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March 1, 2002

Memorandum

To: Superintendent, Glen Canyon National Recreation Area

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Subject: Trip Report for Travel to Glen Canyon National Recreation Area (GLCA) September 24-28, 2001

PURPOSE: The purpose of this trip was to assess the functional condition of several riparian areas and associated uplands on the Kaiparowits Plateau. Additionally, GLCA staff is interested in any recommendations the assessment team could make regarding potential restoration of the sites in question.

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## EXECUTIVE SUMMARY:

An interdisciplinary team from the NPS Natural Resource Program Center was requested by GLCA to provide an independent assessment of riparian and upland resource conditions at Navajo Point on the Kaiparowits Plateau. A total of five riparian/wetland sites were evaluated using the "Proper Functioning Condition" assessment method developed by the Bureau of Land Management (BLM). The "proper functioning condition" of a riparian or wetland area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. Properly functioning systems control erosion, improve water quality, maintain healthy riparian and wetland communities, and provide good fish and wildlife habitat. Additionally, one upland site was evaluated following the principles of the BLM's *Interpreting Indicators of Rangeland Health* in the upland area south of Fork Canyon. This technique uses an interdisciplinary approach to assess the health of rangelands by evaluating soils and other appropriate ecological information. The product of this assessment is not a single rating of rangeland health, but an assessment of three landscape attributes; Soil/Site Stability, Hydrologic Function, and Integrity of the Biotic Community.

The riparian areas assessed were Cottonwood Spring (Carter Canyon), the Headwaters Area of Carter Canyon, East End Spring, Fork Canyon, and Indian Garden Meadow. All sites indicated signs of moderate to severe stress with the exception of Fork Canyon. Specifically, both Cottonwood Springs and the headwaters area of Carter Canyon were found to be *non-functional*. East End Spring was determined to be *functional-at risk*, meaning that the system is presently functional but a significant risk factor exists that could move the site into the nonfunctional category at any time. Fork Canyon was the only site determined to be in a state of *proper functioning condition*. We did not develop a formal rating for Indian Garden Meadows; however, the assessment suggests that this area is likely *functional-at risk*. The uplands assessment concluded that the area south of Fork Canyon is in a state of *moderate to extreme departure* from properly functioning reference areas with respect to soil/site stability and biotic integrity, and in a state of *moderate departure* with respect to hydrologic function. Specific management recommendations were developed to improve the condition of each site and are described in this report.

## TRIP REPORT TABLE OF CONTENTS

|                                                           |    |
|-----------------------------------------------------------|----|
| Background                                                | 4  |
| General Hydrology and Channel Morphology                  | 4  |
| Channel Entrenchment                                      | 5  |
| Groundwater on the Plateau                                | 6  |
| Riparian-Wetland Resources                                | 6  |
| Process for Assessing "Proper Functioning Condition"      | 7  |
| Discussion                                                | 8  |
| Results of Riparian–Wetland Field Surveys                 | 8  |
| 1) Cottonwood Spring                                      | 8  |
| 2) Headwaters Area                                        | 10 |
| 3) East End Spring                                        | 12 |
| 4) Fork Canyon                                            | 14 |
| 5) Indian Garden Meadow                                   | 14 |
| NPS Wetland Protection Policies and Procedures            | 16 |
| Process for Interpreting Indicators of Rangeland Health   | 17 |
| Results of Assessment on Upland Area South of Fork Canyon | 18 |
| NPS Soil and Vegetation Policies and Procedures           | 20 |
| References Cited                                          | 23 |
| Attachment 1: Assessment Site Locations                   | 24 |
| Figures 1-11                                              |    |
| Tables 1-5                                                |    |

## BACKGROUND:

An interdisciplinary team consisting of a soil scientist, wetland scientist, hydrologist, and terrestrial ecologist from the NPS Natural Resource Program Center (NRPC) was asked by Glen Canyon National Recreation Area to assess resource conditions at several sites on Navajo Point, which is at the southern end of the Kaiparowits Plateau. Focus was placed on riparian zones and associated uplands where domestic livestock grazing has been permitted. The NRPC team was accompanied by the GLCA botanist and range ecologist, and a plant ecologist, hydrologist and mycologist from the adjacent Grand Staircase - Escalante National Monument, which adjoins the Navajo Point area of GLCA.

The NRPC team evaluated present conditions of the resources and projected resource condition trends using published methods and general observations (procedures are explained in following sections). The team did not evaluate specific management practices.

### *General Hydrology and Channel Morphology*

Arid land ecosystems are often described as fragile given the slow rate of recovery from disturbance relative to more humid systems. Much of this is explained through the combination of low precipitation and high evapotranspiration, resulting in lower net primary productivity of a system. Furthermore, the infrequent nature of runoff-producing rainfall events allows stream systems to exist in a metastable state. This creates conditions where substantial flooding may destabilize channels, very likely to the detriment of any adjacent riparian areas.

Streams on the Kaiparowits Plateau are almost all ephemeral, flowing only in response to rainfall. Furthermore, the spotty nature of precipitation and the potentially long periods of time between runoff-producing events may result in channels that do not experience flow for many years. Small spring-fed systems, such as those assessed at Carter Canyon and East End Spring, are the only sources of perennial water. Consequently, these wetlands may experience disproportionate use by wildlife and livestock.

In arid environments, common hydrologic processes take on a different nature than in more humid environments. Dryland river channel flows are subject to transmission losses, namely evaporation and seepage into the banks and bed (often called abstractions). On small to medium sized drainages, floods rarely last long enough for evaporation to be a substantial abstraction. Bed and bank seepage, on the other hand, may be substantial and usually result in a reduction of discharge downstream, often times to zero. Because large percentages of the flow may be lost to bed and bank seepage, erosive potential of any individual flood event may be greatly limited in space.

Furthermore, spatially variable precipitation and relatively long periods between flow events result in difficulties in applying standard magnitude-frequency relationships to dryland stream courses. Consequently, concepts of channel-forming floods, including mean annual flows, bankfull flows and extreme floods such as the 100-year flood, are

less applicable in dryland basins than in more humid areas. The mean annual flood, while statistically very precise, has almost no practical theoretical significance in dryland rivers (Graff, W.L., 1988). Furthermore, conditions in dryland rivers do not lend themselves to "dominant discharge" theory of channel formation and maintenance. Previous studies in dryland channels suggest that a bankfull recurrence interval may range from about a 1-year flood to about a 32-year flood. With a spatially discontinuous sediment transport regime and this extremely variable flood frequency return period, desert channels may persist in otherwise unstable morphologies for many years. These relationships are particularly important when applying the "Proper Functioning Condition" analysis described in this report because the assessment relies heavily on system stability.

### *Channel Entrenchment*

Several of the streams we assessed displayed varying degrees of channel entrenchment. When viewed in the context of geologic time, channel incision is a natural process of valley and basin evolution. However, certain factors, some anthropogenic, may initiate or exacerbate channel entrenchment. From a purely theoretical standpoint, fluvial systems operate within a complex set of thresholds including (but not limited to) slope, velocity, and viscosity. In a more practical sense a stable threshold apparently exists for a given stream course; crossing that threshold in one of any number of variables may lead to instability and channel incision. Once initiated, adjustments are likely to be propagated throughout the drainage networks. However, because fluvial events are intermittent the responses are discontinuous, and stream morphology at any point in time is a representation of partial adjustment. For example, many drainages exhibit discontinuous entrenchment that has been attributed to gradient adjustment due to differential filling (Schumm and Hadley, 1957). Additionally, severe, eroding thunderstorms may initiate entrenchment in an otherwise "stable" channel.

The presence or absence of both upland and riparian vegetation may play a significant role in channel entrenchment. Changes in upland vegetation affect infiltration and runoff and therefore directly affect erosion and sedimentation. Riparian vegetation affects channel stability by anchoring soil, transpiring alluvial ground water, and providing flow resistance that reduces velocities and decreases erosion potential. Consequently, both climate change and overgrazing have been perceived to result in channelization of stream courses. Previous studies have suggested that overgrazing appears to be more of a dominant effect than climate change in small drainages (less than 1-2 square kilometers) (Hereford 1984), while larger streams (tens of square kilometers) have enough area to buffer localized effects. Both grazing and climate explain erosion but they do so at different scales of analysis (W.L. Graff, 1988).

Entrenchment of streams is of concern to land managers because the process usually results in alteration of alluvial groundwater and degradation of the associated riparian corridor. Once initiated, channelization is usually very difficult to arrest. Nickpoint migration is the process of entrenchment for many stream systems, and the rate of migration is dependent on the frequency of eroding flows. Ultimately, the eroding

drainage will reach a stable grade dependent on the predominant flows and the relative integrity of the channel bed and banks. This stable grade is controlled by a downstream "base level" such as a bedrock pour off.

### ***Groundwater on the Plateau***

Due to the general lack of surface water on the Plateau, the occurrence and movement of groundwater must be considered when evaluating these riparian systems. The sedimentary formation that caps the Kaiparowits Plateau is the Straight Cliffs Sandstone of Cretaceous Age. This formation, which varies from about 1200 to 1400 feet, is primarily a massive sandstone with interbedded members of siltstone, claystone and coal. Based on the local geologic structure and stratigraphy, all of the groundwater on the Kaiparowits Plateau is likely of recent meteoric origin. Rainfall and melting snow filter into the coarse sandy soil and percolate downward into the Straight Cliffs Sandstone until reaching either a low permeable layer or a water table. From there the subsurface water will flow down gradient until reaching a location where the water table intersects the land surface and resurge as either distinct spring flow or diffuse sub-irrigation.

Flow of water through the Straight Cliffs Sandstone is probably primarily in vertical fractures and along bedding planes. The drainages on the surface of the plateau intersect many of these fractures and bedding planes and in some locations also intersect the water table, allowing a resurgence of groundwater to the surface. In some locations, this surface or near surface water may persist for some distance down-valley, providing moisture for riparian vegetation. These springs are the only perennial water sources on the Plateau, and therefore, riparian areas are necessarily linked to areas of groundwater discharge.

### ***Riparian-Wetland Resources***

Degradation of GLCA's riparian habitats is a significant management issue because of the high level of functions and values that these resources provide. Healthy riparian systems improve water quality, maintain proper stream flow, temperature, and cover for fish and other aquatic species, stabilize channels against erosion, provide food, cover and nesting sites for many bird species, provide migratory routes and food sources for wildlife, and provide habitat for rare, threatened, and endangered plants and animals.

Riparian habitats are all the more important to protect because they provide such benefits at a disproportionately high level relative to the small percentage of landscapes that they occupy. For example, Chaney et al. (1990) report that although riparian areas cover less than 1% of the western U.S., they are the most important habitats for the majority of western wildlife species. Approximately 80% of all invertebrates in Arizona and New Mexico depend on riparian areas for at least half their life cycles, and more than half of all bird species in the southwestern U.S. are completely dependent upon riparian habitats (Chaney et al., 1990).

Wetlands, which make up a substantial proportion of western riparian zones, provide equally significant functions and values. For example, the U.S. Fish and Wildlife Service reports that 35% of threatened and endangered species depend on wetlands for at least part of their life cycles. For these reasons it is important to evaluate the condition of riparian-wetland resources that are subject to degradation by grazing or other activities and to develop ways to mitigate or prevent adverse impacts.

### *Process for Assessing "Proper Functioning Condition" of Riparian-Wetland Systems*

To evaluate the condition of riparian corridors and wetlands in the Navajo Point area we used methods developed by the Bureau of Land Management, the U.S. Forest Service, and The Natural Resources Conservation Service to assess the "Proper Functioning Condition" (PFC) of these resources. Documentation for the method used to assess riverine or "lotic" areas can be found in "A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas" (USDI - Bureau of Land Management Technical Reference TR 1737-15, 1998). This technique uses an interdisciplinary team to assess the "functional condition" of such systems according to 17 hydrology, vegetation, and stream geomorphology (e.g., erosion, deposition, channel geometry) factors. It provides an initial evaluation that can separate areas that are functioning properly from those in need of more intensive evaluation or management actions. In this way, future resource management efforts can be targeted toward priority areas.

