2003 FIELD SURVEY FOR WILLOW ESTABLISHMENT POTENTIAL ON THE CURLEW NATIONAL GRASSLAND, ONEIDA COUNTY, IDAHO

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ABSTRACT

The Curlew National Grassland (CNG) in Oneida County, Idaho, has a history of intensive agriculture and livestock use. Degraded ecological conditions now prevail for riparian and wetland areas throughout the CNG. Habitat degradation problems include accelerated stream downcutting, the loss of native vegetation, and the establishment of noxious and other aggressive weeds. The Curlew National Grassland 2002 Final Land and Resource Management Plan outlines objectives to improve streams and wetlands within the CNG to Proper Functioning Condition. One of the objectives in the Plan is to promote willow restoration. To help meet this objective, perennial streams were surveyed by the Idaho Fish and Game Idaho Conservation Data Center in 2003, to identify existing and potential willow shrub communities. Two of the eight perennial streams, representing 40% of the total perennial stream distance within the CNG were surveyed. Rock Creek, which extends for approximately six miles through the Grassland, was generally in ecologically degraded condition, although coyote willow (*Salix exigua*) was scattered along much of its length. Meadow Brook Creek, which extends for approximately three miles through the Grassland, was in better condition and shows more potential for rehabilitation.

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INTRODUCTION

The Curlew National Grassland (CNG) is located in southeast Idaho in Oneida County, 17 air miles west of Malad. The Grassland lies within the 524,000-acre Curlew Valley. While its boundaries encompass 75,000 acres, only 47,600 are administered by the Forest Service. The remainder of the acreage is private and in agricultural use. A map of the Curlew Valley, CNG boundaries, and perennial streams is found in Appendix A.

Historical agriculture and ranching dates back to the 1860's from operations based in northern Utah. By the early 1900's the valley began to be parceled out to homesteaders. By the 1920's and 1930's, failed homesteads were sold back to the government. In 1954, the Forest Service was given administration of 47,600 of these acres. The CNG was designated on June 20, 1960. Since that time, 35,500 acres of the area have been treated to benefit livestock grazing, including the removal of sagebrush and seeding of non-native grasses (USDA, 2002b) .

Elevation on the Grassland ranges from 4,570 to 5,940 feet. The valley is surrounded by the Hansel Mountains and Pleasantview Hills to the east; the Deep Creek Mountains to the north; and the Sublette Range to the west. The climate is semi-arid desert/temperate desert (Bailey, 1995). Malad City is the closest weather station, showing average precipitation at 13.18 inches/year (Western Regional Climate Center, 2004).

Riparian Systems

There are eight perennial streams in the CNG: Deep Creek, Meadow Brook Creek, North Canyon, Rock Creek, Rock Spring Creek, Salyer Creek, Sheep Creek, and South Fork Rock Creek (Leffert, personal communication; USDA, 2002b). South Fork Rock Creek drains to the north into the Columbia River Basin, while the remainder drain into the Great Basin to the south.

Hydrology in the valley has been drastically altered by human intervention. Most springs have been tapped for livestock and agriculture. Channels have been diverted in many places. Well drilling has lowered the water table, affecting the amount and timing of spring flow (USDA, 2002b).

There are 24 miles of perennial stream channels within the CNG. Various entities have evaluated some or all of the channels for Properly Functioning Condition (PFC) in the Curlew Valley. Rock Creek and Meadow Brook Creek were evaluated in 1997 by the Idaho Wildlife Federation (1998), and by the USFS in 1998 (2002b). The two evaluations resulted in similar classifications, shown in Table 1.

Peak discharges recorded for Rock Creek range from 30 cubic foot per second (cfs), recorded near Holbrook in 1966, to over 1,000 cfs, recorded in 1962. Base flows of less than 1 cfs have been observed for both Rock and Meadow Brook creeks, while large storm events can result in the hundreds of cfs (USDA, 2002b).

Identifying Willow Restoration Potential

Riparian habitat analysis can be almost infinitely complex and time-consuming. An intensive inventory and analysis was not within the scope of this survey. Less intensive riparian condition rating methods have been designed for on-site modification by the Bureau of Land Management (BLM) (1989) and Forest Service (2002e). Pertinent rating attributes described by these documents include: 1) subsurface water status, 2) streambank stability, 3) vegetation characteristics, and 4) erosion/runoff processes. The condition of each of these attributes is intricately tied to the others; degradation in one may predict future problems with another.

1) Most willows can tolerate flooding (Fish and Wildlife Service, 1980), growing adjacent to the water channel or further away from it, as long as the roots can reach the water table (BLM, 1997).

2) Streambank stability is indicated by features such as bank shape, degree of downcutting and headcutting. These features pertain to willow revegetation and survival. The streambank shape—whether it is concave or convex—affects the ability of roots to remain secure in flooding events (USGS, 1999) and the ability of the stream channel to remain stable. If a channel is deeply downcut, the watertable is lowered accordingly. This narrows the zone in which riparian plants can survive (BLM, 1989). Erosion at a headcut leaves a lowered channel behind it, similarly lowering the water table and diminishing the quality of riparian habitat.

3) Vegetation characteristics can indicate potential willow habitat. The extent of subsurface water beyond the channel is indicated by the presence or absence of hydrophytic species (BLM, 1989). The presence of aggressive or noxious weeds may lower the expectation of revegetation success. The extent of bank protected by vegetation is an indicator of bank stability. The presence of willows themselves indicate that willow habitat is possible elsewhere along the channel (USDA, 2000), and provide a source for willow cuttings adapted to the drainage.

4) Erosion processes affect revegetation potential. Proximity of agricultural fields upstream affect sediment loads and the scouring effect of flood events (USGS, 1999). The composition of riparian and emergent species along the channel affect the erosion potential of the stream. Vegetation and their root systems slow down the water and its capacity to carry sediment, in turn reducing the scouring effect of the stream (USGS, 1999).

OBJECTIVE

The Curlew National Grassland Final Land and Resource Management Plan (2002c) outlines goals and objectives to improve streams and wetlands to meet PFC standards, maintain those already at PFC, and to maintain or restore wildlife habitat. The CNG Plan includes an objective for wildlife riparian habitat to “map stream reaches and identify existing and potential willow shrub communities” (2002c). This survey was conducted to meet that objective.

