Black Canyon of the Gunnison National Park and Curecanti National Recreation Area Survey Design and Site Selection Report

Defining the Upland Resources for Monitoring

Discussions with BLCA/CURE resource management staff identified a wide range of vegetative communities for long-term monitoring. The overall goal of monitoring in these park units is to provide information on the natural variability of upland resources as well as early warning of system degradation. Some of the identified communities have limited spatial extent, and due to this, are especially of concern to park management. Other community types are relatively dominant in individual park units. Sagebrush, the most extensive community type in BLCA/CURE, has additional management concerns. Although historically sagebrush has been grazed over then entire Gunnison Basin, it is not currently grazed in parts of BLCA/CURE, providing a unique opportunity to compare grazed and ungrazed sagebrush communities.

Park resource management staff identified the following communities as Tier 1 priority for monitoring: PJ (Pinyon-Juniper), sagebrush, oak scrub, aspen, and cottonwood. Tier 2 priority was mixed-conifer, Douglas-fir, and mixed shrub. Initial investigations found that Douglas-fir tended to occur on very steep terrain. Due to this and the affordable sampling effort, only Tier 1 communities were considered for the initial monitoring effort in BLCA/CURE.

Accessibility

Steep slopes ($\geq$ 50%) and areas isolated due to steep slopes (e.g., mesa tops) are considered inaccessible for NCPN upland monitoring. NCPN does not rely on boat access for upland monitoring, and therefore, created an accessibility map based on road and trail access. As a standard procedure, inaccessible areas are delineated and eventually eliminated from consideration in the site-selection procedures. Accessibility in BLCA/CURE was derived separately for each park unit using the NCPN Landscape Accessibility Model tool.

Creation of the BLCA/CURE accessibility map involved many unique challenges not found in other NCPN park units. BLCA contains numerous parcels of private property within its boundary, and boundaries change regularly as BLM and private parcels are transitioned to NPS ownership. Only private property with conservation easements and agreeable landowners were considered for the accessibility map. Parcels that were heavily managed with active hay fields and elk ranching (including a 10-foot fence) were eliminated from the accessibility map. Additional discussion with BLCA/CURE resource management staff included NPS land in the Blue Creek and Pine Creek areas accessible by crossing private land with agreeable owners or established NPS access easements through private property.

An additional challenge of the BLCU/CURE accessibility map is that some included areas are inaccessible during high water. Access to islands in the Neversink and Cooper Ranch areas are only accessible by wading through parts of the Gunnison River during low water flows in July and August. The old highway on the south side of the Gunnison River Canyon provides access to sagebrush in the area. However, when the Blue Mesa Reservoir is near complete fill, the old

highway becomes submerged, eliminating access to this area. During spring runoff, many creeks in CURE become impassible although the accessibility map displays them as wadeable.

Though field scouting, we discovered two areas that were not accessible even though the map predicted that they were. This included land on the west sides of the Lake Fork Arm and the Cebolla Arm. These areas were excluded from the final accessibility map.

Specific instructions and maps with special access concerns have been created for BLCA/CURE to assist crews in the future.

Grazing allotments

Much of BLCA/CURE has historically been grazed by cattle and sheep. Because BLCA and CURE have some of the only ungrazed land in the Gunnison Basin, park managers were interested in comparing grazed and ungrazed parts of the parks. Park managers met with BLM range conservationists from the Montrose and Gunnison field offices in May-June 2008 to update their grazing data. New spatial data were received for CURE in addition to time and type of grazing for both parks . Parts of the Grizzly Gulch allotment on the North Rim of Black Canyon have recently expired and a new fence line is expected to be built in the next few years. This fence line was approximated in the sampling frame. This file also contains all grazing allotments relevant to the sampling frame for BLCA/CURE.