The "proper functioning condition" of a lotic riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A healthy or stable riparian area is in dynamic equilibrium with its streamflow forces and channel processes. In a healthy system, the channel adjusts in slope and form to handle larger runoff events with limited perturbation of the channel characteristics and associated riparian-wetland plant communities.

Based on assessments of the 17 hydrologic, vegetative, and geomorphology elements of the lotic riparian area, the interdisciplinary team assigns one of the following three functionality ratings to a site:

Proper Functioning Condition (PFC): Streams and associated riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

1. Dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality;
2. filter sediment, capture bedload, and aid floodplain development;
3. improve floodwater retention and groundwater recharge;
4. develop root masses that stabilize stream banks against cutting action;
5. develop diverse ponding and channel characteristics to provide habitat and the water depths, durations, temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and
6. support greater biodiversity.

Functional-At Risk: These riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. For example, a stream reach may exhibit attributes of a properly functioning riparian system, but it may be poised to suffer severe erosion during a large storm in the future due to likely migration of a headcut or increased runoff associated with recent urbanization in the watershed. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed.

Nonfunctional: These are riparian areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, sustaining desirable channel and riparian habitat characteristics, and so on as described in the PFC definition. The absence of certain physical attributes such as a floodplain where one should exist is an indicator of nonfunctioning conditions.

It is important to note that evaluation of functioning condition is not simply an assessment of the ecological status or seral stage of the vegetation community. Rather, evaluation is based upon the concept that in order to manage for such things as potential natural vegetation communities, the basic elements of physical habitat must first be in place and functioning properly. For example, a vegetation community recovering from a recent fire can be in an early successional stage, but it may still be in proper functioning condition.

## DISCUSSION:

### *Results of Riparian-Wetland Field Surveys*

#### 1. "Cottonwood Spring" (Carter Canyon, Navajo Point)

##### Functional Assessment

Our first field site was a spring system located approximately midway between the Carter Canyon headwaters and the edge of the plateau (see map in Figure 1). Groundwater emerges on the south-facing canyon wall and moves via diffuse surface and subsurface pathways toward the ephemeral channel in the canyon bottom. The spring elevation is well below a bedrock horizon and this, coupled with distinct jointing in the Straight Cliffs Sandstone formation, strongly suggests fracture flow controlled groundwater. Moisture was apparent at the soil surface throughout much of the site, but expected riparian and wetland plant communities were mostly absent. An approximately 3-foot diameter cottonwood tree adjacent to the channel is evidence of a soil moisture source sustained throughout the growing season of every year. Such sites are apparently rare in Carter Canyon, as we saw no other cottonwood trees or similar habitats along this drainage. This stream reach has a well-developed floodplain and channel. In contrast, both up and downstream reaches exhibit v-shaped bedrock controlled channels with predominant step-pool morphology. The reason this reach differs is likely the presence of an

extremely large boulder downstream from the spring that serves to trap sediment and create a local rise in base level.

Figure 2 shows that the lower portion of this spring system continues onto the floodplain and right bank of the ephemeral channel. However, because the water source is clearly the non-riverine spring feature, we decided that it was most appropriate to evaluate the functional condition of this site using the PFC assessment method developed for non-riverine or "lentic" riparian and wetland areas. The reference for the lentic system assessment method is "A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas" (USDI - Bureau of Land Management Technical Reference TR 1737-16, 1999). This method uses essentially the same concepts and terminology as described above for lotic areas, but the evaluation sheets are modified somewhat for non-riverine landscape positions and processes. The resulting functional ratings of "proper functioning condition," "functional-at risk" and "nonfunctional" are also the same.

Results of the lentic PFC assessment for Cottonwood Spring are documented in Table 1. The assessment team determined that trampling and trailing has altered surface flow and soil-water movement patterns. Hoof action has created depressions that allow ponding and ridges that redirect surface flow or allow local drying. Loss of soil-binding vegetation has also begun to allow transport of sediment from higher to lower elevations of the spring system, which further alters hydrologic conditions and sediment budgets. Observed precipitation of calcium carbonate and/or sodium salts at the soil surface near the margins of the site may be evidence that these areas are drying. We are concerned that such possible alterations in soil chemistry could hinder recovery of historic vegetation communities.

Responses to the vegetation section of the checklist indicate severe disturbance to wetland/riparian vegetation. Most notably, the majority of the site was completely lacking in vascular plants. As stated previously, there is one mature cottonwood (sex unknown) at the site, but no evidence of cottonwood recruitment. Site conditions are suitable for willows, but none were observed. Herbaceous species in the small patches of remaining vegetation included *Poa* sp. (probably *Poa pratensis*), *Carex aurea*, *Juncus bufonius*, and *Epilobium ciliatum*, all of which exhibited very limited cover, low vigor, and low reproductive potential. The lack of woody vegetation may be altering soil and water temperature regimes, and is likely altering the water budget at the site through impacts on evapotranspiration rates.

The team rated this site as "nonfunctional." Under current management, the lack of appropriate vegetation cover and community structure do not allow this system to provide the functions provided by a healthy spring system. The most critical issue is the lack of vegetation cover on most of the site, which leaves the area subject to substantial soil loss during large rainfall or flood events. Even in the small patches of vegetation that remain, the low vigor and lack of root masses capable of sustaining high flows in the floodplain portion of the site make substantial erosion an immediate threat. The lack of a vigorous and diverse aquatic and riparian vegetation community is also likely to severely limit

maintenance of appropriate habitats for invertebrates, amphibians, and other wetland- or riparian-dependent species.

### Management Recommendations and Recovery Potential

Although the site has been substantially degraded, the assessment team felt that it could be returned to a functional wetland-riparian system with reasonable effort. Key steps would be to: 1) exclude livestock; 2) allow revegetation from the existing seed bank; and 3) reintroduce native woody species from cuttings. Control of exotic plants such as *Poa pratensis* may be necessary, and plantings of native herbaceous species (plugs) may be desirable if recovery from the seedbank is insufficient. It may not be possible to fully restore this site to pre-disturbance conditions, at least in the near term, because of soil disturbance, hydrologic changes, and soil chemistry changes discussed above.

GLCA management should evaluate the possibility that the degraded condition of this wetland area constitutes "impairment" of park resources as defined in *NPS Management Policies - 2001*, Section 1.4.5. Resource condition factors to consider during this evaluation include: a) the site is rated as "nonfunctional" due to severe resource impacts and the threat of long-term loss of the site's substrate; b) sites with wetland hydrology appear to be relatively infrequent in the Navajo Point area, so Cottonwood Spring may have contributed significantly to the area's biological diversity in its undisturbed state; and c) although the site has reasonable restoration potential as discussed previously, a large flood that would erode away substantial substrate (and wash away any associated native plant seed) could eliminate this potential and cause the damage to be long-term.

### 2. Headwaters Area of Carter Canyon (Navajo Point)

As we proceeded approximately 1/2 mile up the channel from Cottonwood Spring we observed pronounced evidence of relatively recent channel incision (Figure 3). The depth of incision increased as we continued upstream to the headwaters area, and wetland/riparian habitat was virtually nonexistent in these incised reaches. By time we reached a boundary fence in the headwaters area (see map in Figure 1) the channel was very deeply incised with unstable raw banks (Figure 4), and the fence was suspended approximately 10-15 feet above what we presume was the former land surface (Figure 5). Apparently, the incision has reached the water table and therefore is actively draining the local groundwater. Downstream several hundred yards, the stream base level is supported by a substantial logjam. If this logjam were to be lost in a flood (which is likely), then the stream bottom could incise another 3-5 feet.

### Functional Assessment

We conducted a lotic system PFC assessment at this "hanging fence" location, which we felt was representative of the headwaters stream system of Carter Canyon. The results of this assessment are documented on the checklist and notes in Table 2. The assessment team concluded that the hydrologic characteristics of this channel have been severely impacted under current management. Incision is so severe that the channel has no

functional floodplain. Any riparian or wetland vegetation communities that would have been associated with the former channel or swale have been completely eliminated by episodes of channel incision and subsequent lowering of the water table.

The almost complete lack of riparian and wetland vegetation evident in Figures 4 and 5 is reflected in the negative responses to all vegetation checklist items in Table 2. We observed no cottonwoods, willows, or other woody riparian plants in any age class. Although moisture was evident at the soil surface at the bottom of the channel, herbaceous cover was either totally absent or was less than 20% in the few existing patches of vegetation. This vegetation was predominantly "cheatgrass" (*Bromus tectorum*), a non-native, annual, upland species. Only one wetland species, hairy willow-herb (*Epilobium ciliatum*), was found sporadically in the few vegetated areas and these plants exhibited low vigor. Evidence of trampling by livestock was extensive as can be seen in Figure 5. The upper 10-12 feet of the banks were almost completely devoid of vegetation, root systems, or woody debris capable of dissipating energy during high flows.

The team rated this site as "nonfunctional." This headwater stream system has undergone severe incision and loss of virtually all beneficial wetland or riparian structure and functions. The channel remains vertically unstable, and no longer has the capacity to support riparian or wetland habitat. Further erosion and loss of resources is inevitable under current management given the lack of stabilizing vegetation, root structures, woody debris, channel roughness, or other features that would dissipate stream energy. Water quality is compromised, as sediment is also being introduced from upland areas due to livestock trailing and bank destabilization.

#### Management Recommendations and Recovery Potential

Potential management actions in this area include the exclusion of livestock and either allowing the channel to reestablish a floodplain and riparian zone at the new base level or installing check dams to help backfill the channel. In either case, park staff would most likely need to actively revegetate with native wetland/riparian species because most of the native seedbank has been lost via erosion and there are few nearby seed sources for natural establishment of cottonwoods or willows in the near term.

Stabilization of the channel through structural means would be difficult and costly. Transporting equipment and materials to do a major reclamation project of this type in this remote location may be so cost prohibitive that it is impractical to actively restore, so loss would in that case be permanent and irreversible. Furthermore, the end result may not be a vast improvement over the present situation. Soil that eroded from the channel is permanently lost, and any refilling via checkdams would be at the expense of additional erosion from impacted upland areas. Consequently, it seems more likely that the solution would be to remove livestock and allow a riparian zone to develop at the new base level, perhaps supplemented with some plantings.

GLCA management should evaluate the possibility that the severely degraded condition of the Carter Canyon headwaters channel constitutes "impairment" of park resources as defined in *NPS Management Policies – 2001*, Section 1.4.5. Resource condition factors to consider during this evaluation include: a) the site is rated as "nonfunctional" due to severe channel incision and loss of virtually all beneficial wetland or riparian structure and functions; b) further erosion and loss of resources is inevitable under current management; and c) resources lost to erosion are permanent and irreversible.

### 3. East End Spring (Navajo Point)

East End Spring (see map in Figure 1) has been developed as a water supply for livestock. A pipe was inserted into the spring to collect flow and deliver it into a watering trough. Overflow from the trough returns water to the drainageway that continues several hundred feet downstream to a pouroff at the edge of the plateau. Prior to livestock grazing, this site was most likely a vegetated swale that transmitted spring flow and runoff in a diffuse manner via surface and ground water. The observed channel is probably a result of the concentration of discharge from the developed spring and land surface alteration related to grazing. Prior to spring development, this was likely a sub-irrigated system with surface flow rarely present. However, during our site visit we observed channel incision in a number of areas (Figure 6), loss of native vegetation, soil compaction, and significant frost heaving that may have been exacerbated by hoof action (Figure 7). All of the headcuts and associated incised channels were small, on the order of one to two feet, but nevertheless, were numerous. Additionally, much of the area adjoining the stream course had experienced marked erosion as was evidenced by relict land surfaces well above the existing grade.