METHODS

I surveyed Rock Creek and Meadow Brook Creek by walking most of their lengths (Appendix B). Where the road ran adjacent to the channel, a car was used, and the channel observed on foot approximately every 100 m. Plant communities in and around the channel were recorded, as was information concerning water flow, the spatial relation of established willow communities, and threats to willow establishment.

Vegetation sampling plots were established to document plant community information. Standard ecological sampling techniques developed by Natural Heritage programs and Conservation Data Centers in the western U.S. were used (Bougeron et. al 1992) to document and assess site condition and plant associations. Along the stream channel, plot dimensions were linear (10 x 1 meter), while a circular plot (10 m diameter) was chosen for mesic meadows. Form II (Community Survey Form) and Form III (Ocular Plant Species Data) were used to collect data. Completed forms are found in Appendix B. A checklist of the vascular plants occurring on the CNG is included in Appendix D.

Four interrelated elements of the riparian system were used as indicators of willow restoration potential: 1) water availability, 2) streambank stability, 3) vegetation characteristics, and 4) erosion/runoff processes. The status of these indicators was used to judge willow establishment

potential. The status of each indicator was assessed in a subjective manner and based on my field observations.

Water availability was assessed by observing the width of the riparian strip around the channel, and whether subsurface water was available beyond the banks. Extent of subsurface water was inferred by presence or absence of hydrophytic species. Streambank stability was assessed by observing the length and depth of downcutting, presence of headcuts, and bank shape. Vegetation characteristics were assessed by noting each species I observed, highlighting dominant species, and noting where communities were generally located. Noxious and invasive plant species were noted, including information regarding their location and dominance. Erosion/runoff processes were taken into account by locating agricultural fields lying upstream. Overall ratings for willow establishment potential were arrived at in a subjective manner, using each of these four factors.

Reach Name	Length (Miles)	IWF Rating	USFS Rating
Rock Creek 1	0.2	Non-functioning	Functioning at Risk; Upward trend
Rock Creek 2	0.3	Non-functioning	Non-Functioning
Rock Creek 3	0.12	Functioning at Risk Upward Trend	Functioning at Risk; Upward Trend
Rock Creek 4	0.16	Non-functioning	Non-functioning
Rock Creek 5	0.48	Properly functioning	Functioning at Risk; Upward trend
Rock Creek 6	0.2	Non-functioning	Non-functioning
Rock Creek 7	0.2	Functioning at Risk Upward Trend	Functioning at Risk Upward trend
Rock Creek 8	0.92	Non-functioning	Non-functioning
Rock Creek 9	1.16	Properly functioning	Properly functioning
Rock Creek 10	0.15	Non-functioning	Non-functioning
Rock Creek 11	2.1	Functioning at Risk Upward trend	Functioning at Risk; Upward trend
Meadow Brook 1	1.35	Non-functioning	Functioning at Risk; Upward trend
Meadow Brook 2	0.5	Properly functioning	Properly functioning
Meadow Brook 3	0.3	Functioning at Risk No apparent trend	Functioning at Risk; No apparent trend
Meadow Brook 4	0.13	Functioning at Risk No apparent trend	Functioning at Risk; Upward trend
Meadow Brook 5	Private Land*	Functioning at Risk Upward trend	Functioning at Risk; Upward trend

Table 1. Results of Properly Functioning Condition assessments. These results compiled from the Idaho Wildlife Federation (1998) and the Forest Service (2002b). *This land status conflicts with the 1991 Bureau of Land Management (BLM) Surface Management Status map, which shows this segment as BLM property.

RESULTS

Rock Creek, which extends for approximately six miles through the CNG, was generally in poor ecological condition. Coyote willow (*Salix exigua*) was scattered intermittently along its length below Twin Springs. Meadow Brook Creek, which extends for approximately 3 miles through the CNG, was in better condition and shows more potential for rehabilitation. Together, these two streams comprise approximately 40% of the total perennial stream length in the CNG.

Rock Creek

I surveyed Rock Creek on June 25, June 30, and July 2. Two vegetation plots were sampled (Appendix C). I delineated Rock Creek into three zones based on vegetation characteristics and the potential for willow restoration. The location of each zone is included in Appendix B. Field observations concerning hydrologic, bank and vegetation features, and PFC ratings are summarized in Table 2. For all three zones, common detriments to a healthy riparian ecosystem are downcutting, bank destabilization, and cattle impacts.

Rock Creek	Willow Establishment Potential	Water availability	Downcutting/ Bank Stability	Vegetation	Erosion/Runoff Process	PFC Ratings (total length)	
						Forest Service	IWF
Zone 1 (From Lonigan Spring southward for approximately ½ mile.)	Medium	Excellent at spring, decreasing southward.	Downcutting nonexistent at spring; increasing southward to 2-3 m deep.	Dominated by native riparian species at spring; native and riparian species decrease in numbers and frequency southward. No willows present.	Agriculture and grazing occur upstream but are on a relatively low gradient which minimizes erosion impact.	• Functioning at Risk, Upward Trend (.32 miles) • Non-functioning (.46 miles)	• Non-functioning (.66 miles) • Functioning at Risk, Upward Trend (.12 miles)
Zone 2 (Continuing from south end of Zone 1 to Twin Springs.)	Low	Poor, water likely only from storm events.	Channel is downcut to 3 m or more, up to 5 m wide; bank consistently shows 50% bare soil.	Upland and weedy species dominate. Two senescent whiplash willows present.	Agriculture does not take place adjacent to this zone.	• PFC (.48 miles) • Functioning at Risk, Upward Trend (.2 miles) • Non-functioning (1.12 miles)	• PFC (.48 miles) • Functioning at Risk, Upward Trend (.2 miles) • Non-functioning (1.12 miles)
Zone 3 (Twin Springs to Meadow Brook Creek)	High	Sufficient	Channel downcut 0-1 m at northern half; downcut up to 4 m at southern half; banks are denuded and compacted much of the zone.	Coyote willow is dominant; graminoids include Nebraska sedge, smooth brome, Baltic rush.	Agriculture does not take place adjacent to this zone, but a tributary—Rock Springs Creek—carries sediment/ runoff from agriculture.	• PFC (1.16 miles) • Functioning at Risk, Upward Trend (2.1 miles) • Non-functioning (.15 miles)	• PFC (1.16 miles) • Functioning at Risk, Upward Trend (2.1 miles) • Non-functioning (.15 miles)

Table 2. Zones of willow restoration potential on Rock Creek. Based on four indicators for willow restoration potential described in Methods section. PFC ratings show cumulative length attaining the stated rating.