Delineating the Target Population

Defining Target Vegetation Communities & Ecological Site Types

Inspection of the draft NCPN BLCA/CURE vegetation maps (as of 8/31/2007) and field visits to the park units determined the association types which corresponded to the vegetation communities of interest to park management. Initial evaluation of NRCS ecological sites suggested that oak/sagebrush (map unit #40) can not be distinguished from other sagebrush ecological sites. In addition, the similarity of biophysical properties between oak scrub and mixed montane communities suggested the potential to combine them into a more general grouping (Table 1). These groupings are documented in Table 1.

Soil map units of vegetative communities (Table 1) were overlaid on the two existing soil survey maps which cover portions of both park units (NRCS CO662 and NRCS CO679) to acquire an aerial estimates of ecological site by community type. The two soil surveys combined, however, did not cover the entire portion of either park unit. In addition, ecological sites are described as proportions of a soil map unit, and thus, the location of an ecological site within a soil map unit is not explicit.

To complicate matters further, the soil surveys were old (1976 and 1981) and only provided limited range site descriptions for soil map units. This meant that ecological sites for aspen and cottonwood were not well defined in the soil survey, and soil map units with PJ were not paired with any ecological sites. Existing ecological site descriptions for Major Land Resource Area (MLRA) 48 for the most part did not match range sites from the soil surveys. Thus, defining

ecological site types for BLCA/CURE was a challenge, and ecological site types are approximate, based on both range sites and available ecological site descriptions for MLRA 48.

Despite these limitations, ecological site types were characterized for oak scrub and sagebrush (Table 1). PJ ecological sites from MLRA 48 were reviewed, but there was no way to initially determine which sites would be dominant in the parks. They served as a guide for further field evaluation. Aspen and cottonwood were not assessed by ecological site type due to their limited extent in BLCA/CURE.

Table 1. Vegetation map units and dominant ecological sites corresponding with priority vegetation community types for upland monitoring in the BLCA/CURE.

Community type	Dominant ecological site types	Vegetation Map Unit	Vegetation Map Unit Name
Aspen	none	52	Quaking aspen/ tall shrubs
		55	Quaking aspen-Douglas-fir/Saskatoon serviceberry
Cottonwood	none	2	Salix geyeriana / Mesic Graminoids Shrubland
		7	Alnus incana / Agrostis stolonifera Shrubland
Oak scrub / Mixed montane shrubs	Rocky Loam, Brushy Loam	42	Gambel Oak/Montane shrubland
		43	Gambel Oak Woodlands
		44	Serviceberry-Mixed shrub
		48	Scree slope – Mixed Montane shrubs
		49	Mixed Montane Shrub/Big sagebrush
		90	Rock outcrop – UT Serviceberry
PJ	none	69	Sparsely wooded PJ/True Mt. Mahogany
		71	PJ/Oak
		72	PJ/sagebrush
		74	PJ/Mixed grass and shrubs
		78	UT Juniper/WY Big sagebrush
		87	Sparsely wooded PJ
		92	Sparsely wooded PJ-mixed shrubs
Sagebrush	Mountain Loam, Dry Mountain Loam	31	Wyoming Big Sagebrush
		32	Artemisia nova – Purshia tridentata shrubland
		33	Mountain Big Sagebrush
		35	Artemisia tridentata ssp. vaseyana/Pascopyrum smithii shrubland
		40	Gambel Oak/Big Sagebrush

Assessing Ecological Site Types of Community Aggregates

Field scouting was performed in order to assess the suitability of vegetation map units and the extent of dominant ecological site types for proposed community groupings. All potential vegetation map units (Table 1) were combined, clipped to the accessible area in the park boundaries, and rasterized to10 m. Reversed randomized quadrat-recursive raster (RRQRR) was used to randomly select 1000 points within this area. Using RRQRR order, the top 3 points of each unique vegetation/soil/grazing allotment combination were selected (423 points total). At each point, vegetation type and ecological site, if applicable, were recorded in addition to other biophysical site characteristics. An attempt was made to visit all recon points, however, this was not possible in the available time frame. Points that were skipped were either repetitive of other vegetation/soil map unit combinations or could not be reached in the allotted time due to dense oak scrub/mixed montane shrubs and long hikes. A total of 362 points were visited. The spatial extent of priority vegetation types is summarized in Table 2.

