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July 26, 2011

L54(2380)
WRD/PINN

Memorandum

To: Superintendent, Pinnacles National Monument (PINN)

Through: Gary Smillie, Acting Chief, Aquatic Systems Branch (ASB) *Gary Smillie*

From: Mike Martin, Hydrologist, ASB *Mike Martin*

Subject: Trip report of visit to Pinnacles National Monument, January, 2011,
Evaluation of stream conditions and a potential pond restoration site

Introduction

This memo summarizes observations made during a site visit to Pinnacles National Monument in January 2011. The focus of this trip was three-fold: (1) to evaluate the condition of, and make management recommendations regarding, two streams with observed incision; (2) to assess the possibility of restoring a former pond environment; and (3) to evaluate the potential for headcutting and incision of a headwater drainage immediately downstream from the new Visitor Center.

Overview of issues

There are two drainages within PINN identified by park staff as having active headcuts. A concern exists that this ongoing incision could compromise fluvial and associated resources. With that, park staff is interested in identifying the causes of these headcuts and whether there is an appropriate treatment for stabilization. Of a related concern, there is a headwater drainage, Jawbone Canyon, immediately downstream from the site of the new Visitor Center. Park staff is rightly concerned that re-directed runoff from the paved areas associated with the VC may cause this drainage to incise.

A separate and different issue is the potential restoration of a pond/stream habitat that may have existed in the park. There is a developed area on Bear Creek several hundred yards upstream from the headquarters area, where there is anecdotal information that a "turtle pond" may have existed. The turtle referred to would have been the Western pond

turtle (*Clemmys marmorata*), a California Species of Special Concern. This species is found in small numbers in park streams. Such a pond would likely have also provided habitat for federally-listed Threatened California red-legged frogs (*Rana draytonii*). Park staff requested a reconnaissance-level assessment to determine if signs of this former aquatic environment still exist and if there is a reasonable potential for restoration.

Description of individual sites

McCabe Canyon

The first stream site visited was McCabe Canyon, which is a perennial drainage that begins in wilderness and flows south, ultimately joining Sandy Creek in Bear Valley (figure 1). The watershed is fairly small, only extending about two miles north and generally less than one mile wide. The upland slopes are fairly steep with non-cohesive soils as is typical for this area. Near the lower end of the watershed the stream has formed a fairly broad alluvial fan, and incidentally, a private in-holding is located this area.