Zone 1 begins at Lonigan Springs and ends approximately 0.5 miles downstream (southward). It roughly correlates to reaches one through four in the PFC studies by the Forest Service and IWF (1998). A vegetation plot (03JD002) was established in this segment, in an ungrazed mesic meadow. Table 3 includes a list of vascular plant species occurring in the plot. Native riparian species dominate the vegetation and the soil surface is stable. This segment presents relatively good conditions for willow restoration, based on the four indicators discussed in Methods section. Canada thistle is established in the channel at the south end of this zone.

Zone 2 begins at the south end of Zone 1, and extends southward to Twin Springs. This segment roughly correlates to reaches five through eight in the PFC studies. Plot 03JD001 was established in this zone. I found no potential for willow restoration in this segment. The creekbed is dry, and the encroachment of upland species and absence of wetland species suggests the channel has not had consistent water flow for many seasons (Figure 1). At the northern end, common upland species are serviceberry (*Amelanchier utahensis*), Woods' rose (*Rosa woodsii*), mountain snowberry (*Symphoricarpos oreophilus*), bitterbrush (*Purshia tridentata*),

and basin wildrye (*Leymus cinereus*). Large colonies of weedy species such as Canada thistle (*Cirsium arvense*), African mustard (*Malcolmia africana*), and clasping pepperweed (*Lepidium perfoliatum*) are common. Another upland species common in this location is referred to as sagebrush x. This is an undescribed variety intermediate between *Artemisia tridentata* var. *tridentata* and var. *vaseyana*, discussed in Collins and Harper (1982). Progressing southward, dominant upland species shift to sagebrush x and rabbitbrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*). Common forbs are povertyweed (*Iva axillaris*), tumblemustard (*Descurainia pinnata*), silky lupine (*Lupinus sericeus*), and houndstongue (*Cynoglossum officinale*). Common grasses are crested wheatgrass (*Agropyron cristatum*), meadow barley (*Hordeum brachyantherum*), and bulbous bluegrass (*Poa bulbosa*). The channel is downcut 3-4 meters until approaching the southern 300 m, where the channel flattens out into a small mesic meadow. Nebraska sedge (*Carex nebrascensis*) is one dominant species here; identification of other species was difficult due to grazing.

Zone 3 begins at Twin Springs and extends southward to the confluence with Meadow Brook Creek. This segment roughly correlates with reaches nine through eleven in the two PFC studies. I determined this to be the best zone for riparian improvement efforts along Rock Creek. Waterflow is good, and coyote and yellow willow (*Salix lutea*) are consistently distributed along this zone. Where willows are absent, it appears to be due to cattle impacts (Figures 2 and 3). These gaps exhibit compacted soil and denuded banks. For approximately 1.5 miles above its confluence with Meadow Brook Creek, the banks of Rock Creek are downcut up to 3 m (Figure 4). Coyote willow grows along the channel, but bank erosion prevents the development of healthy riparian habitat.

Figure 1. Upland and invasive species overtaking the dry portion of Rock Creek north of Twin Springs. Facing nw.

Figure 2. Rock Creek at its confluence with Meadow Brook Creek. Downcutting is less severe here than just upstream. Facing n.

Figure 3. Rock Creek. Just s of fence at s border of Lonigan Springs. Facing se.

Figure 4. Rock Creek downcutting north of Meadow Brook Creek (confluence at base of tallest peak). Bank erosion continues to base of hill, center photo. Facing sw, from Highway 37.

Meadow Brook Creek

Meadow Brook Creek was surveyed on August 8 and October 1. Channel features and major plant occurrences discussed here are mapped in Appendix B. The channel is in good ecological condition with native riparian species dominating the entire stretch lying within the CNG, as well as upstream to Meadow Brook Spring.

Three mesic meadows along Meadow Brook Creek (Figure 7) occupy approximately 50% of Meadow Brook Creek's length on the CNG. Native riparian species such as Nebraska sedge, hardstem bulrush (*Scirpus acutus*) and common spikerush (*Eleocharis palustris*) dominate. These meadows experienced heavy cattle grazing impacts in 2003 (Figure 8). The two upper meadows are threatened by headcutting; the lower is threatened by downcutting.

Downcutting is problematic on approximately 47% of the total length from Meadow Brook Spring to the Rock Creek confluence. On the CNG alone, approximately 50% of the length is downcut. The banks are in unstable condition, with little vegetation present to prevent bank erosion. Three headcuts were observed; one at the downstream end of the upper meadow, and two at the downstream end of the central meadow. Water in the channel was about 15 cm deep, sluggish, and varied in width from 0.3 to 1.5 m.

Coyote willow was present at two locations on the CNG portion of Meadow Brook Creek. Approximately 25 leaders were observed, which showed signs of moderate to heavy browsing, and reached heights of up to 1 m. More mature coyote willow was observed upstream toward Meadow Brook Spring, on BLM property. Two main willow stands are established along an 80 m stretch in a deeply downcut (up to 4 m) drainage.

Noxious and invasive weeds observed include Canada thistle, bull thistle (*Cirsium vulgare*), and bur buttercup (*Ceratocephala testiculata*). Bur buttercup was found in scattered patches along the stream, but the thistles were limited to scattered individuals on the CNG. Further upstream toward Meadow Brook Spring on BLM property, larger thistle colonies are established.