Table 2. Summary of grazed and ungrazed area (ha) in each priority vegetation type for monitoring in BLCA/CURE

	area (ha)		
Vegetation type	**grazed**	**ungrazed**	**total**
aspen	9	113	122
cottonwood	1	66	67
oak scrub	1384	3041	4425
pj	924	1335	2260
sagebrush	2309	2790	5099

Predictive Mapping

Each vegetation map unit was evaluated for appropriateness in its respective vegetation community type. Based on our field scouting, the following changes were made to the original sampling frame:

1) Polygons of map unit 40 west of the Blues Mesa Dam were switched to oak scrub.
2) Areas of map unit 49 on the north rim were switched to sagebrush. These included:
    a. Polygons of soil map units 64, 81, and 82
    b. Areas around recon points 369, 370, and 371.
3) PJ areas in the center of the south rim were switched to oak scrub.
4) Map unit 90 was excluded from the sampling frame.
5) The vegetation community of specific polygons was corrected when the extent of the entire polygon was assessed in the field.
    a. In map unit 40, the polygon with recon point 218 was switched to oak scrub.
    b. In map unit 43, the polygon with recon point 359 was switched to aspen.
    c. In map unit 71, polygons with recon points 452, 465, and 470 were switched to oak scrub.
    d. In map unit 74, polygons with recon points 486, 533, and 538 were switched to oak scrub.

From this data, a predictive map was created delineating accessible aspen, cottonwood, oak scrub/mixed montane shrubs, PJ, and sagebrush vegetation community types in BLCA/CURE. This map includes areas on the west sides of the Lake Fork Arm and the Cebolla Arm deemed inaccessible for upland monitoring. These areas were included in the original version of the sampling frame because BLCA/CURE used it to select sites for bird monitoring, and their monitoring program includes reliable boat access to monitoring sites.

An alternative version of the sampling frame was created for upland monitoring that does not include inaccessible areas on the west sides of the Lake Fork Arm and the Cebolla Arm (Figure 1).