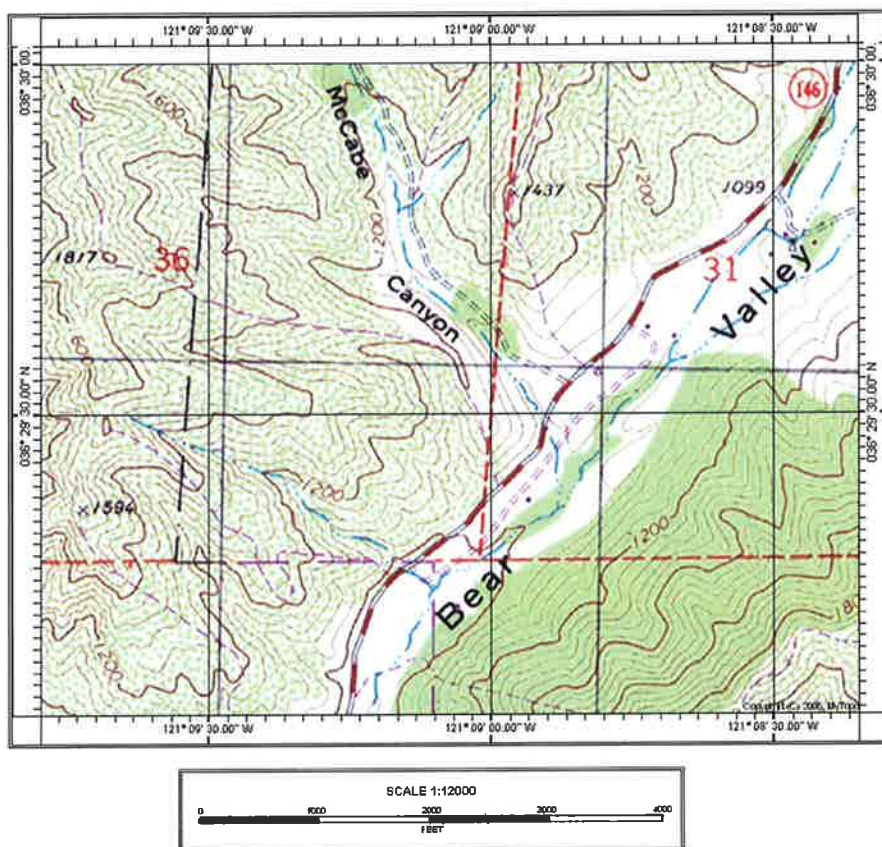


Figure 1. Excerpt from USGS topographic map, North Chalone Peak, California, 1995, showing lower reach of McCabe Canyon watershed.

In recent years, park staff has observed a number of migrating headcuts in the channel, and there is concern that continued geomorphic alteration may compromise natural resources along the drainage. Of special concern are two species of vegetation [*Carex barbarae* (white root sedge) and *Muhlenbergia rigens* (deergrass)], which grow in association with the stream. These species are of interest because they are used by American Indians and are now relatively rare within the monument.

Our reconnaissance of the channel and floodplain began at the downstream reach of the drainage just above the road crossing and continued upstream to the wilderness area. Throughout the length of the drainage we observed alternating reaches where the channel was on grade (figure 2-a) and also where it was undergoing incision (figure 2-b).



Figure 2-a. One reach of McCabe Creek that was "on-grade"



Figure 2-b. One of the incised reaches of McCabe Creek

Additionally, we located a side channel in one reach that had undergone some degree of headcutting, but erosion had ceased when the main flow accessed a different side channel, and, interestingly the new channel in this area was also undergoing incision.

Alternating reaches of on-grade and incised channel morphology is a common condition associated with valley/channel evolution. A stable channel represents a balance between channel slope, sediment input, and predominant flow. If any of these elements change, the channel will adjust to achieve a new equilibrium. One of the adjustments that may occur is downcutting, and this type of adjustment may be in response to a human-derived disturbance or natural conditions of valley evolution.

Several lines of geomorphic evidence associated with McCabe Canyon drainage suggest that the observed incision is part of the natural valley evolution processes. The primary indicator is the fact that the observed headcuts are discontinuous, with the channel alternating between "on-grade" reaches and incised reaches along its length. If some major change in the fluvial system was responsible for channel incision, it would likely be manifested along the entire length of the stream. The discontinuous headcuts are more indicative of small scale and local adjustments in channel slope due to sediment moving through the system. In addition to the discontinuous headcuts, the previously mentioned observation of incision occurring on two different side channels along the same reach suggests that this particular reach is susceptible to incision due to valley conditions rather than channel conditions.

As a reach aggrades, even on a very small scale, the channel slope increases, which in turn will increase the shear stress of any given flow. With enough aggradation (and slope increase), even a relatively small flow may exceed critical shear stress and be capable of initiating an incision in the recently accumulated sediment. As a small channel begins to form, the flow may be concentrated, the depth increases, and the shear stress increases accordingly. Alternatively, natural incision may be initiated in an on-grade drainage by an unusually large flow that exceeds the threshold stress. Ultimately, these conditions may lead to a substantial incision in a previously on-grade channel.

The fact that this watershed was likely subjected to intensive grazing in the last couple of centuries cannot be overlooked. However, during our assessment of the lower reach of McCabe Canyon we did not observe any excessive input of sediment indicative of degraded watershed conditions, nor did we observe any specific areas of severe erosion. The sediment being generated appears to be primarily from within the channel itself, including the headcut areas. Nevertheless, even if the geomorphic adjustment has resulted from past land-use activities, the present wilderness status of the upper watershed should allow the system to trend back to a natural, and presumably, more stable condition.