Recorded Attributes:	Plot Number: 03JD001 (Rock Creek)	03JD002 (Rock Creek)	03JD003 (Meadow Brook Creek)
Water source	Intermittent	Seep, spring	Perennial
Grazing activity	Cattle present	Old cowpies; not recently grazed	Not yet grazed, some recent prints
Area (m^2)	10	375	10
	% Cover		
% Bare Soil	45 – 54.9	0	45 – 54.9
% Litter Cover	25 – 34.9	35 – 44.9	1 - 4.9
% Wood Litter	<1	0	<1
% Basal Vegetation	15 – 24.9	55 – 64.9	15 – 24.9
Representative Species	**% Canopy Cover**		
Trees/Shrubs			
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	5 – 14.9		
Sagebrush *x* (*Artemisia tridentata* var. *x*)	5 – 14.9		
Slender buckwheat (*Eriogonum microthecum*)	<1		
Viscid rabbitbrush (*Chrysothamnus viscidiflorus*)	5 – 14.9		
Total tree/shrub cover:	15 – 24.9	0	0
Forbs			
Blue lettuce* (*Lactuca serriola*)			<1
Canada thistle* (*Cirsium arvense*)			<1
Cinquefoil sp. (*Potentilla* sp.)		<1	
Biscuitroot (*Lomatium* sp.)	<1		
Povertyweed (*Iva axillaris*)	1 – 4.9		
Silky lupine (*Lupinus sericeus*)	<1		
Stickseed sp. (*Hackelia* sp.)			<1
Western aster (*Aster adscendens*)			<1
Western yarrow (*Achillea millefolium*)	<1		
Willowherb sp. (*Camissonia* sp.)			<1
Total forb cover:	5 – 14.9	<1	1 – 4.9
Graminoids			
Baltic rush (*Juncus balticus*)		15 – 24.9	
Bulbous bluegrass* (*Poa bulbosa*)	1 – 4.9		
Common spikerush (*Eleocharis palustris*)			1 – 4.9
Kentucky bluegrass* (*Poa pratensis*)			1 – 4.9
Meadow barley (*Hordeum brachyantherum*)			<1
Nebraska sedge (*Carex nebrascensis*)		45 – 54.9	15 – 24.9
Rabbitfoot grass* (*Polypogon monspeliensis*)			1 – 4.9
Redtop bent* (*Agrostis stolonifera*)		25 – 34.9	
Sedge sp. (*Carex* sp.)		<1	
Unknown grasses	5 – 14.9		
Wheatgrass sp. (*Agropyron* sp.)	1 – 4.9		
Total graminoid cover:	25 – 34.9	95 - 100	25 – 34.9

Table 3. Summary of plant community information for Rock Creek and Meadow Brook Creek. Percent canopy cover was recorded using cover classes. The range in percentages shown here corresponds to the cover class recorded.

*= non-native species.

Plot 03JD03 was sampled along the channel (Figures 5 and 6; Appendix C). Plant community information is summarized in Table 3. Native graminoids such as hardstem bulrush, Nebraska sedge, and common spikerush dominate the vegetation.

The IWF and Forest Service PFC studies agreed that 11% of Meadow Brook Creek attains a PFC rating, and 43% is "Functional-at-risk." The remaining 46% was determined to be "Non-functional with a downward trend" by the IWF, and "Functional-at-risk with an upward trend" by the Forest Service. My survey confirms that the most intact riparian habitat occurs in the mesic meadows, where the 11% PFC ratings were given.

Figure 5. Meadow Brook Creek transect site, before grazing (August 8). Facing e.

Figure 6. Meadow Brook Creek transect site, after grazing (October 1). Facing e.

Figure 7. Meadow Brook Creek, before grazing (August 8). Facing n.

Figure 8. Meadow Brook Creek, after grazing (October 1). Facing n. Near, but not the same site as Figure 7. Channel runs horizontally in photo, 2/3 from bottom of photo.

Other perennial streams

I intensively surveyed Rock and Meadow Brook creeks. In contrast, the other perennial watercourses within the CNG received only cursory survey visits in 2003. They are listed in Table 4, along with a summary of observation notes.

Creek Name	Date Visited	Observation
Deep Creek	June 10	Portion above the spring is dry; below the spring to Stone Reservoir waterflow is strong. Stone Reservoir surrounded by Russian Olive (*Elaeagnus angustifolia*).
North Canyon	June 10	Cattail (*Typha latifolia*), hardstem bulrush community.
Rock Springs Creek	June 10	Good waterflow, narrow drainage; channel dominated by Baltic rush, water cress (*Rorippa nasturtium-aquaticum*) dominating.
Salyer Creek	Not visited	N/A
Sheep Creek	June 10	Dry, apparently for many seasons. Lone whiplash willow (*Salix lasiandra*) is dying.
South Fork Rock Creek	June 10	Visited tributary to SF Rock Creek--North Kurtz Spring. Heavy erosion from agricultural activity fills this channel with sediment during large storm events.

Table 4. List of perennial channels not intensively surveyed.

DISCUSSION

There are four main threats to the riparian systems on the CNG (USDA, 2002b): (1) water pumped from the aquifer for irrigation and household use has lowered the water table. This has dried up or reduced the flow of springs in the valley; (2) livestock grazing has denuded many of the banks, compacted the soil, and caused bank destabilization; (3) agricultural fields located upstream increase the sediment load in the streams; and (4) patchy ownership within the CNG presents a management challenge for uniform and coordinated rehabilitation efforts. For example, after Rock Creek enters the CNG at Lonigan Springs, it changes ownership at least five times before its confluence with Deep Creek.

Addressing each of these four threats has the potential to improve riparian conditions. The Idaho Wildlife Federation report (1998) argues that removing one of these threats, livestock grazing, can alone bring drastic improvements to wetland habitats within the CNG. According to their study, the portions of Rock Creek that meet PFC standards occur within the "campground, fenced highway right-of-way and riparian pasture—non grazed areas." The Forest Service found these same reaches to also be in PFC. My survey indicates that cattle, while not the only threat, continue to adversely affect riparian areas through soil compaction, bank destabilization, and grazing impacts.