We examined a portion of the drainage that extends approximately 300 feet below the spring origin, and decided to conduct a lotic PFC assessment for this entire reach. Although this is predominantly a spring-fed vegetated swale, we determined that the lotic assessment was appropriate because this drainage also periodically carries runoff from rainstorms and snowmelt.

#### Functional Assessment

Documentation for this assessment is found on the annotated standard checklist in Table 3. As explained above, we determined that grazing has affected the morphology of the swale and its hydrologic processes. Livestock trailing probably caused or at least exacerbated the channel incision seen in several short reaches. Such incisions concentrate flow and lower adjacent water tables, leading to narrowing of wetland habitats in these reaches. A key observation at this site is that we saw no evidence of past flood flows either adjacent to these small channels or along the margins of the swale. The assessment team interpreted this as evidence that large erosive flows are probably rare in this small watershed.

The vegetation section of the checklist shows that there are problems with both the composition and age class distribution of riparian and wetland vegetation throughout

most of this site. Willows (probably *Salix lutea*) would be expected along at least the margins of the site but were completely absent. Although native wetland sedges such as *Carex nebrascensis* and *Carex aurea* were co-dominants in a number of locations, they were patchy in distribution, not producing seed, and often in moderate to poor condition. The non-native wetland grass "redtop" (*Agrostis stolonifera*) was a frequent co-dominant, and the upland grass *Poa pratensis* was invading many areas. *Juncus bufonius*, *Juncus balticus*, *Epilobium ciliatum* and *Plantago major* were patchy, minor components of the wetland communities. Upland species *Poa pratensis* and *Taraxacum* sp. (most likely *T. officinale*) were common on the drier margins of the site and appeared to be invading wetland communities, including on the frost heave mounds that may now be perched above the water table. These findings were interpreted as evidence of a narrowing riparian zone.

Responses to questions 11 and 13 were discussed at length because of the rainfall-runoff characteristics and small size of the contributing watershed. Had this been a system that is subject to high energy flow conditions, we would have had to answer "no" to these questions. However, due to the lack of any evidence of large flows in this drainage (probably due to rapid infiltration in sandy soils and small watershed size), we assumed that the existing plant community could continue to adequately dissipate flow energies expected in a 20-25 year return interval (or more) without significant damage to the system.

The assessment team rated this drainage as "functional-at risk" with a downward trend rather than "nonfunctional" only because of the apparent lack of erosive flows discussed above. However, we emphasize that the site is actually at *very high* risk because: a) continued trailing may cause increased incision, concentration of flows, and riparian zone narrowing, and; b) an extreme flow event could cause major bank destabilization and soil loss because of the replacement of deep-rooted native wetland species (willows, sedges, rushes) with shallow-rooted species on the margins of the site.

#### Management Recommendations and Recovery Potential

The assessment team believed that this drainage could be returned to a fully functional riparian-wetland ecosystem despite its present "at risk" condition. After some discussion we reduced the restoration prescription to four broad actions: 1) exclude livestock; 2) re-establish sub-irrigation by eliminating concentrated flow from the spring; 3) harden and stabilize incised channels through judicious placement of native boulders from the immediate vicinity; and 4) restore native woody vegetation via cuttings. Control of exotic plants may also be necessary. It may not be possible to fully return this site to pre-disturbance conditions, at least in the near term, due to changes in microtopography associated with hoof action and frost heaving.

GLCA management should evaluate the possibility that observed conditions at East End Spring constitute "impairment" of park resources as defined in *NPS Management Policies - 2001*, Section 1.4.5. Resource condition factors to consider during this evaluation include: a) channel incision, riparian zone narrowing, invasion of upland and

non-native species, and generally moderate to poor condition of native wetland species; b) East End Spring was rated "functional – at risk" with a downward trend, i.e., under present management the site has maintained its physical integrity, but expected worsening of these conditions leave it susceptible to significant damage during extreme flow events that could leave the site "non-functional." GLCA management must decide if leaving this resource in an "at-risk" condition qualifies as impairment even though the more significant resource degradation that may happen over the longer-term has not yet occurred.

#### 4. Fork Canyon (Navajo Point)

In the lower end of this drainage we found a channel reach that is apparently inaccessible to livestock due to large rock obstructions and several substantial vertical drops (see map in Figure 1). We saw this as an opportunity to evaluate the functional condition of a riparian area within the Lake allotment that is free of direct use by livestock. Figure 8 shows a portion of the reach looking downstream and Table 4 provides documentation for the lotic system PFC evaluation we completed for this site.

##### Functional Assessment

Responses to the hydrology section on the checklist indicate that these aspects of the site are functioning appropriately. We did not observe evidence of recent overbank flooding here, but the N/A response to item #1 reflects our view that frequent inundation of the floodplain above bankfull is not characteristic of this system. Responses to the vegetation checklist items were also nearly all positive. Herbaceous wetland species were largely absent due to the ephemeral nature of flow and the (natural) lack of a high water table in this channel reach. However, sandbar willow (*Salix exigua*), yellow willow (*Salix lutea*), and wood rose (*Rosa woodsii*) provide an appropriate woody community capable of stabilizing the riparian zone under flood conditions and provide other riparian habitat benefits. There was some evidence of drought stress in the willows, which led to a "no" response to item #10, but we felt that this was a temporary response to drought conditions that did not represent a threat to the stability of the system. Responses to the erosion/deposition section were uniformly positive except for item #14, which we felt was not applicable to this channel form.

Based on the discussion above and the annotated checklist responses in Table 4, we rated this channel reach as being in "proper functioning condition." No management actions are necessary at this location.

#### 5. Indian Garden Meadow

Indian Garden Meadow is part of a north-south trending, first order drainage (see map in Figure 1) that runs about one mile from its headwater area on the top of the Kaiparowits Plateau to the bedrock controlled "pour-off" on the south edge of the plateau. This site is on BLM land, but is part of the same grazing allotment as the NPS-managed Navajo Point sites discussed above. Although we did not conduct a formal Proper Functioning

Condition assessment at this site, we recorded observations about vegetation, hydrology, and geomorphology.

The overall morphology of the meadow is a broad, flat-bottomed, herbaceous swale bordered by sandstone outcrops on the margins. These outcrops rise several to tens of feet above the swale elevation, forming what is commonly known as a "box canyon." All of the rock units in this area are within the Straight Cliffs Sandstone formation of Cretaceous Age. The Straight Cliffs Sandstone is subdivided into four members with multiple interbedded layers of siltstone, claystone, and coal. It is one of these interbedded siltstones that is the underlying unit of the swale and, due to low permeability, supports the perched water table that sub-irrigates Indian Garden Meadow.

The swale is well vegetated and supports wetland and riparian species including *Juncus balticus*, *Equisetum* sp., *Carex nebrascensis* (found sporadically in very wet pockets) and the willow *Salix lutea* (found on somewhat drier meadow margins), all indicating some degree of sub-irrigation. Non-native species such as redtop and dandelion were co-dominants in many areas. The willows appeared to be heavily grazed. All were stunted (< 2 ft. tall), and the few live stems were resprouts from repeatedly grazed older plants. A number of dead willows were evident, with increasing numbers of dead plants as we approached the lower end of the swale. The swale habitat appears to be supported almost exclusively by groundwater, as there is little or no expression of a surface channel. It is possible that some surface water enters the drainage during extreme precipitation events, however, given the relatively small watershed (< 0.5 square miles) and the absence of a well defined channel, most of the water supporting the wetland and riparian vegetation likely enters the area via the subsurface.

Down gradient from the swale, a series of three headcuts have formed and are actively draining groundwater from Indian Garden Meadow. The lowest of the three headcuts displays distinct groundwater sapping both at the headcut and from the left bank of the channel. This lowest headcut creates a vertical drop of about 8-12 feet, however, a mature juniper tree is "pedestaled" about 4-5 feet above the top of the headcut, indicating that about 12-17 feet of soil has been eroded at this location (Figure 9). Moving upstream, the second headcut has a vertical drop of only about 2-3 feet. The channel between the second and the uppermost headcut has been incised to a depth that varies between a few inches to over one-foot. The third and uppermost headcut, which is at the lower end of the vegetated swale, is about six feet high and unstable (Figure 10). Although this headcut is quite high, it could probably be sloped back with handtools and stabilized with hand placement of coarse material. In addition to the channel incision and active headcutting at this location, the soil adjoining the drainage has been degraded and numerous slumps are evident, apparently related to livestock activity.

The ultimate result of the observed headcut migration will be the entrenchment of Indian Garden Meadow and the consequential draining of the local groundwater to the stable level of the channel. The time required to reach this future morphology is undeterminable and completely dependent on the frequency of eroding flows. It may

certainly be said, however, that this process will continue if not arrested, with the final change being a dramatically altered channel/wetland system.

### ***NPS Wetland Protection Policies and Procedures***

Substantial portions of the riparian habitats we visited are "wetlands" as defined by Department of the Interior and NPS wetland classification standards. Executive Order 11990 "Protection of Wetlands" directs the NPS "to provide leadership and to take action to minimize the destruction, loss, or degradation of wetlands" and "to preserve and enhance the natural and beneficial values of wetlands." NPS wetland management policies reiterate these goals, but also establish a "no net loss of wetlands" policy for the Service (NPS Management Policies, 4.6.5). These policies also state that "When natural wetland characteristics or functions have been degraded or lost due to previous or on-going human actions the Service will, to the extent practicable, restore them to pre-disturbance conditions."

NPS Procedural Manual #77-1: "Wetland Protection" provides specific procedures that NPS managers must follow when past or ongoing activities are degrading wetlands:

#### **5.5 Restoring Wetlands Degraded by Human Activities**

*Where natural wetland functions have been degraded or lost due to previous or ongoing human activities (e.g., drainage facilities, structures, agriculture), NPS General Management Plans, Resource Management Plans, Development Concept Plans, or similar planning documents must outline actions to reestablish environments in which wetland ecological processes can function as they did prior to disturbance, to the extent practicable. Highest priority should be placed on removing such damaging facilities, structures, or activities and restoring pre-existing wetland habitats and processes. Where removing such facilities or activities is not practicable, the NPS should seek ways to minimize and, to the extent possible, reverse the adverse impacts.*

#### **5.6 Retaining or Removing Structures and Facilities in Existence Prior to May 28, 1980**

*General Management Plans (GMPs) or subsequent planning documents for NPS units should include inventories of structures or facilities in existence prior to May 28, 1980 that are located in or otherwise have the potential to have adverse impacts on wetlands. These documents should justify and record decisions on the retention or removal of these facilities. ... Decisions to retain such facilities should be supported by a discussion of why relocation to a site less damaging to wetlands is not practicable, but do not require Statements of Findings. Expansion or full reconstruction of such facilities require full compliance with Director's Order #77-1 and these procedures...*

Based on these NPS policies and procedures, and the non-functional or functional at-risk riparian/wetland conditions described previously, GLCA should reevaluate grazing management practices in these areas with the objective of protecting and restoring pre-disturbance wetland plant communities and physical/biological processes, to the extent practicable.

### ***Process for "Interpreting Indicators of Rangeland Health" on Upland Areas***

To evaluate the condition of the upland areas in the Navajo Point area, we utilized qualitative assessment methods co-developed by the Natural Resources Conservation Service, Agricultural Research Service, the Bureau of Land Management, and the United States Geological Survey. These methods are described in the publication "Interpreting Indicators of Rangeland Health" (USDI – Bureau of Land Management Technical Reference TR 1734-6, 2000).

This assessment tool is designed to provide a preliminary evaluation of soil/site stability, hydrologic function, and integrity of the biotic community at the ecological site level. It is designed to assist land managers in identifying areas that are potentially at risk of degradation, and can help in the selection of sites in the development of a future monitoring program. However, this tool is not designed to identify the specific causes of resource problems, or make grazing or other management decisions.