If specific areas of erosion, especially in the more upland zones exist in the watershed, then some type of treatment (likely revegetation) may be worthy of consideration. However, in-channel stabilization is much more problematic. Even if the observed channel incision present a severe resource threat, stabilization of the headcuts would be very difficult in this geologic setting. The local soils are very non-cohesive and easily eroded. Engineered structures have limited functionality in this setting, and stabilizing vegetation is not easily established in this relatively dry climate.

In reference to the plant species of concern, we paid close attention in reaches where either species was present. We observed no relation between the vigor of the plant communities and the degree of incision of the stream. More specifically, in reaches where substantial incision had occurred, the vegetation on the upper level terraces—those where groundwater levels would have been most affected by the channel incision—showed no signs of stress compared to plants growing on the lower channel margins.

While the main focus of this reconnaissance was to evaluate the observed erosion throughout the stream system, it is worthy to note that we identified an isolated erosion problem near the Francis residence in-holding. The flow from a small spring that emanates upslope some distance has been ditched and directed toward McCabe Creek. As it enters the creek channel, it forms a headcut with about a two-foot drop. While this is not a major area of concern, the headcut will continue to migrate along the ditch alignment. At this point the head cut would be fairly easy to treat using some form of bio-revetment such as a brush mattress at the nickpoint and redirecting the springflow out of the ditch to a more sheetflow like condition. WRD staff will be available for further consultation on treatment, if needed.

West Fork of Chalone Creek

A second site within the monument where park staff has observed active headcutting is the West Fork of Chalone Creek, located on the west side of the monument. This site is far different from McCabe Canyon with a much gentler grade and a very different morphology.

The stream reach of interest is in the upper reaches of the creek just downstream of Chaparral Campground and southwest of Machete Ridge (figure 3). The general morphology of the creek is a meandering stream with well developed cutbanks and associated point bars present along some reaches. Additionally, there is a distinct armor layer of cobbles lining most of the channel bottom and protecting the underlying soils from erosion. At one point along this reach, however, the channel becomes incised, the armor layer has been compromised, and a rapidly headward migrating nickpoint has been observed by park staff (figure 4).

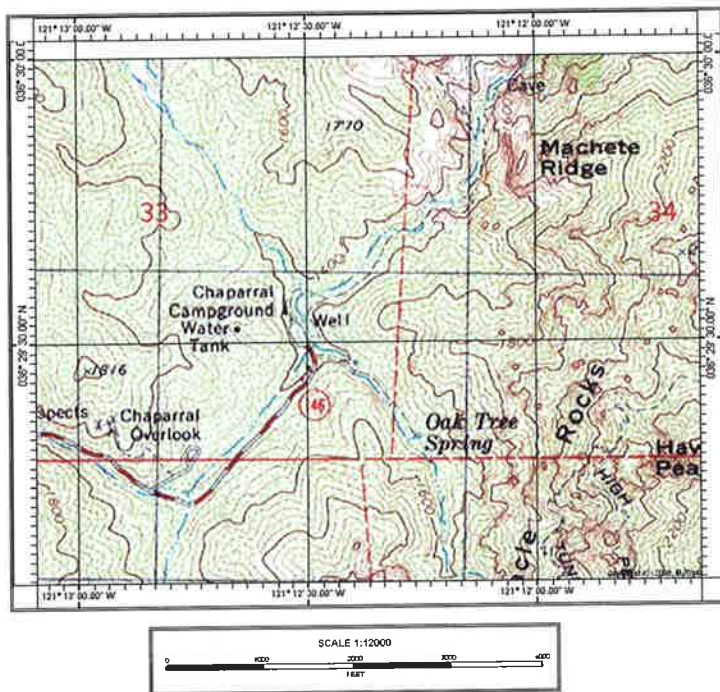


Figure 3. Excerpt from USGS topographic map, North Chalone Peak, California, 1995, showing West Chalone Creek. The creek is unlabeled, but the reach of interest is in the center of the figure downstream of Chaparral Campground.

There is a small footbridge across the creek that basically marks the transition from an on-grade meandering channel to the incised portion of the channel. Specific areas of erosion are evident downstream from this transition, but all such areas that we observed were associated with cutbank/pointbar morphology common in a meandering channel. Upstream of the transition, however, the small channel has obviously undergone recent incision breaking through the protective armor layer and even exposing a buried utility pipe (figure 4).