RECOMMENDATIONS

Pertinent management objectives outlined in the CNG EIS, CNG Land and Resource Management Plan, and CNG Record of Decision (2002b; 2002c; 2002d) include, but are not limited to:

1) Bring all perennial streams in the CNG to PFC and maintain them at that level.
2) "…corridor fence those streams that are 'at risk' and will benefit from that fencing. These would be the streams that have the greatest recovery potential over the shortest amount of time."
3) Manage remaining perennial streams in riparian pastures and reduce cattle usage.
4) Develop and implement a riparian grazing management protocol.
5) Coordinate with adjacent land owners to promote ecosystem-scale management.
6) Continue to monitor streams for PFC and compare recovery rates between annually and periodically grazed pastures.

My recommendations support these objectives. Riparian and wetland habitat improvements, including willow restoration, do not appear possible without changes in grazing management and cooperation with adjacent land owners. My recommendations largely parallel commitments the Forest Service has already made in its Management Plan for the CNG (2002c).

Two general recommendations apply to all CNG riparian areas. First, establish permanent monitoring transects in riparian areas to track effectiveness of management decisions. The Forest Service also declares monitoring as a goal for the CNG in order to understand "how ecosystems respond to management" (2002b.)

Second, consider revegetation with other species in addition to willow. Various sources assert that bank stability and riparian ecosystem function is better preserved with a diverse riparian plant community than a monotypic one. A riparian system which includes trees, bushes, and graminoids is more effective in dissipating stream energy, filtering out sediment, and increasing the infiltration capacity of a watershed than a system with less diversity (USDI, 1989; USDI, 1997; USDA, 2002e). The riparian areas in the CNG have the potential to support these diverse vegetation types, as evidenced by the stream segments in which these elements are currently established. The USDA (2001) suggests using these established areas as reference points on which to base species selections for revegetation efforts. Species occurring in these reference points include: aspen (*Populus tremuloides*), black hawthorn (*Crataegus douglasii*), red-osier dogwood (*Cornus sericea*), water birch (*Betula occidentalis*), beaked sedge (*Carex utriculata*), Nebraska sedge, water sedge (*Carex aquatilis*), Baltic rush, and swordleaf rush (*Juncus ensifolius*).

Rock Creek

Zone 1 (Table 2) has good willow establishment potential. I recommend removing grazing pressure in this zone and focusing revegetation efforts on the east side of Highway 37, and on the south end of Lonigan Springs. The plot established in this section (03JD002) was placed in a reach rated "Functional at risk with an upward trend" and "Non-functional" by the Forest Service and IWF, respectively. The data from this plot shows that native species are well established in this mesic meadow. This stable community could provide a central point, around which restoration efforts could expand up and downstream. Cooperation should be sought with the private land owner(s) upstream. South of Lonigan Springs, willow establishment potential decreases as water dissipates.

Willow reestablishment is unlikely in zone 2. This area shows degraded riparian conditions, as noted in Table 2. There is high potential for further bank destabilization. This segment has the capacity to adversely influence ecosystem potential downstream through sediment loading and weed dispersal. I recommend controlling the Canada thistle and other invasive weeds in this segment. I recommend stabilizing the banks with perennial native graminoids that have extensive root mass, and augmenting the woody species already present to protect banks from further sloughing, and perhaps excluding cattle from the drainage to protect the revegetation efforts.

In zone 3, willows are present intermittently. Bank stabilization should be a priority along this stretch to prevent further riparian degradation. The studies presented in Table 1 rank the northern 1.16 miles of this stretch as PFC, a central 0.15 miles as "Non-functional," and the southern 2.1 miles to the confluence of Meadow Brook Creek as "Functional-at-risk with an upward trend."

My survey confirms these stretches have the best potential for rehabilitation due to sufficient waterflow, existing stands of willow and native graminoids, absence of large weed colonies, and continuity of ownership. Downstream of the confluence with Meadow Brook Creek, ownership is private. Although the channel extends to Deep Creek, water becomes intermittent after this point, being diverted or disappearing in the unconsolidated alluvium (Leffert, personal communication).

Meadow Brook Creek

Meadow Brook Creek is a good candidate for riparian improvements, including willow restoration. Native vegetation is already well established within the channel. Downcutting has not yet reached the extreme degree seen on Rock Creek. The Forest Service has jurisdiction over the headwaters and creek, with the exception of 0.5 miles owned by the BLM. Meadow Brook Creek is fed by two springs: Huffman Springs and Meadow Brook Springs. The drainage system around Huffman Springs is managed by the Forest Service. The drainage system around Meadow Brook Springs is managed by the BLM. This ownership continuity brings the health of the riparian ecosystem on Meadow Brook Creek under federal agency control.

Despite these positive factors, heavy grazing in and around Meadow Brook Creek leaves its banks susceptible to bank destabilization and downcutting. The plot established on Meadow Brook Creek shows the dominance of native riparian species in the channel, and the vulnerable state of the streambanks. I recommend excluding cattle from this creek and supplementing the existing coyote willow with more willow plantings and other riparian species. Huffman Springs is in close enough proximity that it might be included in the same exclosure.

The three meadows are poised to be eliminated by the head- and downcuts at their downstream borders. The upper headcut has been reinforced with riprap, but the other two are apparently untreated. I recommend bank and headcut stabilization with native woody and graminoid species. In addition, I recommend the two headcuts furthest downstream be structurally reinforced.

Canada thistle is present at low cover throughout the drainage on the CNG. I recommend control measures begin next season while this aggressive weed is still manageable. Cooperation with the BLM should be sought to eradicate the colonies upstream towards Meadow Brook Spring.

Other streams in the CNG

Deep Creek

Further investigation is needed to determine willow restoration potential at this site. The headwaters are in the Pleasantview Hills to the north. The drainage produces ephemeral flow for approximately 17 miles, until reaching the privately owned Holbrook Spring. Flow is perennial (20-30 cfs) at the spring, and most is diverted during the growing season (USDA, 2002b). There may be other springs emerging within the channel downstream from Holbrook Springs (Timothy, personal communication). Any water not diverted at the spring is contained by Stone Reservoir one mile to the south. Stone Reservoir stretches southward for approximately 2.5 miles. Water released from the reservoir drains toward the Great Basin and soon dissipates, usually before reaching the Utah border. The drainage from the headwaters to the Utah border reaches approximately 25 miles. The Forest Service manages approximately 4 contiguous miles (16%), including land surrounding Stone Reservoir. Stone Reservoir itself is managed by irrigators. Potential for riparian improvements may depend on the nature of water rights at Holbrook Spring and southward.

