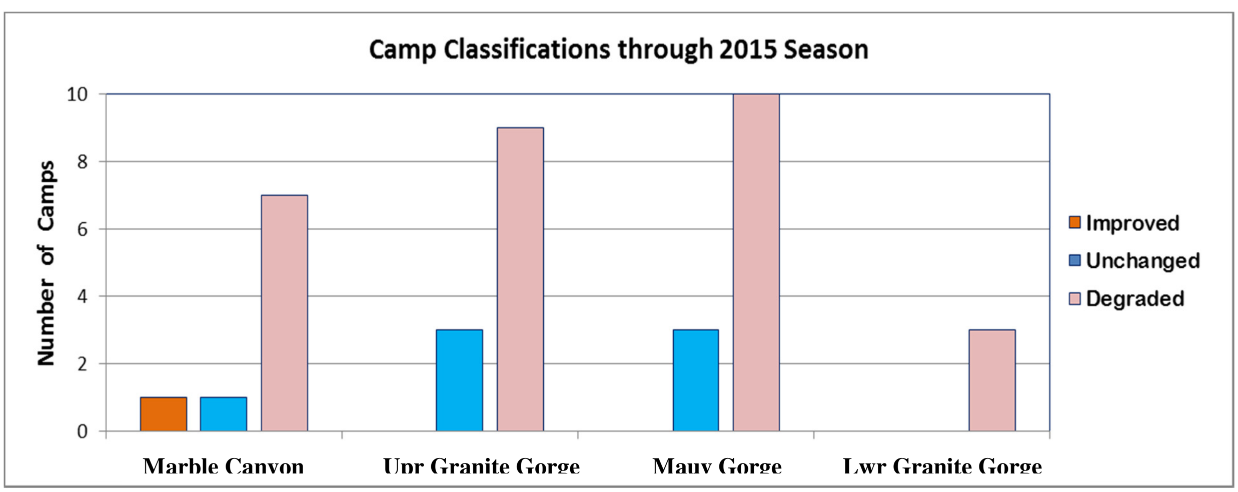

Figure 15. Graphic illustration for 2015 seasonal evaluations

Figures 16 & 17 Illustration of both beach recession across beach front due to fluctuating dam releases and wind deflation. Note rock (circled) protruding from beach. North Canyon Camp June 16, 2015 (top) and September 3, 2015(bottom)

Winter of 2014 - 2015

Per Classification

A High Flow Experiment was conducted in the Grand Canyon in November of 2014 (see Fig. 4). This event complicated the normal analysis of how the winter flow regime and weather factors affected the beaches between October 2014 and April 2015, as photos of the HFE results were not obtained until some months after the fact and after the winter flow regime. So, this evaluation partly addresses both instances.

At the beginning of April 2015, 29 of the beaches had enough photographic evidence available to be evaluated for changes during the previous 5 months. Of the twenty-nine, 8 (28%) displayed little, if any Change. Four of the beaches (14%) had Degraded over the winter and 17 (59%) showed evidence of Improvement. All of the beaches which received a classification of Improved not only demonstrated the results from the November 2014 HFE but also the ability to hold that status despite a relatively high fluctuating flow regime in December 2014 through January 2015. Three of the four Degraded beaches appeared to have benefitted by sand deposition during the HFE but were also severely damaged by beach front loss, possibly subsequent to the November event. This is frequently the result of prolonged fluctuating flow releases from Glen Canyon dam, especially when the flows reach the mid to upper teen cubic/feet/second levels as they did in December and January.

Per Reach

Those beaches receiving a classification of Unchanged only occur in the upper three reaches, with 2 in both the Marble Canyon and Upper Granite Gorge sections and 4 in the Muav Gorge reach. Beaches which Degraded were found in only two of the reaches, split evenly with 2 in both the Marble Canyon and Muav Gorge sections. Improved beaches were distributed throughout the river corridor, though not as evenly. There were three in Marble Canyon, 6 in the Upper Granite Gorge, 7 in the Muav Gorge and 1 in the Lower Granite Gorge.