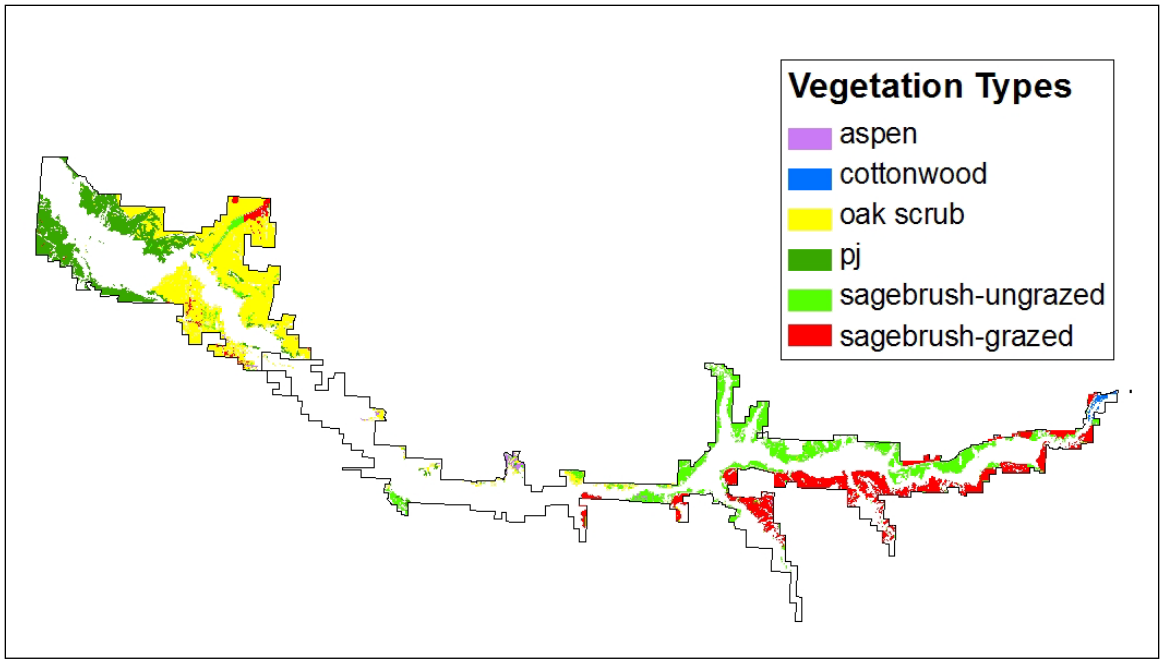

Figure 1. Map of accessible BLCA/CURE target vegetation types for upland monitoring.

Target Ecological Site Types

Field scouting confirmed that Brushy Loam was the dominant ecological site type in the oak scrub/mixed montane shrub vegetation type. Scouting also confirmed that Mountain Loam and Dry Mountain Loam were the dominant sagebrush ecological site types in BLCA/CURE. They seemed to form a continuum across the landscape, however, making it extremely difficult to classify sagebrush sites in the middle of the range. Initially, the plan is to attempt to distinguish Mountain Loam and Dry Mountain Loam sites, but eventually we may have to lump these sites. The dominant ecological sites types for PJ were Upland Shallow Loam and Upland Stony Loam. These ecological sites are similar and were often mixed on the landscape, therefore, we decided to combine the two for monitoring PJ. Aspen and cottonwood sites will be accepted based on the presence of trees from the appropriate forest type. Target vegetation and ecological site types selected for monitoring are described in Table 3 and illustrated in Figure 2. Additional photos, a table, and a dichotomous key were assembled to help distinguish target and non-target ecological site types in the field.

The proposed number of monitoring sites per vegetation/ecological site type is listed in Table 4. These numbers will be reassessed after 3 years of pilot monitoring, and the actual number of sites will be based on estimates variability within each ecological site type.

Table 3. Description of target vegetation and ecological site types selected for upland monitoring in BLCA/CURE.

Vegetation Type	Ecological site type	Physio-gnomic type	Soil properties	Geological properties	Vegetative properties	Disturbance-mediated alternative states	Potential non-target areas
aspen	no stratification	forest	deep loams on mountain sides	alluvium, glacial till, or colluvium	Dominated by aspen, chokecherry, Saskatoon serviceberry, snowberry	Ranges from skeleton to climax forest.	areas with no live aspen
cottonwood	no stratification	forest	deep alluvium of varying texture	recent alluvium on floodplains	Dominated by cottonwoods, willows, sedges, grasses, rushes	Ranges from skeleton to climax forest.	riparian areas with no cottonwood
oak scrub/ mixed montane shrubs	Brushy Loam	shrubland	deep loams on uplands and mountain sides	alluvium, slope alluvium, or glacial deposits	Dominated by Gamble oak, serviceberry, snowberry, mountain big sagebrush	Grazing: Decreased perennial grasses, increased woody shrubs. Fire: increased Gambel oak, snowberry, and rabbitbrush, decreased perennial grasses, forbs, and other shrubs.	shallow, rocky areas dominated by grasses and forbs; steep colluvial slopes with oak scrub/ mixed montane shrubs
pinyon pine / Utah juniper	Upland Shallow / Stony Loam	woodland	shallow to moderately deep loams and stony loams on ridges and mountain sides	residuum or colluvium	Pinyon pine and Utah juniper with sparse to moderate understory cover of shrubs, grasses and forbs	Grazing: decreased understory plants, increased PJ. Fire: temporarily decreased PJ, increased perennial grasses and shrubs.	sparse PJ on badlands; sparse PJ in dense oak scrub, PJ on deep soils
sagebrush	Mountain Loam	shrubland	deep loams on valleys, benches, and hillslopes	alluvium, slope alluvium, or glacial deposits	Tall big sagebrush with dense cover of grasses; may also include small amounts of mixed montane shrubs	Grazing: decreased perennial grasses, increased sagebrush. Fire: decreased sagebrush, increased rabbitbrush and snowberry.	very shallow sandy areas with black sagebrush; depressions with basin big sagebrush and basin wildrye
	Dry Mountain Loam	shrubland	shallow to moderately deep loams to stony loams on benches, ridges, and hills	residuum, alluvium, glacial deposits	Smaller big sagebrush with bunchgrasses and gravelly/stony interspaces	Grazing: decreased perennial grasses, increased sagebrush and snakeweed. Fire: decreased sagebrush.	