North Canyon
We made a cursory visit to the North Canyon stream where it first crosses onto Forest Service land from the north. Willow restoration potential is fair at this site. The stream has downcut approximately 1.5 m. Waterflow is consistent upstream on BLM land but becomes intermittent downstream as water seeps into the ground. Cattle are already partially excluded, and stands of native vegetation are well established. My preliminary recommendation is to exclude cattle from this drainage and seek cooperation with the BLM upstream for continued riparian improvement efforts.

Rock Spring Creek
This stream has consistent water flow and good potential to support willows. The primary challenge with improving riparian conditions here is the agricultural fields upstream. Large storm events scour out the vegetation with its sediment loads (Leffert, personal communication). The spring and creek lie entirely on Forest Service land. Preliminary recommendations are to exclude livestock grazing from the spring and creek. In addition, obtaining cooperation from upstream private land owners will be key to having this stream achieve a PFC rating.

Salyer Creek
I did not visit this creek. It reportedly supports a willow/aspen community, and has been rated at PFC (USDA, 2002b). The spring and entire stretch of this creek lies within the CNG. Ownership is private 0.5 miles upstream of the spring, and remains private for approximately 2.5 miles before crossing on to BLM land.

Sheep Creek
The drought and other adverse hydrologic conditions have dried up this segment of Sheep Creek (Leffert, personal communication), so willow reestablishment is not likely until more water is available. The portion of Sheep Creek we visited had one dying whiplash willow and one small coyote willow. Water is perennial further upstream on BLM land (Leffert, personal communication). I recommend excluding cattle from the channel area as a first step in restoring native vegetation and bank stability.

South Fork Rock Creek
Further investigation is required to determine willow restoration potential within this drainage system. Kurtz Spring and North Kurtz Spring are the major tributaries to South Fork Rock Creek. Both cross agricultural fields before entering Forest Service land. South Fork Rock Creek has been identified by the EPA as a 303(d) water quality limited stream. The limiting factor is identified as sediment (USDA 2002b). Riparian improvements, including willow restoration, on these tributaries and Rock Creek must begin with cooperation with the private land owners. Kurtz Spring and its drainage cross one section of farmed land. North Kurtz Spring and its drainage cross one half section of farmed land. Further upstream, these drainages cross approximately two miles of BLM land before crossing back onto Forest Service land. I recommend seeking a management agreement (such as placing the 1.5 sections in the Conservation Reserve Program) with the private land owners and the BLM, so that the headwaters of this creek can be uniformly managed and improved.

CONCLUSION
Degraded ecological conditions prevail on most of the streams in the CNG. Of the two creeks intensively surveyed in 2003, Meadow Brook Creek shows the most promise for recovery. While the lower portion of Rock Creek shows the most potential for recovery along that creek, the upper reach should also be of management concern because of its influence on the rest of the drainage system.

The remaining channels receiving cursory visits have varying degrees of potential. Salyer Creek is reportedly in excellent condition, and measures should be taken to ensure its PFC rating in the future. North Canyon, Rock Spring Creek, and South Fork Rock Creek could be improved by reaching management agreements with adjacent land owners. Deep Creek and Sheep Creek show lesser potential at present, due to water diversion and ownership conditions (Deep Creek) and drought (Sheep Creek).

The Curlew National Grassland 2002 Final Land and Resource Management Plan includes goals, objectives, standards and guidelines for maintaining and improving riparian communities. This may include revegetation of willows and other desirable plant species. Revegetation will aid riparian recovery to PFC. The success of revegetation is reliant on several factors, including removal of cattle grazing pressure and minimizing upstream erosion. Construction of exclosures around all perennial streams, removing grazing pressure, and cooperating with adjacent land owners are key companions to revegetation and healthy riparian systems on the CNG. Finally, monitoring the response to these management decisions will provide valuable insight into management effectiveness and the ability of riparian areas to heal.

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Appendix A

Map of Curlew Valley, Curlew National Grassland Boundaries, and perennial streams.

Appendix B

Map showing stream reaches surveyed, plant community transect locations, and zones of potential willow restoration.

Appendix C

Data sheets for plant community transects.

Appendix D

Checklist of the Vascular Plants of the Curlew National Grasslands

Nomenclature follows USDA, Natural Resources Conservation Service (NRCS, 2004), except for *Chrysothamnus nauseosus*

This list includes both upland and riparian species, and was compiled from:

- Collins and Harper (1982)
- Appendices Final Environmental Impact Statement for the Curlew National Grassland (2002a)
- Klara Varga fieldnotes (1999), and
- author's observations.

* = Introduced species
** = Native and introduced (according to NRCS)
Names in **bold** are likely misidentified (Welsh, 2004)

Scientific name	Common Name
TREES AND SHRUBS	
Acer glabrum	Rocky Mountain maple
Acer negundo	boxelder
Amelanchier utahensis var. *utahensis*	serviceberry
Artemisia nova	black sagebrush
Artemisia tridentata ssp. *tridentata*	basin big sagebrush
Artemisia tridentata ssp. *vaseyana*	mountain big sagebrush
Artemisia tridentata ssp. *vaseyana* (*x*)	mountain big sagebrush hybrid
Artemisia tridentata ssp. *wyomingensis*	Wyoming sagebrush
Artemisia tripartita	three tip sagebrush
Atriplex confertifolia	shadscale saltbush
Atriplex tridentata	basin saltbush
Betula occidentalis	water birch
Chrysothamnus nauseosus	rubber rabbitbrush
Chrysothamnus viscidiflorus	viscid rabbitbrush
Cornus sericea ssp. *sericea*	red osier dogwood
*Elaeagnus angustifolia**	Russian olive
Eriogonum heracleoides	parsnip flower buckwheat
Eriogonum microthecum	slender buckwheat
Eriogonum ovalifolium	cushion buckwheat
Eriogonum umbellatum	sulpher flower buckwheat
Gutierrezia sarothrae	broom snakeweed
Juniperus osteosperma	Utah juniper
Lycium barbarum (=*L. halimifolium*)	matrimony vine
Pachystima myrsinites	mountainlover
*Populus alba**	white poplar
Populus angustifolia	narrowleaf cottonwood
Populus balsamifera	balsam poplar
Populus tremuloides	quaking aspen
*Prunus americana**	apricot
Prunus virginiana	chokecherry
Purshia tridentata	bitterbrush
Rhus trilobata	skunkbrush sumac
Ribes aureum	golden currant
Rosa woodsii	Woods' rose
*Salix amygdaloides**	peachleaf willow
Salix boothii	Booths' willow
Salix exigua	coyote willow
Salix geyeriana	Geyer's willow
Salix lutea	yellow willow
Salix scouleriana	Scouler's willow
Sambucus nigra ssp. *cerulea*** (= *Sambucus caerulea*)	European black elderberry
Sarcobatus vermiculatus	greasewood
Symphoricarpos oreophilus	mountain snowberry
*Tamarix ramosissima**	tamarisk