The point where the incision began appears to be associated with the small footbridge that spans the channel. This is not an unusual occurrence as constricting a channel by placing bridge abutments may increase depth of flow, increasing stream power, and lead to channel incision. This particular bridge configuration does not create a dramatic constriction encroaching only slightly on one side of the channel (figure 5). Nevertheless, the proximity of the bridge to the initial headcut strongly suggests a relationship between the two.



Figure 4. Reach of Chalone Creek where it has undergone incision, exposing a previously buried utility line



Figure 5. View of the small footbridge that could be the cause of the incision. Note the encroachment of the abutment on the far bank.

At this time the incision is not severe (not deep) and therefore appears to be treatable at the headcut. Such treatments generally take the form of reducing the channel slope over the nickpoint(s) either by grading the vertical feature back or by filling it forward. Then some type of surface stabilization is placed over the new slope. In this particular case, replacement of the armor layer with locally derived stones could serve as reasonable surface treatment. One problem that often ensues is undermining of the base soil by flowing water. This condition may be alleviated by placement of some type of filter layer, either a graded layer of small gravel or geotextile fabric, under the new armor layer. An

additional hydraulic structure often used in incised channels is a check dam, which is designed to collect sediment and actually restore the level of the channel. While this type of treatment is relatively simple, inadequacies in the design often times lead to failure. WRD staff will be available for detailed consultation if park staff undertakes stabilization measures.

Jawbone Canyon

The site of concern within Jawbone Canyon is located in the headwaters of the drainage. Construction of a new Visitor Center (VC) just upstream from the channel raises the issue of stormwater delivery and possible channel alterations (figure 6). It certainly appears that once any substantial storm water is delivered to the headwaters of the canyon there is going to be significant erosion and geomorphic degradation of the natural channel. The boundary of the project is right at the transition between a grassy swale (sometimes referred to as a zero-order basin) and the beginning of a channel (first-order basin). According to park staff, overland flow is very rare if it occurs at all; nevertheless, the channel is showing signs of nickpoint formation at several locations immediately downstream of the project site. This indicates that the channel, with its present slope and soil type, is right at the threshold of stability with natural runoff conditions. The soils appear to be mostly sand and very non-cohesive at the surface, so there will likely be little resistance to hydraulic forces. We did not do a comprehensive soil analysis, but our simple assessment, coupled with numerous examples of mass wasting in the surrounding hills, supports this conclusion.



Figure 6-a. (Left) Jawbone Canyon headwater area. Looking downstream from below construction site.
Figure 6-b. (Right) Jawbone Canyon headwater area. Looking upstream from below construction site.

Accepting that the soils are highly erodible and given the relatively steep slope of the drainage, if a substantial amount of water is delivered to the channel, the depth of the erosion could be dramatic, and the generated sediment could also be a resource issue downstream. Conversely, if the bedrock is fairly shallow underneath the channel, the conditions may not be so unacceptable. We looked around fairly carefully but could find no indication that there was shallow bedrock in the immediate area, although there are sizable boulders in the colluvium and obvious shallow bedrock exposed in the channel several hundred yards downstream.

Moses Spring area

The Moses Spring parking lot and associated infrastructure is located several hundred yards upstream of the HQ area along Bear Creek (figures 7 and 8). The developed area includes an 11 vehicle parking lot, a comfort station, a water fountain, and fire hose as well as underground water and sewer lines. The parking lot, which measures about 0.25 acres, actually straddles the stream channel, providing flow conveyance through three corrugated metal pipes, one of which is plugged with sediment and is nonfunctional. The downstream face of the parking lot has a drop of about 8-10 feet to meet the grade of Bear Creek. The face of this drop is stabilized with grouted stone (figure 9).