This technique uses an interdisciplinary approach to assess the health of rangelands following a multiple step process to address ecological processes occurring at the site. It involves the use of soil survey information, ecological site descriptions, and appropriate ecological reference areas.

The product of this qualitative assessment is not a single rating of rangeland health, but an assessment of three landscape attributes; Soil/Site Stability, Hydrologic Function, and Integrity of the Biotic Community. Definitions of these three closely interrelated attributes are:

***Soil Site Stability:*** The capacity of the site to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water.

***Hydrologic Function:*** The capacity of the site to capture, store, and safely release water from rainfall, run-on (inflow), and snowmelt (where relevant), to resist a reduction in this capacity, and to recover this capacity following degradation.

***Integrity of the Biotic Community:*** The capacity of the site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure due to disturbance, and to recover following disturbance.

As part of the assessment process, 17 indicators relating to these attributes are evaluated, and the category descriptor or narrative that most closely describes the site is recorded. "Optional Indicators" may also be developed to meet local needs. The critical link

between observations of indicators and determining the degree of departure from the ecological site description and/or ecological reference area is the interpretation process.

This process will not provide for just one rating of rangeland health, but based upon a "preponderance of evidence" approach, it will provide the three attribute's departure from the ecological site description/ecological reference area(s). There are 5 categories of departure recognized, which include "none to slight", "slight to moderate," "moderate," "moderate to extreme," and "extreme." Areas of interest with "moderate" to "extreme" ratings may stimulate other actions (i.e., such as a review of existing inventory or monitoring efforts, communication with other groups or agencies involved in the management of the area) to then determine the cause of the problems.

### ***Results of Assessment on Upland Area South of Fork Canyon***

After returning from our riparian assessment in Fork Canyon, the group felt it would prove beneficial to evaluate the rangeland resources of the upland areas above Fork Canyon to understand the processes that may be affecting the overall health of the area. Figure 11 shows a portion of the assessment area. Table 5 provides documentation for the Interpreting Indicators of Rangeland Health we completed for this site. Due to time constraints, only one assessment on upland areas was performed.

Present vegetation at this upland site was scattered pinyon (*Pinus edulis*), juniper (*Juniperus osteosperma*), big sagebrush (*Artemisia tridentata*), Antelope bitterbrush (*Purshia tridentata*) and green rabbitbrush (*Chrysothamnus viscidiflorus*), with scattered Indian ricegrass (*Stipa hymenoides*), muttongrass (*Poa fendleriana*) squirreltail (*Elymus elymoides*), and blue grama (*Bouteloua gracilis*) present. Many of the woody shrub individuals were heavily browsed, and numerous decadent or dead shrubs were observed. The grasses present seemed to express low vigor, and tended to be concentrated under the canopy of the shrub species. Non-native cheatgrass (*Bromus tectorum*) was widely distributed throughout the site, and appeared to be the dominant grass species present. Biological soil crusts were present, but were limited to protected areas under shrub canopies, and in many instances were observed currently being buried by active littoral sand movement. Biological soil crusts which were observed in open areas expressed significant pedestalling, which provided a visual indicator of the amount of soil loss from these areas.

Soils at the site exhibited examples of active movement by wind, with several "blowouts" and coalesced coppice dunes present, displaying a drifted or rippled surface. A large amount of unvegetated soil surface was found in the interspaces between the shrubs, with some minor evidence of water erosion (sheet and rill) following discontinuous flow patterns. Much of the original surface horizon of these soils have been removed over time, and in several instances the calcareous subsoils are now at the surface. Surface soil texture was a very fine loamy sand, with little or no aggregate stability present. Organic matter, which normally accumulates in the soil surface horizon, was minimal. Numerous exposed plant roots were observed, and much of the available plant litter was deposited

on the leeward sides of plants, and other surface obstacles. Terracettes were also noted in the interspaces.

After consulting the Glen Canyon NRA Soil Survey for this area (USDA - Soil Conservation Service, 1988), we identified that we were within soil map unit 149 - "Palma Family - Lanver Family complex, 2 to 25 percent slopes." Upon observing the soils at the assessment location, we confirmed that we were on a fairly representative pedon of the Palma series, which are very deep, somewhat excessively drained, moderately rapidly permeable soils that formed in eolian and mixed alluvial material derived from sandstone. These soils have a high potential for wind if disturbed.

Past evidence of fire was observed in the area, with several charred pinyon and juniper trunks still present. It was unclear as to when the last major fire episode for this particular area occurred. This would be beneficial to determine, as the corresponding range site description for this soil map unit denotes that when the potential native plant community is burned, pinyon, juniper, and non-sprouting shrubs decrease, while grasses, forbs, and other sprouting shrubs increase.

Due to lack of specific Ecological Site Descriptions for the soil map units identified in the existing soil survey for the area, and an adequate Ecological Reference Area nearby, we developed local worksheets as allowed for under the procedures.

#### Assessment Results

Using the preponderance of evidence approach, the group noted a moderate to extreme departure from the Soil/Site Stability attribute, a moderate departure from the Hydrologic Function attribute, and a moderate to extreme departure from the Biotic Integrity attribute.

Under current management, the lack of appropriate vegetation cover and community structure, along with the impacts to the soils and overall site stability do not allow this system to provide the normal functions of a healthy rangeland site. However, the group feels it is important to note that this protocol performed is not intended to be used as a "stand alone tool" to determine the final "health" or functional status of the three attributes of rangeland health.

Other actions, such as additional assessments in other surrounding areas, or the initiation of a quantitative inventory and monitoring effort may be recommended.

#### Management Recommendations and Recovery Potential

Accelerated wind erosion appears to have had the biggest impact on this site, and may be as a result of past and ongoing disturbances in the area. Wind erosion occurs when windspeed at the soil surface is sufficient to detach and transport soil particles. Soils are more susceptible to wind erosion when disturbance exposes individual particles and soil

aggregates to the wind. Conditions such as crushed or broken soil physical and biological crusts, a reduction in plant cover, and a decrease in the amount of plant litter and soil organic matter, and an increase in distance between wind barriers can increase the susceptibility of the soil to wind erosion.

Impacts such as heavy grazing, can disrupt or destroy physical and biological crusts on the soil surface which normally "armor it". Heavy grazing can also impact the vegetative community, and open up larger areas of unprotected soil surface to the forces of wind.

Potential management actions in this area might focus on the initial exclusion or reduction of livestock, in conjunction with the incorporation of other qualitative and quantitative assessment methods which might provide additional information. Questions as to the actual impairment of soils, vegetative communities, and hydrologic function are in most cases not the result of only one factor, but may occur in conjunction with man's impact on the landscape, as well as with other natural variables such as climatic change and fire history. At this time, the recovery potential for this site might be evaluated through recent techniques addressed in ecological site descriptions and state and transition models. (Stringham et al, 2001)

GLCA management should evaluate the possibility that the degraded condition of this upland area constitutes "impairment" of park resources as defined in *NPS Management Policies – 2001*, Section 1.4.5. Resource condition factors to consider during this evaluation include: a) loss of surface soil resources due to accelerated wind erosion evident across a large extent of the uplands in this area, with a threat of long-term loss of the site's overall soil productivity, or ability to properly function; b) the lack of appropriate vegetation cover and community structure to potentially allow for natural plant succession; and c) although the site has reasonable restoration potential, it still remains vulnerable to large natural events such as high intensity wind storms, intense rainfall, or fire, that could increase the probability of future soil erosion, and with it the removal of any associated native plant seed, and cause the damage to be long-term.

***NPS Soil and Vegetation Policies and Procedures as noted in the NPS Management Policies 2001***

**4.8.2.4 Soil Resource Management**

*The Service will actively seek to understand the soil resources of parks, and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or it's contamination of other resources.*

The section goes on to state:

*Management action will be taken by superintendents to prevent, or if that is not possible, to minimize adverse, potentially irreversible impacts on soils.*

#### 4.4.1 General Principles for Managing Biological Resources

These principles are...

*Preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur;*

*Restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions; and*

*Minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them.*

##### 4.4.1.1 Plant and Animal Population Management Principles

*The individual plants and animals found within parks are genetically parts of species populations that may extend across both park and non-park lands. As local populations within a group of populations naturally fluctuate in size, they may become vulnerable to natural or human-caused extirpation during periods when their numbers are low. The periodic disappearance of local populations is common in some species, and the regional persistence of these species depends upon the natural recolonization of suitable habitat by individuals from the remaining local populations. Thus, providing for the persistence of a species in a park may require maintaining a number of local populations, often both within and outside the park.*

##### 4.4.1.2 Genetic Resource Management Principles

*The Service will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity.*

This section continues by explaining that:

*... the management goal is to increase the variability of the park gene pool to mitigate past, human-induced loss of genetic variability. Actions to transplant organisms for purposes of restoring genetic variability through gene flow between native breeding populations will be preceded by an assessment of the genetic compatibility of the populations.*

And the section concludes,

*...when native plants or animals are removed for any reason -- such as hunting, fishing, pest management, or culling to reduce unnatural population conditions resulting from human activities -- the Service will maintain the appropriate levels of natural genetic diversity.*

#### 4.4.2.4 Management of Natural Landscapes

*Landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to mitigate for excessive disturbance caused by past human effects... Landscape and vegetation conditions altered by human activity may be manipulated where the park management plan provides for restoring the lands to a natural condition.*

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Attachments: 17

Cc:

GLCA – Spence, Bobowski  
2380 – Kimball, Jackson

**ATTACHMENT 1****Assessment Site Locations**

Universal Transverse Mercator, Zone 12, North American Datum 1927

| Site Number | Site Name                      | Northing (meters) | Easting (meters) |
|-------------|--------------------------------|-------------------|------------------|
| 1           | Cottonwood Spring              | 4114431           | 497082           |
| 2           | Headwaters Area, Carter Canyon | 4115156           | 497478           |
| 3           | East End Spring                | 4113430           | 497390           |
| 4           | Fork Canyon                    | 4116956           | 496182           |
| 5           | Upland Assessment              | 4116102           | 496219           |
| 6           | Indian Garden Meadow           | 4123358           | 487957           |



Figure 2. Cottonwood Spring, Carter Canyon. (Rating = Nonfunctional)