Aspen

Cottonwood

Brushy Loam (Oak Scrub)

Upland Shallow/Stony Loam (PJ)

Mountain Loam (sagebrush)

Dry Mountain Loam (sagebrush)

Figure 2. Examples of the six target vegetation/ecological site types for Upland Vegetation and Soils Monitoring in BLCA/CURE (see Table 3 for descriptions).

Table 4. Proposed number of monitoring sites for each ecological site type in BLCA/CURE.

Vegetation Type	Ecological site type	Grazing	Proposed number of sites
aspen	no stratification	no stratification	4-5
cottonwood	no stratification	no stratification	4-5
oak scrub/ mixed montane shrubs	Brushy Loam	no stratification	30
pinyon pine / Utah juniper	Upland Shallow / Stony Loam	no stratification	30
sagebrush	Mountain Loam	grazed	30
		ungrazed	30
	Dry Mountain Loam	grazed	30
		ungrazed	30

Monitoring Site Selection

Using the sampling frame created from field scouting, monitoring sites were selected using RRQRR (Theobold et al. 2007) and a 10-m grain size. Sites were selected separately for aspen, cottonwood, oak scrub, PJ, and sagebrush by giving the selected vegetation type a selection probability of “1” and the other vegetation types a probability of “0” for each RRQRR run. For each vegetation type, sites were selected with equal probability of selection. The use of a 10-m grid was to ensure complete coverage of the landscape. In field implementation of monitoring plots, selected sites must be rejected if too close to an established plot. Points from each RRQRR run were clipped using a 20-m buffer to help eliminate points that would get rejected for being to close to a vegetation type boundary. The sampling frame was not buffered prior to RRQRR site selection because BLCA/CURE was also using this same sampling frame for bird monitoring site selection, which required a different buffer size. Sagebrush points were further separated by grazed and ungrazed area. Additionally, the number of monitoring locations by sagebrush ecological site must be tracked during plot establishment to ensure a balanced number of locations per ecological site in both grazed and ungrazed areas.

Monitoring Site Selection Shape Files

For each vegetation type, the shape file listed below contains the first X number of potential monitoring plot locations in sequential order that are contained within the sampling frame minus the 20 m buffer and inaccessible area (X=20 for aspen and cottonwood; X=100 for oak and pj; X=200 for sagebrush). These shape files also contain the PlotID attribute used by field crews and recorded in the upland database.

BLCU_aspen20 – contains PlotID’s 1 to 20.
BLCU_cw20 – contains PlotID’s 21 to 40.
BLCU_oak100 – contains PlotID’s 41 to 140.
BLCU_pj100 – contains PlotID’s 141 to 240.
BLCU_sage200 – contains PlotID’s 241 to 440.

The sagebrush points in BLCU_sage200.shp have further been separated into grazed and ungrazed areas of the park.

Tracking Monitoring Sites

Using the order provided by RRQRR, the first 20 aspen locations, the first 20 cottonwood locations, the first 100 oak locations, the first 100 PJ locations, and the first 200 sagebrush locations were consecutively renumbered. This generated the PlotIDs used by field crews and recorded in the upland database.

BLCU_upland_master.shp includes all points given PlotID's and any relevant tracking information (Table 5). The attributes include acceptance or rejections of plots, reasons for rejection, and date of plot establishment. It is used to schedule pre-monitoring evaluation of sites and for the eventual derivation of selection probabilities. In this file, the GRID_CODE attribute was renamed "RQorder" for consistency among parks.