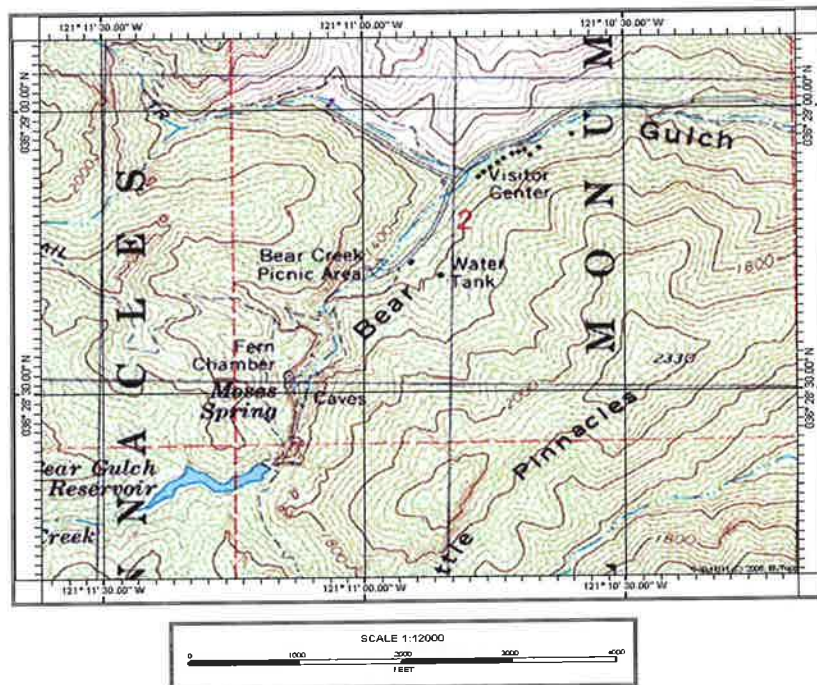


Figure 7. Excerpt from USGS topographic map, North Chalone Peak, California, 1995, showing the location of Moses Spring and Bear Creek Picnic area



Figure 8. Google Earth image portraying the setting of Moses Spring parking lot and comfort station.

There is anecdotal information that prior to parking lot construction, the Moses Springs area supported a pond habitat. Consequently, part of our objective was to identify physical features indicative of this past environment, as well as to assess the possibility of restoration.

During our reconnaissance, the only feature suggestive of a pond environment was the broad, flat area of the parking lot, and that was likely altered with fill. Other than that, we were unable to locate any signs of a previous pond habitat. Nevertheless, it is certainly possible that a small pond existed and was obliterated by site development, but there is no obvious evidence present at this time. Consequently, unless some type of documentation supporting the presence of a former pond environment comes to light, it will be difficult to view creation of a pond environment as a restoration project.

However, we continued to evaluate the immediate area around Moses Spring for the potential of creating a pond environment. First of all, we evaluated the parking lot site itself for pond creation. At this location it would be physically possible to create a pond basically by removing all parking lot pavement, fill, and buried infrastructure and replacing it with a basin structure—essentially creating a contrived pond with an artificial impoundment. Such a feature may be roughly visualized in figures 8 and 9 by mentally substituting the pavement with open water.



Figure 9. Downstream face of parking lot at Moses Springs

In addition to the parking lot itself, we considered another site immediately upstream. The channel upstream of the parking lot has a low enough gradient and a broad enough floodplain that it could be considered for pond construction. The simplest approach would be to install standpipes on the culvert inlets that would raise the water to the height of the pipe. This approach could create a shallow pond just upstream from the parking lot, with a depth ultimately limited by the parking lot elevation. To build a more substantial pond, excavation and or construction of a containment berm would be required.

Another nearby area we evaluated was immediately downstream of the parking lot. Overall, this area would not lend itself well to pond creation due to the overall channel and floodplain morphology. The channel of Bear Creek downstream from the parking lot is characterized by a gentle V-shaped valley running through the Bear Creek Picnic ground. There is a fairly well-developed floodplain/terrace on both sides of the channel (the location of most of the picnic sites), but both sides of the floodplain sit at an elevation well above the channel. Consequently, creation of a pond would require a fairly large containment structure; therefore, it does not appear that any likely pond site exists in this area.