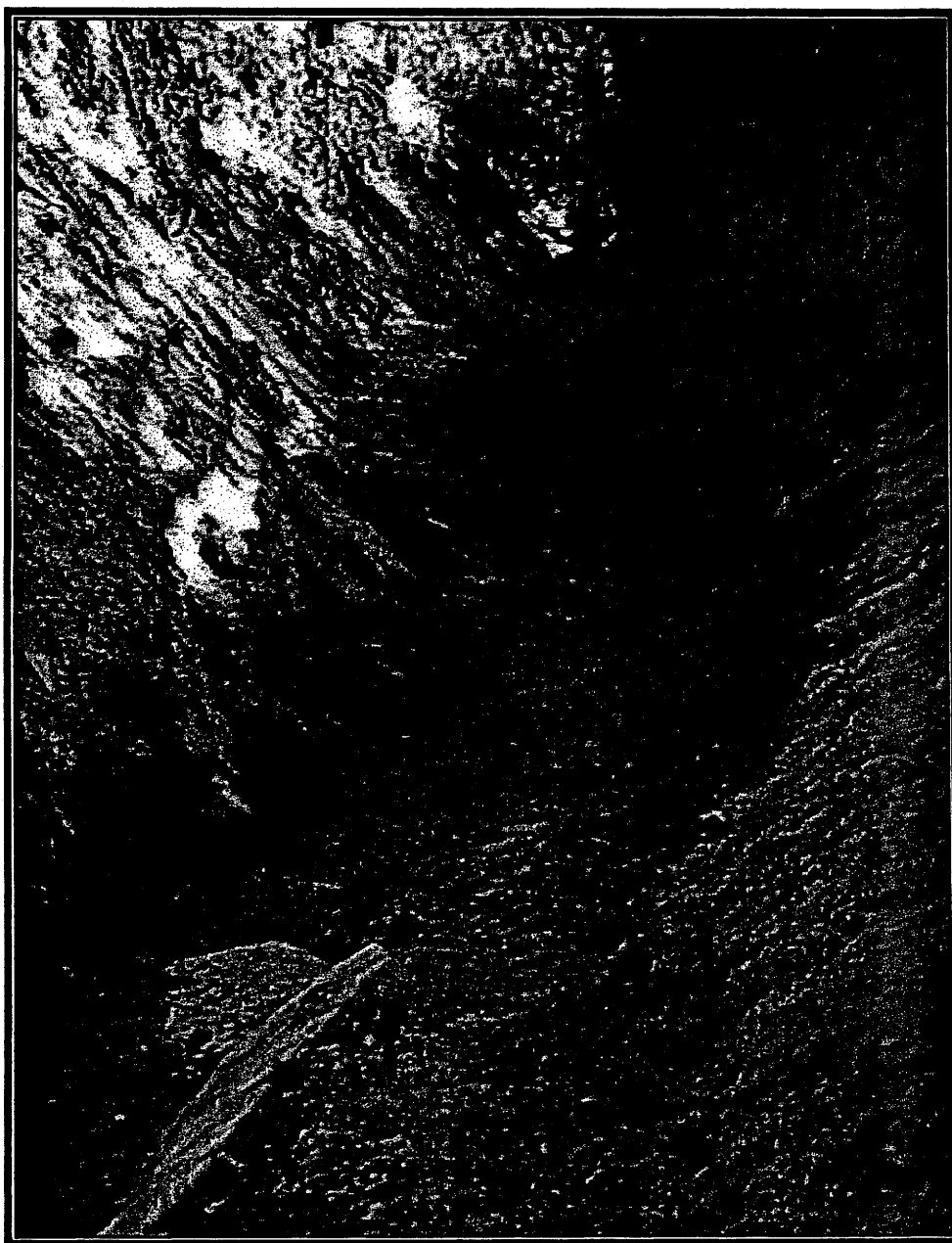


Figure 3. Carter Canyon channel above Cottonwood Spring.

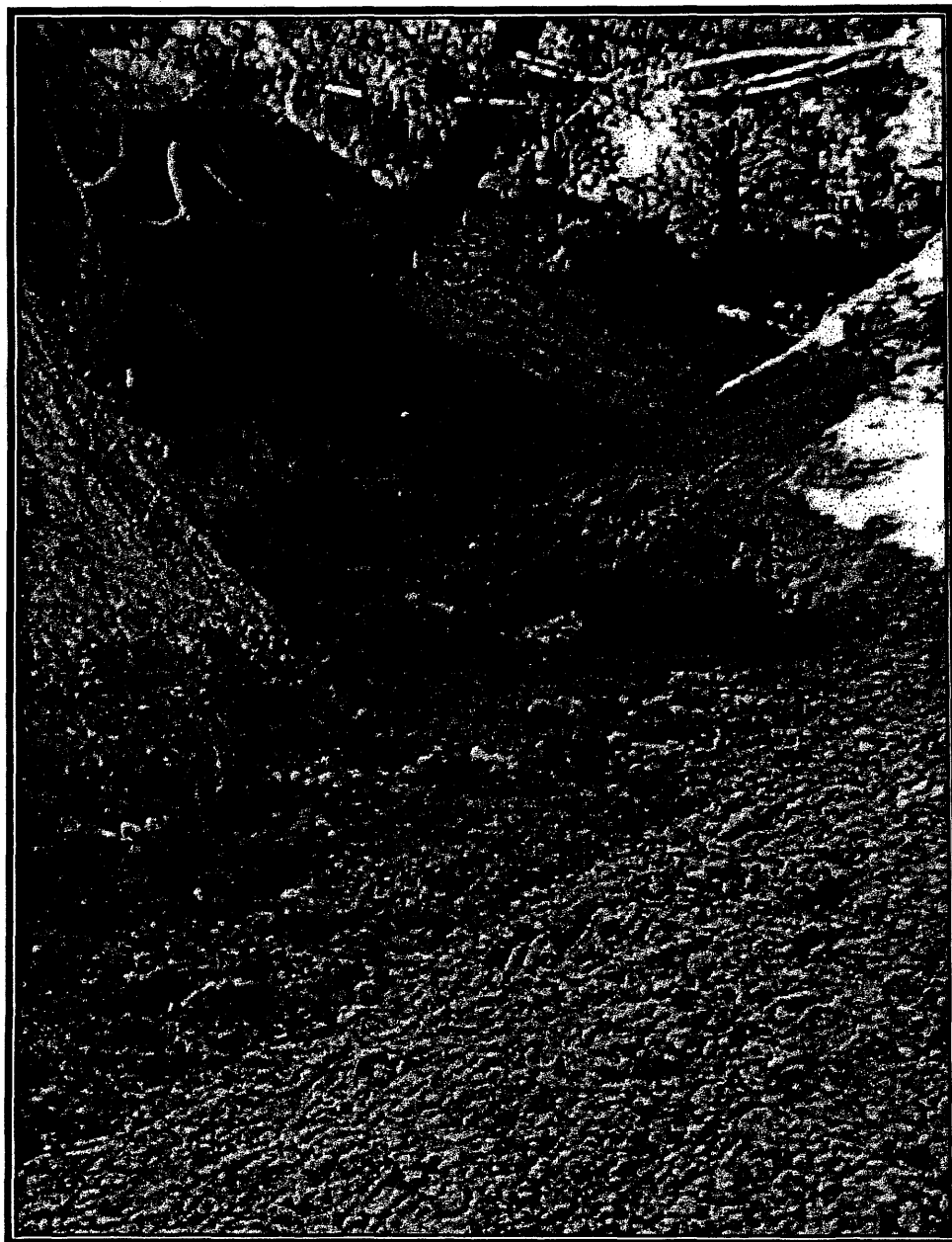


Figure 4. Carter Canyon headwaters channel. (Rating = Nonfunctional)



Figure 5. Hanging Fence, Carter Canyon headwaters channel. (Rating = Nonfunctional)

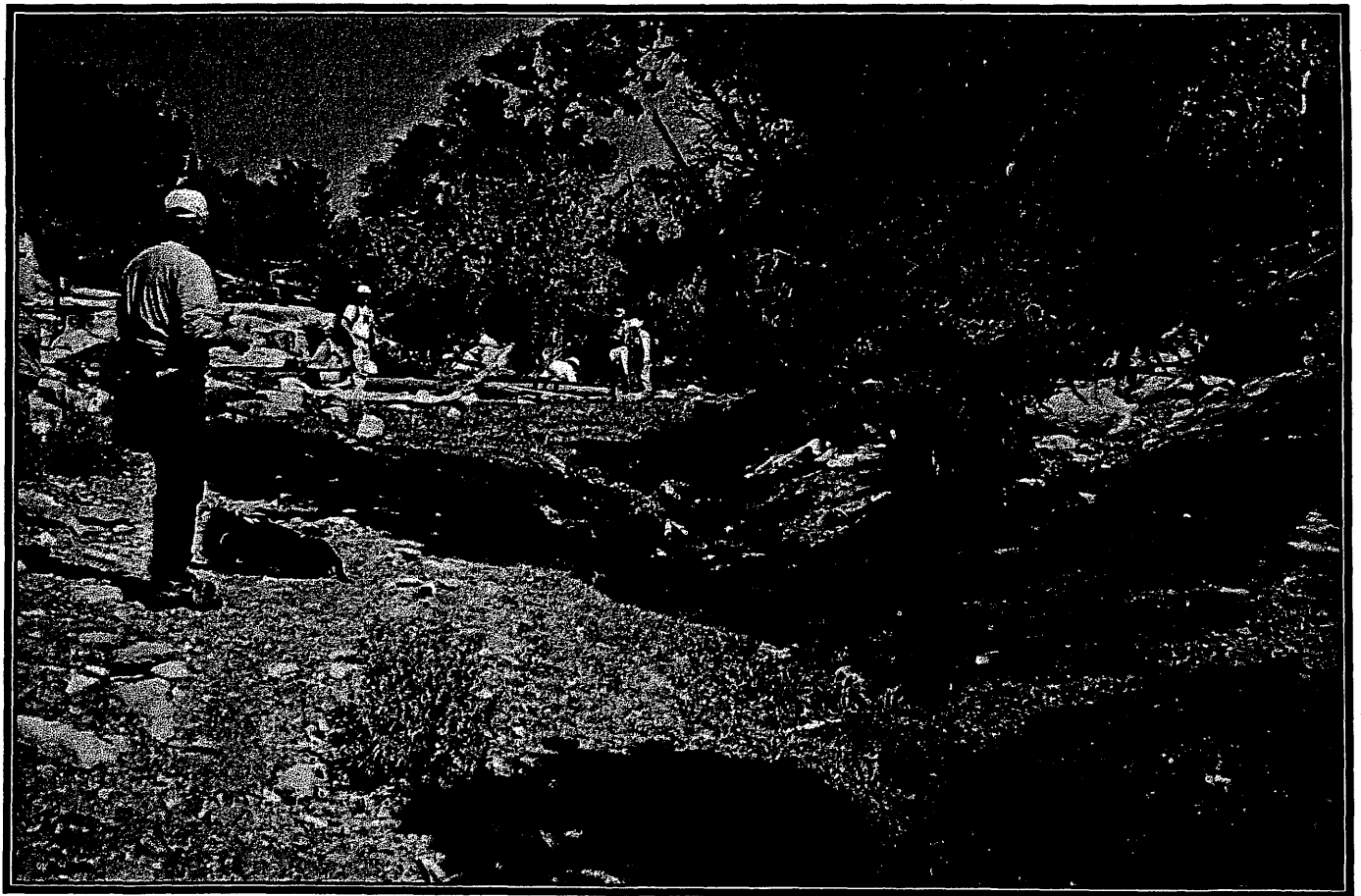


Figure 6. East End Spring. Note incised channel in foreground and spring development in background. (Rating = Functional at-risk with downward trend)



Figure 7. East End Spring. Note small mounds and irregular surface formed by grazing activity and periodic frost action.



Figure 8. Functional riparian zone, lower Fork Canyon.