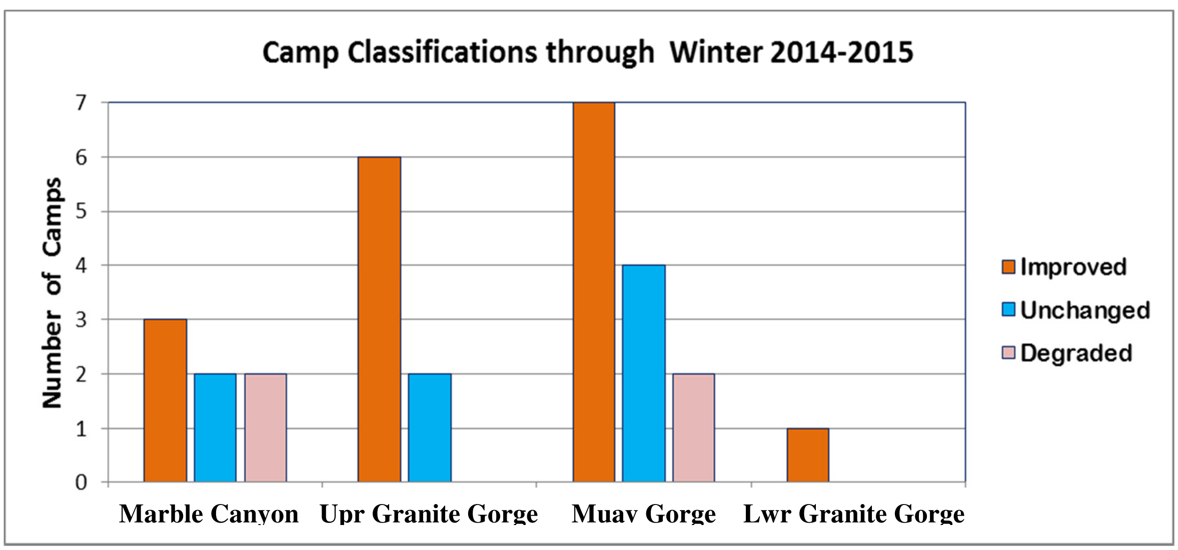

Figure 18. Graphic illustration for winter 2014 to 2015 evaluations

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. As reported in earlier studies by various investigations, fluctuating releases from Glen Canyon Dam are usually the agent of change most often associated with beach degradation, but it is certainly not the only factor.

Subsequent analysis using the results accumulated during the past nineteen years of observations could perhaps consider the hierarchical role of these factors of change.

The benefits to the beaches attributed to the HFE are well documented. This was again evident when the early April images were examined. Of particular concern, however, is the severe erosional damage found across the beach fronts, apparently inflicted by the two months of constant high fluctuating flow releases almost immediately following the November HFE. This sequence of events seems counter-productive and can hopefully be addressed in the upcoming Long Term Experimental and Management Plan Record of Decision.

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Appendix A

Results of Analysis in Tabular Form

Page 1 Results of evaluations, late 2014 season to early April 2015, including 2014 HFE

Camp name	Rvr mile	Late 2014	to	Early 2015	reason
		Same	Improved	Degraded	POST HFE
Soap Creek	11.3 R				No late season photos
12.4 Mile	12.4 L				No late season photos
Hot Na Na	16.6 L	X			No change
19.4 Mile	19.4 L		X		Much improved, lots of fresh sand
Upper North Canyon	20.7 R				No late season photos
23 Mile	22.7 L				No late season photos
Shinumo Wash	29.5 L		X		Slight improvement. Shear cutbank, post HFE fluc flow?
Nautaloid	35 L			X	Shear across front. Post HFE fluc flow?
Tatahatso	37.9 L			X	Extreme shear across front. Fluc flow?
Martha's	38.6 L		X		More sand covering rocks in front
Buck Farm	41.2 R	X			Larger camp but cutbank and scour across front
Total above	11	2	3	2	
Nevills	76 L	X			No change
Hance	77.1 L				No late season photos
Grapevine	81.7 L				No late season photos
Clear Creek	84.6 R		X		Slight improvement
Zoroaster	85 L		X		Slightly larger, but shear cutbank across front
Trinity Creek	92.1 R		X		Rain gullies filled, rocks covered in camp
Schist	96.6 R		X		Slight increase in sand around camp
Boucher	97.3 L				No late season photos
Crystal	98.7 R				No late season photos
Lower Tuna	100.2 L				No late season photos
Ross Wheeler	108.3 L				No late season photos
Bass	109 R				No late season photos
110 mile	110 R	X			No change
Upper Garnet	114.9 R		X		Sand increase at front, in camp
Lower Garnet	115.1 R		X		Sand increase at front, in camp
Total above	15	2	6	0	
Below Bedrock	131.7 R	X			No change
Stone Creek	132.5 R		X		Rocks covered in camp area, but beach is same
Talking Heads	133.7 L	X			Almost identical
Racetrack	134.2 R	X			Almost identical
Lower Tapeats	134.5 R		X		Some sand increase, but shows signs of fluc flow
Owl Eyes	135.2 L		X		Slight improvement
Backeddy	137.8 L			X	Shear across front. Post HFE fluc flow?
Kanab	144 R			X	Huge sand loss. From early March flash?
Olo	146.1 L	X			Sand relocated. No gain/loss percieved
Matkat Hotel	148.9 L		X		Huge rain gullies filled. Rocks covered throughout
Upset Hotel	150.9 L				No late season photos
Last Chance	156.3 R		X		Slight improvement in lower camp area
Tuckup	165.2 R		X		Rain gullies filled, rocks covered at front of camp
Upper National	167 L		X		Increase in camp area in back
Lower National	167.2 L				No late season photos
Total above	15	4	7	2	
Travertine Falls	230.6 L				No late season photos
Gneiss	236.1 R				No late season photos
250 Mile	250.0 R		X		Some sand added to upper end
Total above	3	0	1	0	
Totals	44	8	17	4	