Tetradymia canescens	spineless horsebrush
FORBS	
Achillea millefolium	common yarrow
Agoseris glauca	pale agoseris
Allium acuminatum	tapertip onion
Allium brandegeei	Brandegee's onion
*Alyssum alyssoides**	pale madwort
*Amaranthus albus**	prostrate pigweed
*Amaranthus blitoides**	mat amaranth
Antennaria dimorpha	low pussytoes
Arabis holboellii	Holboell's rockcress
*Arctium minus**	lesser burrdock
Argentina anserina (= *Potentilla anserina*)	silverweed cinquefoil
Arnica spp.	arnica
Artemisia biennis	biennial wormwood
Artemisia dracunculus	tarragon
Artemisia ludoviciana	white sagebrush
Asclepias speciosa	showy milkweed
*Asperugo procumbens**	German madwort
Aster adscendens	Western aster
Astragalus beckwithii	Beckwith's milkvetch
Astragalus brandegeei	Brandegee's milkvetch
Astragalus cibarius	browse milkvetch
Astragalus convallarius	lesser rushy milkvetch
Astragalus eurekensis	Eureka milkvetch
Astragalus malacus	shaggy milkvetch
Astragalus patens	[Unknown]
*Atriplex hortensis**	garden orache
*Atriplex rosea**	tumbling saltweed
Balsamorhiza sagittata	arrowleaf balsamroot
Calochortus nuttallii	sego lily
*Camelina microcarpa**	littlepod false flax
Camissonia sp.	suncup
*Capsella bursa-pastoris**	shepherd's purse
*Carduus nutans**	nodding plumeless thistle
Castilleja applegatei ssp. *martinii* (= *C. chromosa*)	wavyleaf Indian paintbrush
Castilleja linariifolia	Wyoming Indian paintbrush
*Ceratocephala testiculata** (= *Ranunculus testiculatus*)	bur buttercup
Chaenactis douglasii	Douglas' dustymaiden
*Chenopodium album***	lambsquarter
Chenopodium capitatum	Blite goosefoot
Chenopodium fremontii	Fremont's goosefoot
Chenopodium leptophyllum	narrowleaf goosefoot
*Chorispora tenella**	crossflower
*Cirsium arvense**	Canada thistle
Cirsium foliosum	elk thistle
Cirsium neomexicanum var. *utahense*	Utah thistle
*Cirsium vulgare**	bull thistle

Claytonia lanceolata	lanceleaf springbeauty
Collinsia parviflora	blue eyed Mary
Collomia linearis	tiny trumpet
Comandra umbellata	bastard toadflax
Cordylanthus ramosus	bushy bird's beak
Crepis modocensis	Modoc hawksbeard
Cryptantha humilis	roundspike cryptantha
Cymopterus longipes	longstalk springparsley
*Cynoglossum officinale**	houndstongue
Delphinium nelsonii	twolobe larkspur
Descurainia pinnata	tansymustard
*Descurainia sophia**	herb sophia
*Dipsacus sylvestris**	fuller's teasel
Draba spp.	draba
Epilobium brachycarpum	tall annual willowherb
Epilobium ciliatum ssp. *ciliatum* (= *E*. *adenocaulon*, *E*. *californicum*)	fringed willowherb
Equisetum laevigatum	smooth horsetail
Erigeron engelmannii	Engelmann's fleabane
Erigeron filifolius	threadleaf fleabane
*Erodium cicutarium**	redstem stork's bill
Erysimum capitatum var. *capitatum* (= *E*. *asperum*)	sanddune wallflower
*Erysimum cheiranthoides**	wormseed wallflower
Galium aparine	bedstraw
Galium bifolium	twinleaf bedstraw
Galium triflorum	fragrant bedstraw
Glycyrrhiza lepidota	American licorice
Grindelia squarrosa	curlycup gumweed
Hackelia patens	spotted stickseed
Helianthus annuus	common sunflower
Helianthus petiolaris	prairie sunflower
Heuchera richardsonii	Richardson's alumroot
Hydrophyllum capitatum	ballhead waterleaf
*Hyoscyamus niger**	black henbane
Ipomopsis aggregata ssp. *aggregata* (= *Gilia aggregata*)	scarlet gilia
Iva axillaris	povertyweed
*Kochia scoparia**	Mexican fireweed
*Lactuca serriola**	prickly lettuce
Lappula occidentalis var. *cupulata* (= *L*. *texana*)	flatspine stickseed
*Lepidium perfoliatum**	clasping pepperweed
Leptodactylon pungens	granite prickly phlox
Linum lewisii	prairie flax
Lithophragma tenellum	slender woodland star
Lithospermum ruderale	western stoneseed
Lomatium grayi	Gray's biscuitroot
Lomatium triternatum	nineleaf biscuitroot
Lupinus sericeus	silky lupine