Response Design

The response design for BLCA/CURE is based on NCPN upland monitoring protocols and varies by vegetation type. In BLCA/CURE, sagebrush is monitored using the grassland/shrubland response design, PJ is monitored using the woodland response design, aspen is monitored using the forest response design, and oak scrub is monitored using a variation of the forest/woodland response design outlined in SOP #19. Table 6 outlines specific methods used for each response design.

Table 5. Attributes of BLCU_upland_master.shp for tracking BLCA/CURE upland monitoring locations.

Field	Description
Veg_Type	Vegetation type for upland sampling methods (grassland/shrubland, forest, woodland, or oak)
EcoType	Predicted vegetation type based on sampling frame (aspen, cottonwood, oak, PJ, or sagebrush)
Grazing	Indicates whether grazed or ungrazed for sagebrush; not applicable to any other vegetation types (na)
MasterStrt	Indicates groups for analyzing data (aspen, cottonwood, oak, pj ungrazed sage DML, grazed sage DML, ungrazed sage ML, or grazed sage ML)
PlotID	The plot number, based on ascending order of the RQorder field, renumbered to give unique plot numbers for each point on the list.
panel	Panel that plot is associated with in the revisit design
PanelYear	Year(s) that panel is sampled
EvalStatus	Ultimate status of a plot (estab = established; NotEval = not visited; accept = visited and deemed to be acceptable as a monitoring site; reject = rejected)
S_Action	Status of plot determined in the field and recorded on GPS (accept or reject)
EvalReason	Describes why a site was accepted or rejected
Estab_Date	Month, day, and year of plot establishment
Soil_MU	Soil map unit from CO662 (Gunnison) or CO679 (Paonia)
X	UTM E (NAD83, Zone 13)
Y	UTM N (NAD83, Zone 13)
Hike_km	Hiking distance to plot in kilometers
AreaDescr	General area of the park where the plot is located
Comments	Miscellaneous
ActualEco	Actual ecological site name for sagebrush sites (Mountain Loam, Dry Mountain Loam); not listed for other vegetation types
RQorder	Sequence number produced by RRQRR that doesn't start at 1 or increment by 1 (=GRID_CODE in original smpts shape files)
inc_prob	inclusion probability
SoilSurvey	Soil survey (CO662=Gunnison or CO679=Paonia) associated with soil map units

Table 6. Response design for vegetation types in BLCA/CURE.

Method	Grassland, Shrubland	Woodland	Forest	Oak
Transects	3 – 50 m transects	3 – 50 m transects	3 – 50 m transects	3 – 20 m transects
Plot establishment	Rebar at transect ends	Rebar at transect ends, plot side slopes, optional witness trees	Rebar at transect ends, plot side slopes, optional witness trees	Rebar at transect ends, optional witness trees
Photos	Transect origin, BSCs	Transect origin & end, BSCs	Transect origin & end	Transect origin & end
Point-intercept	0.5 m intervals	0.5 m intervals	0.5 m intervals (hits below monopod only)	0.25 m intervals
Gap intercept	X			
Soil stability	X	X		
1-m belt (shrubs, seedlings, & exotic frequency)	X	X	X	Seedlings and exotic frequency only
5-m belt (saplings)	X	X	X	X
Tree census	Quadrat 1 only (if trees are present)	Quadrat 1 only	Quadrat 1 only, record crown health & crown class	Entire plot & include Quegam >10 cm DBH
Spherical densiometer			X	
Fuels		X	X	
Site Impact	X	X	X	X

Modifications of Original Design

After field visits to the cottonwood areas proposed for monitoring, we decided that our upland response design was not well-suited for monitoring this area. The areas of interest tended to be long and narrow and did not fit a forest upland monitoring plot in most areas. In addition, the upland response design would not allow us to investigate the hydrology and geomorphology of the Gunnison River, important parts of understanding the vegetation dynamics. The river is wadeable in just a couple sections at the lowest flows, therefore, this vegetation type is best suited for big rivers riparian monitoring.

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