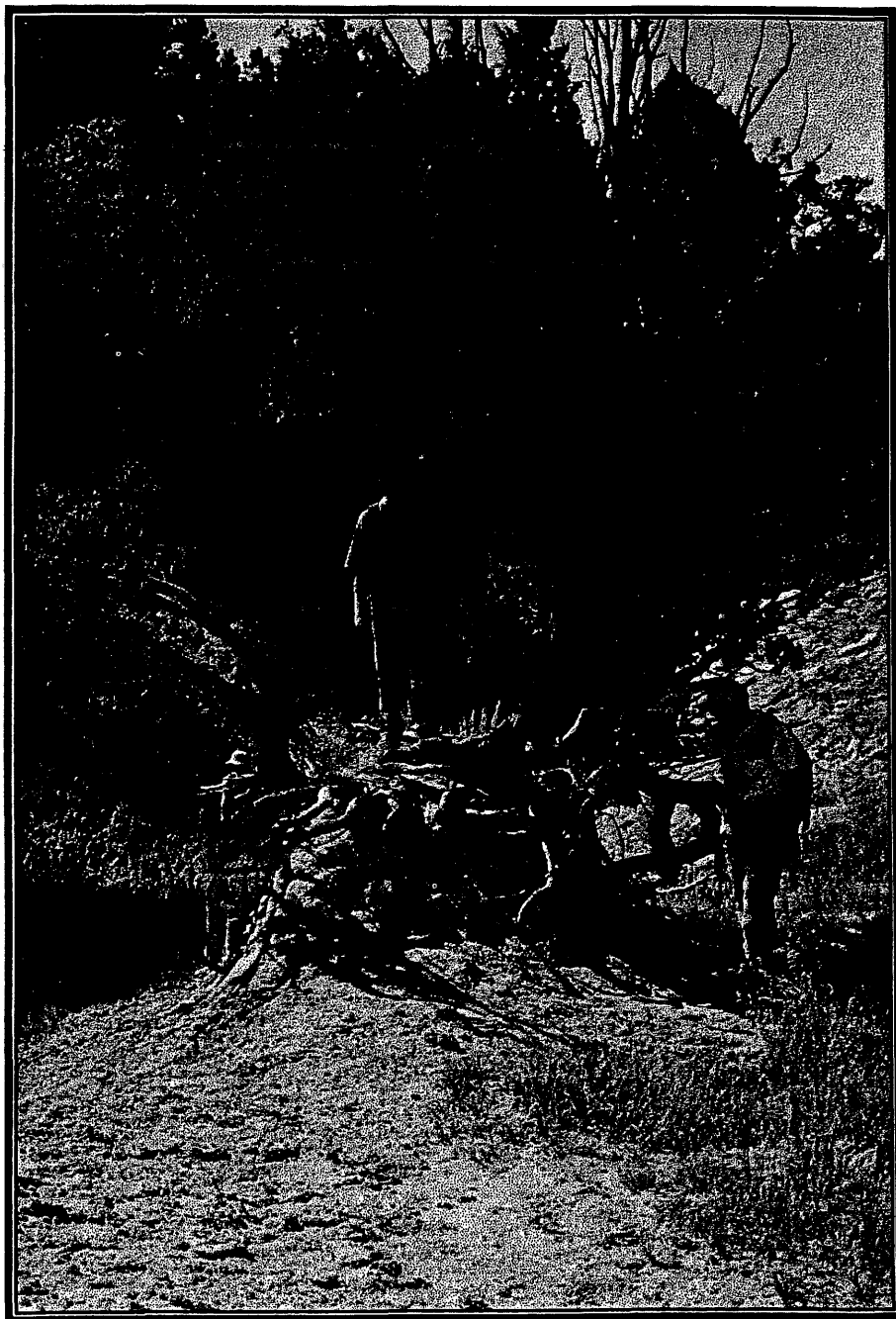


Figure 9. Indian Garden Meadow. Pedestalled Utah juniper.

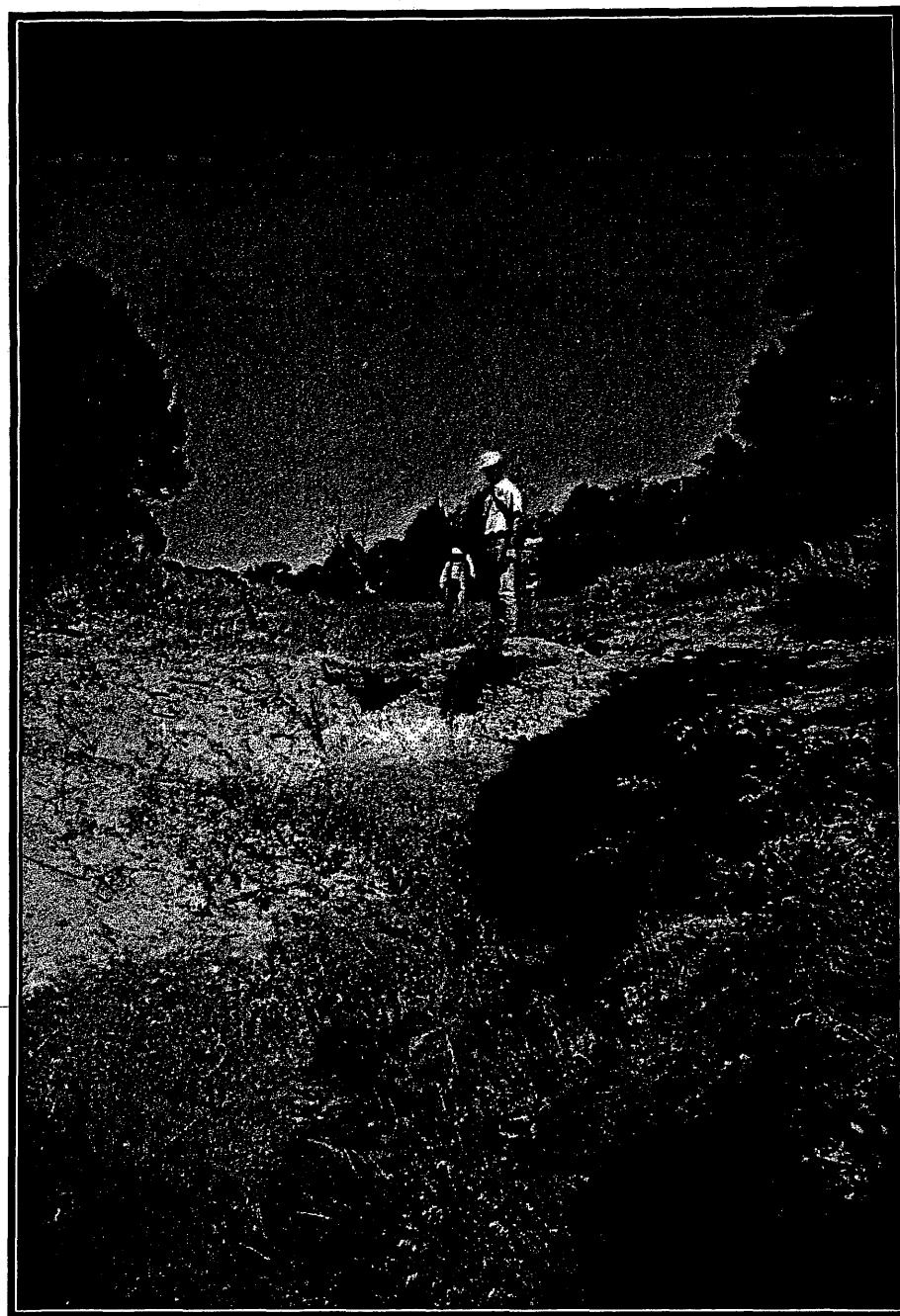


Figure 10. Upper headcut at Indian Garden Meadow.

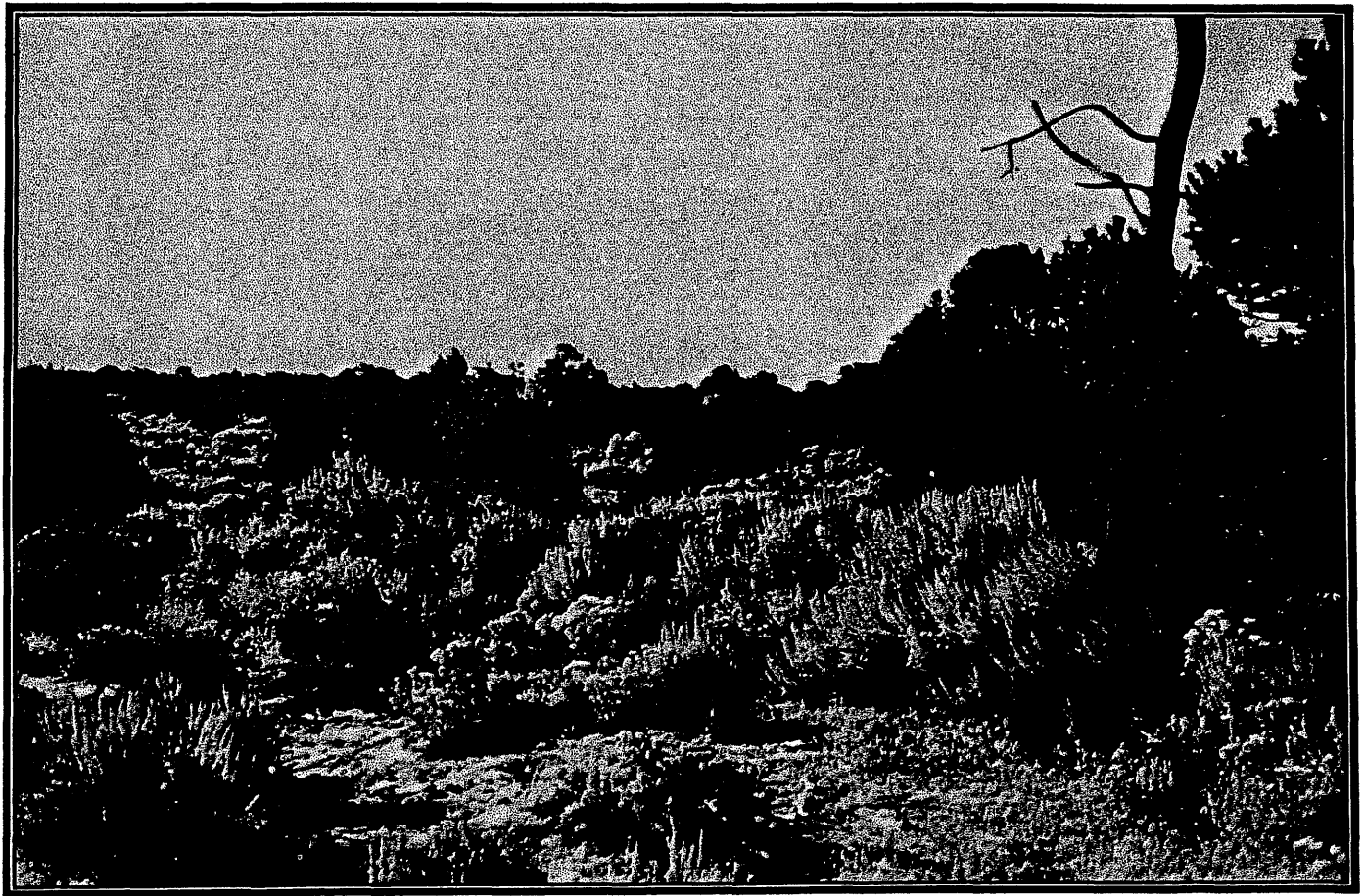


Figure 11. Upland area south of Fork Canyon.

Table 1.