In spite of the difficulties of creating a true pond environment in the area of Moses Spring, there may be a potential to enhance the desired habitat in this stream reach by restoring the buried stream segment with a step-pool-riffle morphology. This could be accomplished by breaking up the gradient of the stream channel with large boulders forming upstream pools and downstream steps. Whether this approach would really be effective in creating desired habitat is unclear, but it would certainly serve as a stream restoration.

Creating/restoring habitat in the vicinity of the Bear Creek Picnic area would provide frog breeding habitat between Bear Gulch Reservoir and Chalone Creek. These areas are separated by 1.5 miles of non-breeding habitat of varying quality. Creating such a “stepping stone” for the frogs would help connect the reservoir population to habitat in the rest of the monument. Currently, the reservoir is considered the only breeding habitat here that is buffered from flooding, which has the potential to wash away eggs and tadpoles throughout the stream habitat in the monument. For this reason, from 2001–2003 the park put considerable effort into re-establishing a breeding population at the reservoir.

In addition to the Moses Spring area there may be alternate locations within the park to create pond habitat. A comprehensive review of potential sites within the monument was beyond the scope of this site visit, but at least two possible locations have previously been identified. One is the bottomlands area in the vicinity of Needlegrass Canyon and another is the Kingman fish pond. Both of these sites differ from Moses Spring area as they would be groundwater-supported surface-water features.

To evaluate the viability of these or any other sites, a simple hydrologic investigation would provide the background information necessary to assess the potential for pond creation. This investigation would entail installation of a series of piezometers or observation wells that would then be measured on a regular basis. A simple yet comprehensive shallow groundwater monitoring program would not only provide valuable information on depth to groundwater, but will also ascertain the approximate seasonal fluctuation of the water table. From these data, detailed designs for viable pond habitat may be constructed. While this type of groundwater monitoring program may be simple, associated details must be considered carefully prior to well placement. A comprehensive description is beyond the scope of this memo; however, WRD staff would be available to provide on-site technical assistance to park staff on request.

An issue related to the broad consideration of pond habitat creation is the presence of several earthen impoundment structures within the park. Such structures may be responsible for a variety of hydrologic impacts, both positive and negative. One of the worst impacts is catastrophic failure, and unless earthen structures are properly designed and maintained, failure is inevitable. With that, complete removal of these structures is probably advisable. However, many of these features provide habitat for the California red-legged frog and/or California tiger salamander (*Ambystoma californiense*).

Conclusions/Recommendations

By all appearances, the discontinuous headcuts present in McCabe Canyon are part of the natural valley evolution, and therefore, stabilization measures are probably not appropriate. Furthermore, the soils of the watershed do not easily lend themselves to most types of stabilization.

Conversely, in West Chalone Creek the observed incision is likely related to the footbridge crossing. Given the relatively small incision and the presence of an armored channel, stabilization through re-grading and hardening where appropriate, and the possible inclusion of a number of small, loose-rock check dams, could probably be effective in arresting the headcut.

Jawbone Canyon, or more specifically the headwaters of Jawbone Canyon, appears to be at risk of serious channel incision due to storm water delivery from a new VC site. A complete review of construction diagrams and a stormwater management plan during a subsequent visit failed to yield unequivocal conclusions regarding potential incision. Stormwater management strategies were incorporated into the engineering design and emplaced during construction. However, little or no consideration was given the “managed stormwater” after it leaves the construction site. As stated earlier, it is our opinion that an increase of flow to the headwaters of Jawbone Canyon will result in channel incision. The depth of this incision will likely be limited by the depth of bedrock under the channel. Fortunately, there is some evidence that the bedrock may be very shallow, although the true depth is unknown at this time.

The Moses Spring parking lot area may have been a pond environment before development; however, no unequivocal evidence of this was identified at the time of the site visit. The overall setting could support a created pond environment, but it does not appear to be an ideal site from a hydrologic and geomorphic perspective, as such a pond would basically be an engineered water retention structure. Perhaps a more viable approach would be to restore the stream channel through the parking lot area incorporating a step-pool morphology to potentially maximize desired habitat. Additionally, there may be a number of other locations within the monument where an appropriate pond system could be constructed.

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