Lygodesmia grandiflora	largeflower skeleton plant
Machaeranthera canescens	hoary tansy aster
Maianthemum stellatum (= *Smilacina stellata*)	starry false lily of the valley
*Malcolmia africana**	African mustard
*Malva neglecta**	common mallow
*Marrubium vulgare**	horehound
*Medicago lupulina**	black medick
Medicago sativa ssp. *falcata** (= *M. falcata*)	yellow alfalfa
*Medicago sativa**	alfalfa
*Melilotus alba**	white sweetclover
*Melilotus officinalis**	yellow sweetclover
*Mentha arvensis**	wild mint
Mertensia ciliata	tall fringed bluebells
Mertensia oblongifolia	oblongleaf bluebells
Mimulus guttatus	seep monkeyflower
Monolepis nuttalliana	Nuttal's povertyweed
*Nepeta cataria**	catnip
Oenothera caespitosa	tufted evening primrose
Opuntia fragilis	brittle pricklypear
Opuntia polyacantha	plains pricklypear
Packera multilobata (= *Senecio multilobatus*)	lobeleaf groundsel
Penstemon humilis	low penstemon
Petradoria pumila	grassy rock goldenrod
Phlox gracilis ssp. *gracilis* (= *Microsteris gracilis*)	slender phlox
Phlox hoodii	spiny phlox
Phlox longifolia	longleaf phlox
*Polygonum aviculare**	prostrate knotweed
Polygonum douglasii	Douglas' knotweed
Polygonum ramosissimum	bushy knotweed
Potentilla glandulosa	sticky cinquefoil
Ranunculus cymbalaria	alkalai buttercup
*Rorippa nasturtium-aquaticum**	watercress
Rudbeckia occidentalis	western coneflower
*Rumex crispus**	curly dock
Rumex salicifolius var. *mexicanus* (= *R. mexicanus*)	Mexican dock
*Salsola tragus** (= *Salsola kali*)	Russian thistle
Schoenocrambe linifolia (= *Sisymbrium linifolium*)	flaxleaf plains mustard
Senecio integerrimus	lambstongue ragwort
Senecio serra	tall ragwort
Silene drummondii	Drummond's campion
Silene menziesii	Menzies' campion
*Sisymbrium altissimum**	tall tumblemustard
*Solanum dulcamara**	climbing nightshade
*Solanum nigrum**	black nightshade
Sonchus spp.*	sowthistle
Sphaeralcea coccinea	scarlet globemallow
Sphaeralcea munroana	Munro's globemallow
Swertia perennis	felwort
Symphyotrichum spathulatum var. *spathulatum* (= *Aster*	western mountain aster

occidentalis)	
*Taraxacum officinale**	common dandelion
*Thlaspi arvense**	field pennycress
*Tragopogon dubius**	yellow salsify
Triglochin maritimum	arrowgrass
Urtica dioica	stinging nettle
Urtica dioica spp. *gracilis* (= *U. gracilis*)	stinging nettle
*Verbascum thapsus**	common mullein
*Verbena bracteata**	big bract verbena
Veronica americana	American speedwell
*Veronica biloba**	twolobe speedwell
Veronica peregrina	neckweed
Viola praemosa	canary violet
*Xanthium strumarium**	rough cockleburr
Zigadenus elegans	mountain deathcamas
Zigadenus paniculatus	foothill deathcamas
FERNS	
Woodsia oregana	Oregon cliff fern
GRAMINOIDS	
Achnatherum hymenoides (= *Oryzopsis hymenoides*)	Indian ricegrass
*Agropyron cristatum**	crested wheatgrass
*Agropyron desertorum**	desert wheatgrass
Agrostis scabra	rough bentgrass
*Agrostis stolonifera**	redtop bent
Alopecurus geniculatus	water foxtail
*Avena fatua**	wild oat
Bromus carinatus	mountain brome
*Bromus inermis**	smooth brome
*Bromus japonicus**	Japanese brome
*Bromus tectorum**	cheatgrass
Carex aquatilis	water sedge
Carex filifolia	cleft sedge
Carex nebrascensis	Nebraska sedge
Carex utriculata	beaked sedge
Catabrosa aquatica	water whorlgrass
Distichlis spicata	inland saltgrass
Eleocharis palustris	common spikerush
Elymus elymoides ssp. *elymoides* (= *Sitanion hystrix*)	squirreltail
Elymus glaucus	blue wildrye
Elymus lanceolatus ssp. *lanceolatus* (= *Agropyron dasystachyum, A. riparium*)	streambank wheatgrass
Elymus trachycaulus (= *Agropyron caninum*)	slender wheatgrass
Elymus trachycaulus ssp. *subsecundus* (= *Agropyron subsecundum*)	slender wheatgrass
Elymus trachycaulus ssp. *trachycaulus* (= *Agropyron trachycaulum*)	slender wheatgrass
Hesperostipa comata ssp. *comata* (= *Stipa comata*)	needle and thread grass

Hordeum brachyantherum	meadow barley
Hordeum jubatum	foxtail barley
Juncus balticus	Baltic rush
Juncus ensifolius	swordleaf rush
Koeleria macrantha (= *K. cristata*)	prairie Junegrass
Leymus cinereus (= *Elymus cinereus*)	basin wildrye
Leymus triticoides (= *Elymus triticoides*)	beardless wildrye
*Lolium perenne**	perennial ryegrass
*Lolium pratense** (= *Festuca elatior*)	meadow ryegrass
Muhlengergia asperifolia	scratchgrass
Pascopyrum smithii (= *Agropyron smithii*)	western wheatgrass
*Phalaris arundinacea**	reed canarygrass
*Phleum pratense**	timothy
*Poa bulbosa**	bulbous bluegrass
Poa curta	Wasatch bluegrass
*Poa pratensis**	Kentucky bluegrass
Poa secunda (= *P. ampla, P. scabrella*)	Sandberg bluegrass
*Polypogon monspeliensis**	rabbitsfoot grass
Pseudoroegneria spicata (= *Agropyron spicatum*)	bluebunch wheatgrass
Puccinellia distans	weeping alkaligrass
Schoenoplectus americanus (= *Scirpus olneyi*)	chairmaker's bulrush
Scirpus acutus	hardstem bulrush
*Secale cereale**	cereal rye
*Thinopyrum intermedium ** (= *Agropyron trichophorum*)	intermediate wheatgrass
*Thinopyrum ponticum** (= *Agropyron elongatum*)	rush wheatgrass
*Triticum aestivum**	common wheat
Typha latifolia	broadleaf cattail
Vulpia octoflora var. *octoflora* (= *Festuca octoflora*)	sixweeks fescue