## Lentic Standard Checklist

Name of Riparian-Wetland Area: "Cottonwood Spring," Carter Canyon, Navajo Point, GLCA

Date: 9/25/01

Area/Segment ID: \_\_\_\_\_

Acres: \_\_\_\_\_

ID Team Observers: P. Biggam, G. Eckert, M. Martin, J. Wagner

| Yes | No | N/A | HYDROLOGY                                                                                                                                                          |
|-----|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X   |    |     | 1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events                                                          |
| X   |    |     | 2) Fluctuation of water levels is not excessive                                                                                                                    |
|     | X* |     | 3) Riparian-wetland area is enlarging or has achieved potential extent                                                                                             |
| X   |    |     | 4) Upland watershed is not contributing to riparian-wetland degradation                                                                                            |
| X*  |    |     | 5) Water quality is sufficient to support riparian-wetland plants                                                                                                  |
|     | X* |     | 6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) |
|     |    | X   | 7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)                                                                       |

| Yes | No | N/A | VEGETATION                                                                                                                                                                                     |
|-----|----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)                                                                               |
|     | X  |     | 9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)                                                                                                      |
| X   |    |     | 10) Species present indicate maintenance of riparian-wetland soil moisture characteristics                                                                                                     |
|     | X  |     | 11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) |
|     | X  |     | 12) Riparian-wetland plants exhibit high vigor                                                                                                                                                 |
|     | X  |     | 13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows                            |
| X   |    |     | 14) Frost or abnormal hydrologic heaving is not present                                                                                                                                        |
|     | X* |     | 15) Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics                                                               |

| Yes | No | N/A | EROSION/DEPOSITION                                                                                                                                 |
|-----|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 16) Accumulation of chemicals affecting plant productivity/composition is not apparent                                                             |
|     | X* |     | 17) Saturation of soils (i.e., ponding, flooding frequency and duration) is sufficient to compose and maintain hydric soils                        |
| X*  |    |     | 18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation                                             |
|     | X* |     | 19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)          |
|     |    | X   | 20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies |

\* - see remarks on reverse

(Revised 1999)

## Remarks

- (3) Hoof action has altered flow patterns/extent and increased sedimentation. Result is more ponding in hoof depressions, other areas pushed up above water (dry) or altered by sediment.
- (5) On margins of site, precipitation of calcium carbonate and probably Na salts is evident. Limited vegetation still present; park may not be able to immediately restore native vegetation community due to increased salt concentration.
- (6) See note for #3.
- (8) There is one mature cottonwood (sex unknown) and no evidence of cw recruitment. No willow present at all (though expected). Herbaceous spp. include *Poa pratensis*, *Carex aurea*, *Juncus bufonius*, *Epilobium ciliatum*. All are heavily impacted (presumably by grazing) with low to no seed production, low diversity, low recruitment, low vigor. (Park staff have never seen more cover here than we observed today).
- (15) Lack of adjacent woody vegetation (willow, cottonwood) thought to alter temp. regime and ET rates (change in water budget).
- (16) Observed ppt. of calcium carbonate and possibly sodium salts on drier margins (see #5)
- (17) Wetland area appears to be getting smaller due to hoof action as explained in note # 3 above.
- (18) "Geologic structure" is bedrock.
- (19) Upgradient impacts (in spring) from livestock concentration, trailing, etc., is causing some erosion at higher elevations and some deposition below.

## Summary Determination

### Functional Rating:

Proper Functioning Condition \_\_\_\_\_  
 Functional – At Risk \_\_\_\_\_  
 Nonfunctional   X    
 Unknown \_\_\_\_\_

### Trend for Functional – At Risk:

Upward \_\_\_\_\_  
 Downward \_\_\_\_\_  
 Not Apparent \_\_\_\_\_

### Notes:

Most critical problem is lack of vegetative cover over most of the site. Where there was some vegetation cover, dominant species don't have root systems that could hold site together during storm events. Erosion and alteration of flow paths is evident. Patterns of unnatural ponding and areas of drying are common, with precipitation of calcium carbonate and probably sodium salts on dry margins. Result is degraded and decreased habitat and potential difficulty in recovery.

### Are factors contributing to unacceptable conditions outside the control of the manager?

Yes \_\_\_\_\_  
 No   X  

### If yes, what are those factors?

\_\_\_ Dewatering      \_\_\_ Mining activities      \_\_\_ Watershed condition  
 \_\_\_ Dredging activities      \_\_\_ Road encroachment      \_\_\_ Land ownership  
 \_\_\_ Other (specify) \_\_\_\_\_

Table 2.

### Lotic Standard Checklist

Name of Riparian-Wetland Area: Headwaters Channel at "Hanging Fence," Carter Canyon, Navajo Point, GLCA

Date: 9/25/01

Segment/Reach ID: \_\_\_\_\_

Miles: \_\_\_\_\_

Acres: \_\_\_\_\_

ID Team Observers: P. Biggam, G. Eckert, M. Martin, J. Wagner

| Yes | No | N/A | HYDROLOGY                                                                                                                                 |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 1) Floodplain above bankfull is inundated in "relatively frequent" events                                                                 |
|     |    | X   | 2) Where beaver dams are present they are active and stable                                                                               |
|     | X  |     | 3) Sinuosity, width/depth ratio, and gradient are in balance with the Landscape setting (i.e., landform, geology, and bioclimatic region) |
|     | X* |     | 4) Riparian-wetland area is widening or has achieved potential extent                                                                     |
|     | X* |     | 5) Upland watershed is not contributing to riparian-wetland degradation                                                                   |

| Yes | No | N/A | VEGETATION                                                                                                                                      |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)                                |
|     | X* |     | 7) There is diverse composition of riparian-wetland vegetation for Maintenance/recovery)                                                        |
|     | X* |     | 8) Species present indicate maintenance of riparian-wetland soil Moisture characteristics                                                       |
|     | X* |     | 9) Streambank vegetation is comprised of those plants or plant Communities that have root masses capable of withstanding high-Streamflow events |
|     | X* |     | 10) Riparian-wetland plants exhibit high vigor                                                                                                  |
|     | X* |     | 11) Adequate riparian-wetland vegetative cover is present to protect Banks and dissipate energy during high flows                               |
|     | X  |     | 12) Plant communities are an adequate source of coarse and/or large Woody material (for maintenance/recovery)                                   |

| Yes | No | N/A | EROSION/DEPOSITION                                                                                                                               |
|-----|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 13) Floodplain and channel characteristics (i.e., rocks, overflow channels, Coarse and/or large woody material) are adequate to dissipate energy |
|     |    | X   | 14) Point bars are revegetating with riparian-wetland vegetation                                                                                 |
|     | X* |     | 15) Lateral stream movement is associated with natural sinuosity                                                                                 |
|     | X* |     | 16) System is vertically stable                                                                                                                  |
|     | X  |     | 17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)                  |

\* - see remarks on reverse

(Revised 1999)

## Remarks

- (1) Channel incision has eliminated floodplain.
- (4) Riparian/wetland area has narrowed due to channel incision and lowering of base level.
- (5) Livestock trailing from uplands over channel banks and into channel introduces sediment and channelized flow from uplands.
- (6) No cottonwoods, willows or other woody riparian vegetation, and virtually no herbaceous wetland cover present in riparian zone (a few scattered patches exist, with < 20% cover ).
- (7) Only one herbaceous wetland plant species noted (*Epilobium ciliatum*).
- (8) In the sparse patches of vegetation cover that does exist, it is predominantly cheatgrass, an exotic upland species.
- (9) Incision is so severe that roots of any trees on the bank are now too high above channel to provide this function.
- (10) *Epilobium ciliatum* is the only wetland species represented and it is in poor shape; all other herbaceous plants are upland species.
- (11) Cover < 20% within wetland area adjacent to and within the channel, and almost all is cheatgrass. Upper 10'-12' of incised banks are bare soil.
- (13) Floodplain does not exist
- (15/16) System is undergoing active incision; erosion is in downcutting action, with no development of "natural sinuosity."

## Summary Determination

### Functional Rating:

Proper Functioning Condition \_\_\_\_\_  
Functional - At Risk \_\_\_\_\_  
Nonfunctional   X    
Unknown \_\_\_\_\_

### Trend for Functional - At Risk:

Upward \_\_\_\_\_  
Downward \_\_\_\_\_  
Not Apparent \_\_\_\_\_

### Notes:

### Are factors contributing to unacceptable conditions outside the control of the manager?

Yes \_\_\_\_\_  
No   X  

### If yes, what are those factors?

\_\_\_ Flow regulations    \_\_\_ Mining activities    \_\_\_ Upstream channel conditions  
\_\_\_ Channelization    \_\_\_ Road encroachment    \_\_\_ Oil field water discharge  
\_\_\_ Augmented flows    \_\_\_ Other (specify) \_\_\_\_\_

Table 3.

### Lotic Standard Checklist

Name of Riparian-Wetland Area: East End Spring and 300' downstream, East End Drainage, Navajo Point, GLCA

Date: 9/26/01

Segment/Reach ID: \_\_\_\_\_

Miles: \_\_\_\_\_

Acres: \_\_\_\_\_

ID Team Observers: P. Biggam, G. Eckert, M. Martin, J. Wagner

| Yes | No | N/A | HYDROLOGY                                                                                                                                 |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 1) Floodplain above bankfull is inundated in "relatively frequent" events                                                                 |
|     |    | X   | 2) Where beaver dams are present they are active and stable                                                                               |
|     | X* |     | 3) Sinuosity, width/depth ratio, and gradient are in balance with the Landscape setting (i.e., landform, geology, and bioclimatic region) |
|     | X* |     | 4) Riparian-wetland area is widening or has achieved potential extent                                                                     |
| X   |    |     | 5) Upland watershed is not contributing to riparian-wetland degradation                                                                   |

| Yes | No | N/A | VEGETATION                                                                                                                                      |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------|
|     | X* |     | 6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)                                |
|     | X* |     | 7) There is diverse composition of riparian-wetland vegetation for Maintenance/recovery)                                                        |
| X*  |    |     | 8) Species present indicate maintenance of riparian-wetland soil Moisture characteristics                                                       |
| X*  |    |     | 9) Streambank vegetation is comprised of those plants or plant Communities that have root masses capable of withstanding high-Streamflow events |
|     | X  |     | 10) Riparian-wetland plants exhibit high vigor                                                                                                  |
| X*  |    |     | 11) Adequate riparian-wetland vegetative cover is present to protect Banks and dissipate energy during high flows                               |
|     |    | X   | 12) Plant communities are an adequate source of coarse and/or large Woody material (for maintenance/recovery)                                   |

| Yes | No | N/A | EROSION/DEPOSITION                                                                                                                               |
|-----|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| X*  |    |     | 13) Floodplain and channel characteristics (i.e., rocks, overflow channels, Coarse and/or large woody material) are adequate to dissipate energy |
|     |    | X   | 14) Point bars are revegetating with riparian-wetland vegetation                                                                                 |
|     | X  |     | 15) Lateral stream movement is associated with natural sinuosity                                                                                 |
| X*  |    |     | 16) System is vertically stable                                                                                                                  |
|     | X* |     | 17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)                  |

\* - see remarks on reverse

(Revised 1999)

## Remarks

- (1) Drainage probably originally diffuse subsurface and surface flow, with perhaps a lower vegetated swale conducting runoff from periodic higher flows (rainfall/snowmelt). However, more recent incision appears to keep such flows in narrower incised channel.
- (3) Incised channel segments in upper part of site are straight; perhaps started in livestock trails.
- (4) Channel incision in some areas is causing drainage and narrowing of riparian zone.
- (6) Willows would be expected at least along the margins of the site, but are completely absent. For herbaceous veg., poor production of seed by native wetland species (grazing impact) and invasion by drier or non-native spp.
- (7) *Carex nebrascensis* and *Juncus balticus* are very patchy and in moderate to poor condition where they do exist. *Agrostis stolonifera* (non-native wetland plant) and *Poa pratensis* (predominantly upland plant) are more robust and dominate significant areas. Woody riparian species absent.
- (8) Generally a yes, but on a downward trend because riparian zone narrowing.
- (9) Yes, based more on presence of *C. nebrascensis* in center channel and fact that we saw no evidence of high flow events in past.
- (11) OK at say 20-25 yr. flows, which are still probably relatively low, but there is a very real risk of degradation in more extreme flows.
- (13) Same as note 11.
- (16) Incising in some sections, but overall considered stable. Problem could be worsened by continued grazing or very high flows, but such flows appear to be rare.
- (17) Diffuse groundwater flow and flow through vegetated swale has been concentrated into a channel in some areas, with signs of erosion in those areas due to increased velocities.

## Summary Determination

### Functional Rating:

Proper Functioning Condition \_\_\_\_\_  
Functional - At Risk   X    
Nonfunctional \_\_\_\_\_  
Unknown \_\_\_\_\_

### Trend for Functional - At Risk:

Upward \_\_\_\_\_  
Downward   X    
Not Apparent \_\_\_\_\_

### Notes:

Site is called functional (at-risk) at this time because site could dissipate energy from 20-25 yr. flow, which we determined to be low energy (no evidence of high flows from the past). However, this is a very marginal call, and the site is considered to be at very high risk due to:

- (a) continued livestock trampling and trailing may cause increased incision and concentration of flows;
- (b) higher flows could cause banks to be lost because incision is narrowing the riparian zone and plant species colonizing margins are shallow-rooted and susceptible to erosion.