 Results of evaluations, April through November 2015 season

Camp name	Rvr mile	2015	thru	season	reason
		Same	Improved	Degraded	Primary - Secondary
Soap Creek	11.3 R			X	Rain erosion from mid season flash
12.4 Mile	12.4 L			X	Rain erosion with fluc flow recession
Hot Na Na	16.6 L			X	Slight cutbank and steeper across front
19.4 Mile	19.4 L			X	Washed away by fluc flows through season
Upper North Canyon	20.7 R			X	Sand loss from fluc flow and wind erosion
23 Mile	22.7 L	X			Little change noted
Shinumo Wash	29.5 L				No late season photos (but cutbank was increasing)
Nautaloid	35 L			X	Rain erosion and cutbank from fluc flow
Tatahatso	37.9 L		X		Only improved due to sand slump, allowing easier access
Martha's	38.6 L			X	Rocks exposed from fluc flow cutbank, rain erosion loss
Buck Farm	41.2 R				No late season photos
Total above	11	1	1	7	
Nevills	76 L			X	Recession from fluc flow, some veg increase
Hance	77.1 L	X			No change
Grapevine	81.7 L			X	Veg increase compounds loss from beach recession
Clear Creek	84.6 R			X	Rain erosion through kitchen area, veg increase
Zoroaster	85 L			X	Shear across front and much recession from fluc flow
Trinity Creek	92.1 R			X	Loss of sand across front from fluc flow
Schist	96.6 R	X			Slight rain impact
Boucher	97.3 L				No late season photos
Crystal	98.7 R	X			No change
Lower Tuna	100.2 L			X	Lots of recession from fluc flows and rain gully
Ross Wheeler	108.3 L			X	Rain erosion, wind ersosion and human traffic
Bass	109 R			X	Huge shear across front from fluc flow
110 mile	110 R			X	Rain ersosion and cutbank from fluc flow
Upper Garnet	114.9 R				No late season photos
Lower Garnet	115.1 R				No late season photos
Total above	15	3	0	9	
Below Bedrock	131.7 R	X			Sand movement but no overall change
Stone Creek	132.5 R			X	Huge recession across front of beach from fluc flow
Talking Heads	133.7 L				No late season photos
Racetrack	134.2 R			X	Cutbank across front from fluc flow
Lower Tapeats	134.5 R	X			Little change
Owl Eyes	135.2 L			X	Huge recession from fluc flow, wind erosion evident
Backeddy	137.8 L	X			No significant change
Kanab	144 R			X	No sand remaining except under vegetation
Olo	146.1 L				No late season photos
Matkat Hotel	148.9 L			X	Rain erosion with human impacts
Upset Hotel	150.9 L			X	Some loss from fluc flow, but mostly human erosion
Last Chance	156.3 R			X	Huge loss of camp area due to rain erosion
Tuckup	165.2 R			X	Rain erosion, fluc flow recession
Upper National	167 L			X	Huge rain erosion gullies
Lower National	167.2 L			X	Some sand loss toward rear of beach. Front same
Total above	15	3	0	10	
Travertine Falls	230.6 L			X	Fluc flow recession and minor rain erosion
Gneiss	236.1 R			X	Fluc flow recession and obvious wind loss
250 Mile	250.0 R			X	Drainage flash, fluc flow and possibly wind loss
Total above	3	0	0	3	
Totals	44	7	1	29	

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

Do you find evidence of tamarisk beetles currently in/near this beach? YES NO

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)