Bottom line: The only reason site is functional at all is that it appears that erosive flow events are quite rare, and this system would likely hold together under most flow conditions. Otherwise, at very high risk, downward trend.

### Are factors contributing to unacceptable conditions outside the control of the manager?

Yes \_\_\_\_\_  
No   X  

### If yes, what are those factors?

\_\_\_ Flow regulations    \_\_\_ Mining activities    \_\_\_ Upstream channel conditions  
\_\_\_ Channelization    \_\_\_ Road encroachment    \_\_\_ Oil field water discharge  
\_\_\_ Augmented flows    \_\_\_ Other (specify) \_\_\_\_\_

Table 4.

### Lotic Standard Checklist

Name of Riparian-Wetland Area: Lower Fork Canyon, Navajo Point, GLCADate: 9/26/01 Segment/Reach ID: (Reach below large Salix lutea)

Miles: \_\_\_\_\_ Acres: \_\_\_\_\_

ID Team Observers: P. Biggam, G. Eckert, M. Martin, J. Wagner

| Yes | No | N/A | HYDROLOGY                                                                                                                                 |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------|
|     |    | X*  | 1) Floodplain above bankfull is inundated in "relatively frequent" events                                                                 |
|     |    | X   | 2) Where beaver dams are present they are active and stable                                                                               |
| X   |    |     | 3) Sinuosity, width/depth ratio, and gradient are in balance with the Landscape setting (i.e., landform, geology, and bioclimatic region) |
| X   |    |     | 4) Riparian-wetland area is widening or has achieved potential extent                                                                     |
| X   |    |     | 5) Upland watershed is not contributing to riparian-wetland degradation                                                                   |

| Yes | No | N/A | VEGETATION                                                                                                                                      |
|-----|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------|
| X*  |    |     | 6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)                                |
| X*  |    |     | 7) There is diverse composition of riparian-wetland vegetation for Maintenance/recovery)                                                        |
| X*  |    |     | 8) Species present indicate maintenance of riparian-wetland soil Moisture characteristics                                                       |
| X   |    |     | 9) Streambank vegetation is comprised of those plants or plant Communities that have root masses capable of withstanding high-Streamflow events |
|     | X* |     | 10) Riparian-wetland plants exhibit high vigor                                                                                                  |
| X   |    |     | 11) Adequate riparian-wetland vegetative cover is present to protect Banks and dissipate energy during high flows                               |
|     |    | X*  | 12) Plant communities are an adequate source of coarse and/or large Woody material (for maintenance/recovery)                                   |

| Yes | No | N/A | EROSION/DEPOSITION                                                                                                                               |
|-----|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| X   |    |     | 13) Floodplain and channel characteristics (i.e., rocks, overflow channels, Coarse and/or large woody material) are adequate to dissipate energy |
|     |    | X   | 14) Point bars are revegetating with riparian-wetland vegetation                                                                                 |
| X   |    |     | 15) Lateral stream movement is associated with natural sinuosity                                                                                 |
| X   |    |     | 16) System is vertically stable                                                                                                                  |
| X   |    |     | 17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)                  |

\* - see remarks on reverse

(Revised 1999)

### Remarks

- (1) Apparent lack of relatively frequent above bankfull events appears to be normal for this site.
- (6) Herbaceous wetland community largely absent due to ephemeral nature of channel, but *Salix exigua* spreading well vegetatively and/or from seed.
- (7) Composition includes *Salix exigua*, *Rosa woodsii*, *Salix lutea*, *Castilleja* sp. *Clematis ligusticifolia*.
- (8) True for woody species, herbaceous largely absent.
- (10) Some possible signs of drought stress in willows, but not serious.
- (12) Not much coarse woody debris present, but not really critical in this bedrock controlled system.

### Summary Determination

**Functional Rating:**

|                              |          |
|------------------------------|----------|
| Proper Functioning Condition | <u>X</u> |
| Functional – At Risk         | _____    |
| Nonfunctional                | _____    |
| Unknown                      | _____    |

### Trend for Functional – At Risk:

Upward \_\_\_\_\_  
Downward \_\_\_\_\_  
Not Apparent \_\_\_\_\_

**Notes:**

[illegible]

**Are factors contributing to unacceptable conditions outside the control of the manager?**

Yes \_\_\_\_\_  
No \_\_\_\_\_

**If yes, what are those factors?**

☐ Flow regulations    ☐ Mining activities    ☐ Upstream channel conditions  
☐ Channelization    ☐ Road encroachment    ☐ Oil field water discharge  
☐ Augmented flows    ☐ Other (specify) \_\_\_\_\_

# Rangeland Health Evaluation Summary Worksheet

|                                                                                                              |                                 | Departure from Ecological Site Description/Ecological Reference Area(s) |                     |          |                    |                |
|--------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------------------------|---------------------|----------|--------------------|----------------|
| Indicators                                                                                                   |                                 | Extreme                                                                 | Moderate to Extreme | Moderate | Slight to Moderate | None to Slight |
| S,H                                                                                                          | 1. Rills                        |                                                                         |                     |          |                    | X              |
| Comments: <i>Very few evident due to soil infiltration/permeability</i>                                      |                                 |                                                                         |                     |          |                    |                |
| S,H                                                                                                          | 2. Water Flow Patterns          |                                                                         |                     |          |                    | X              |
| Comments: <i>Patterns, where present, are discontinuous</i>                                                  |                                 |                                                                         |                     |          |                    |                |
| S, H                                                                                                         | 3. Pedestals and/or Terracettes |                                                                         |                     |          | X                  |                |
| Comments: <i>Occasional terracettes present above litter depositional areas</i>                              |                                 |                                                                         |                     |          |                    |                |
| S,H                                                                                                          | 4. Bare Ground                  |                                                                         | X                   |          |                    |                |
| Comments: <i>Bare ground dominates in interspaces between shrubs, loss of biological soil crusts evident</i> |                                 |                                                                         |                     |          |                    |                |
| S,H                                                                                                          | 5. Gullies                      |                                                                         |                     |          |                    | X              |
| Comments: <i>None Evident</i>                                                                                |                                 |                                                                         |                     |          |                    |                |



|                                                                                                                             |                                                                                             | Departure from Ecological Site Description/Ecological Reference Area(s) |                     |          |                    |                |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------|----------|--------------------|----------------|
| Indicators                                                                                                                  |                                                                                             | Extreme                                                                 | Moderate to Extreme | Moderate | Slight to Moderate | None to Slight |
| <b>S</b>                                                                                                                    | <b>6. Wind-Scoured, Blowouts, Depositional Areas</b>                                        |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Soil Blowouts present, shrubs are being buried, some wind scoured areas exposing subsoil</i>                   |                                                                                             |                                                                         |                     |          |                    |                |
| <b>H</b>                                                                                                                    | <b>7. Litter Movement</b>                                                                   |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Litter is loosely concentrated around surface obstructions, movement by water and wind</i>                     |                                                                                             |                                                                         |                     |          |                    |                |
| <b>S,H,B</b>                                                                                                                | <b>8. Soil Surface Resistance to Erosion</b>                                                |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>No physical crusts, minimal biological crusts, no aggregate stability, minimal litter or organic matter</i>    |                                                                                             |                                                                         |                     |          |                    |                |
| <b>S,H,B</b>                                                                                                                | <b>9. Soil Surface Loss or Degradation</b>                                                  |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Severe soil loss evident, as well as degradation occurring by "drifting sands"</i>                             |                                                                                             |                                                                         |                     |          |                    |                |
| <b>H</b>                                                                                                                    | <b>10. Plant Community Composition and Distribution Relative to Infiltration and Runoff</b> |                                                                         |                     | <b>X</b> |                    |                |
| Comments: <i>Increase in Cheatgrass affecting some areas, increase in shrubs (rabbitbrush) evident</i>                      |                                                                                             |                                                                         |                     |          |                    |                |
| <b>S,H,B</b>                                                                                                                | <b>11. Compaction Layer</b>                                                                 |                                                                         |                     |          |                    | <b>X</b>       |
| Comments: <i>None present, loose, single grain soils</i>                                                                    |                                                                                             |                                                                         |                     |          |                    |                |
| <b>B</b>                                                                                                                    | <b>12. Functional/Structural Groups</b>                                                     |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>loss of perennial grasses, biological soil crusts evident, invasive annuals are subdominant</i>                |                                                                                             |                                                                         |                     |          |                    |                |
| <b>B</b>                                                                                                                    | <b>13. Plant Mortality/Decadence</b>                                                        |                                                                         |                     | <b>X</b> |                    |                |
| Comments: <i>Some dead big sagebrush and antelope bitterbrush present, others decadent</i>                                  |                                                                                             |                                                                         |                     |          |                    |                |
| <b>H, B</b>                                                                                                                 | <b>14. Litter Amount</b>                                                                    |                                                                         |                     | <b>X</b> |                    |                |
| Comments: <i>litter produced and present is being displaced by wind, concentrating around surface obstructions</i>          |                                                                                             |                                                                         |                     |          |                    |                |
| <b>B</b>                                                                                                                    | <b>15. Annual Production</b>                                                                |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Estimated at approximately 35% of potential production</i>                                                     |                                                                                             |                                                                         |                     |          |                    |                |
| <b>B</b>                                                                                                                    | <b>16. Invasive Plants</b>                                                                  |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Cheatgrass is common throughout the site</i>                                                                   |                                                                                             |                                                                         |                     |          |                    |                |
| <b>H</b>                                                                                                                    | <b>17. Reproductive Capability of Perennial Plants</b>                                      |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Past drought showing effects, poor distribution of seed stalks on grasses, bitterbrush heavily browsed</i>     |                                                                                             |                                                                         |                     |          |                    |                |
| <b>B</b>                                                                                                                    | <b>18. Biological Crusts (Optional Indicator)</b>                                           |                                                                         | <b>X</b>            |          |                    |                |
| Comments: <i>Present mainly in protected areas, under shrub canopies, downed tree limbs, limited species representation</i> |                                                                                             |                                                                         |                     |          |                    |                |

### Part 3. Summary

#### A. Indicator Summary

#### Departure from Ecological Site Description/Ecological Reference Area(s)

| Rangeland Health Attributes |                                                            | Extreme | Moderate to Extreme  | Moderate  | Slight to Moderate | None to Slight |
|-----------------------------|------------------------------------------------------------|---------|----------------------|-----------|--------------------|----------------|
| <b>S</b>                    | <b>Soil/Site Stability (Indicators 1-6, 8, 9&amp;11)</b>   |         | <b>XXXX</b>          |           | <b>X</b>           | <b>XXXX</b>    |
| <b>H</b>                    | <b>Hydrologic Function (Indicators 1-5, 7-11 &amp; 14)</b> |         | <b>XXX</b>           | <b>XX</b> | <b>XX</b>          | <b>XXXX</b>    |
| <b>B</b>                    | <b>Biotic Integrity (Indicators 8-9, 11-18)</b>            |         | <b>XXXXXX<br/>XX</b> | <b>XX</b> |                    | <b>X</b>       |

**B. Attribute Summary** - Check the category that best fits the "preponderance of evidence" of the three attributes relative to the distribution of indicator ratings in the preceding Indicator Summary table

| Attribute                  | Extreme | Moderate to Extreme | Moderate | Slight to Moderate | None to Slight |
|----------------------------|---------|---------------------|----------|--------------------|----------------|
| <b>Soil/Site Stability</b> |         | <b>X</b>            |          |                    |                |
| <b>Hydrologic Function</b> |         |                     | <b>X</b> |                    |                |
| <b>Biotic Integrity</b>    |         | <b>X</b>            |          |                    |                |