Black Canyon of the Gunnison National Park



2003-2004 Invasive Non-native Plant Inventory

Northern Colorado Plateau Inventory and Monitoring Network

Final Report

July 2005

Prepared by

Steven Dewey and Kimberly Andersen

Utah State University

Cover photo:

Carduus nutans in the Son-of-a-Gun Burn. Photo by S. A. Dewey.

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Report prepared for: Northern Colorado Inventory and Monitory Network, National Park Service, 2282 S. West Resource Blvd., Moab UT 84532 by Utah State University.

Suggested citation:

Dewey, S. A. and K. A. Andersen. 2005. An Inventory of Invasive Non-native Plants in Black Canyon of the Gunnison National Park (2003-2004) – Final Report. Prepared for the National Park Service, Northern Colorado Plateau Network, by Utah State University; Plants, Soils, and Biometeorology Department; Weed Science Research Project Report No. SD0511A, 36 pp. plus appendices.

FINAL REPORT

Inventory of Invasive Non-native Plants
Conducted during 2003-2004 in Portions of Black Canyon of the Gunnison National Park,
Northern Colorado Plateau Network of the National Park Service.

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INTRODUCTION

Utah State University conducted a two-year project to inventory and map invasive non-native plants for the National Park Service (NPS), Northern Colorado Plateau Network in the summers of 2003 and 2004. The project included portions of Arches National Park (ARCH), Black Canyon of the Gunnison National Park (BLCA), Bryce Canyon National Park (BRCA), Canyonlands National Park (CANY), Capitol Reef National Park (CARE), Cedar Breaks National Monument (CEBR), Colorado National Monument (COLM), Dinosaur National Monument (DINO), Hovenweep National Monument (HOVE), Mesa Verde National Park (MEVE), Natural Bridges National Monument (NABR), and Zion National Park (ZION). This document contains the results of the portion of this inventory project that occurred within Black Canyon of the Gunnison National Park. Results from other Parks are documented in separate Park-specific project reports. Also, please note that this report updates and replaces the Black Canyon National Park portion of the 2003 Northern Colorado Plateau Network invasive non-native plant inventory annual progress report (Dewey et al. 2003).

BACKGROUND AND JUSTIFICATION

Numerous recent studies demonstrate that invasive non-native plant species pose one of the greatest threats to natural ecosystems regionally and globally by altering native plant communities, wildlife populations, fire regimes, nutrient cycling, hydrology, and energy budgets of native ecosystems (D'Antonio and Jackson 2003, Duncan and Clark 2005, Mack et al. 2000, Sakai et al. 2001, Westbrooks 1998). A panel of scientists recently commissioned by the Council for Agricultural Science and Technology compiled an extensive list of those invasive plant species considered to be of greatest ecological and economic concern in the United States (Mullin et al. 2000). Most of those species are present in our region, and some have already invaded Parks of the Northern Colorado Plateau Network.

In a 1992 nationwide survey of Nature Conservancy stewards, 59 percent ranked invasive plants among their top-ten conservation concerns, and 13 percent considered them the greatest challenge they faced (Randall 1995). In a similar survey of National Park Superintendents regarding the conditions in their Parks, 61 percent of the 246 respondents indicated that non-native plants were a moderate or major problem (Layden and Manfredo 1994). Currently, invasive non-native plants are estimated to infest in excess of 7 million acres of National Park System lands (USDI-NPS 1996). Scientists estimate that invasive exotic plants are spreading on federal lands at a rate in excess of 4600 new acres per day, and warn that without significantly increased prevention, detection, and control efforts, the situation is certain to worsen dramatically (Asher and Harmon, 1995).

The management and control of invasive non-native species has been identified as a high priority issue within the National Park Service and is specifically, under the Government Performance and Results Act (GPRA 1993), identified as an accountable goal for all National Park units. Executive Order 13112 signed on February 3, 1999 (Clinton 1999), further identifies and strengthens the obligations of federal agencies to address the significant economic and biological threats posed by non-native species.

Additionally, the NPS has emphasized the importance of invasive species issues and their associated impacts by identifying non-native species as one of three major areas of focus under the Natural Resource Challenge initiative (USDI-NPS 1999). The Natural Resource Challenge specifically states, "Identifying, mapping and evaluating nonnative species are critical for effective management". Similarly, the development of the Exotic Plant Management Team (EPMT) initiative has further confirmed the dedication of the NPS to the management and control of invasive plant species. However, the EPMT program has a primary funding focus on the actual treatment and control of weed infestations and has not been established as a funding source for the actual inventory and mapping of invasive weed populations. Although the Natural Resources Challenge identifies the need for obtaining "accurate data about nonnative species distributions" as critical to meeting the goal of effective and efficient management, a specific funding source to accomplish this goal was not identified.

To meet this need, in 2001, the Intermountain Region Support Office in Denver prepared a successful Natural Resource Preservation Program (NRPP) proposal (USDI-NPS 2001) to conduct invasive plant mapping in high priority areas of Parks throughout the Intermountain Region, including six Parks within the Northern Colorado Plateau Inventory and Monitoring Network (NCPN). NCPN took the lead of coordinating this project and added network funding to increase the project scope to encompass work in 12 Park units. A cooperative agreement was negotiated between NCPN and Utah State University (USU) Extension to conduct inventory work during 2003 and 2004. Black Canyon National Park is a member of the Northern Colorado Plateau Inventory and Monitoring Network. A knowledge of current weed distribution, especially in or near previously disturbed areas and riparian areas, was identified as an extremely high priority need by the Northern Colorado Plateau Network.

OBJECTIVES

1) The primary objective of this project was to document distribution and abundance of targeted invasive non-native plant species across the range of habitats and areas of management concern in Black Canyon of the Gunnison National Park. It was anticipated that information from this inventory will be useful in the Park's ongoing efforts to improve strategic planning and to increase the effectiveness and efficiency of field operations associated with invasive plant management.

2) Based on the inventory results, efforts were to be made to identify potential sources of weed introductions and significant vectors involved in weed spread in the Park.

3) Within the scope of this project, USU was to work with regional, network and Park staff to test and refine data collection and field inventory techniques that might be used by NCPN in future invasive plant inventories.

METHODS

Utah State University supplied a 4-person crew in 2003 and 2004 to inventory designated areas within Black Canyon of the Gunnison National Park. Crew qualifications are documented in Appendix A.

SELECTION OF TARGET SPECIES AND INVENTORY AREAS

Twenty-four species were identified as high-priority targets in the 2003-2004 BLCA inventory (Table 1), and were searched for systematically by all inventory crew members. Any other non-native species recognized as relatively new to BLCA and potentially invasive on wildlands in the West were documented if found. Forty-seven species were listed in the 2004 GPS data dictionary, representing all species targeted for inventory by the 12 Parks included in this project, plus some additional species of regional or national concern.

Table 1. List of invasive plant species targeted in Black Canyon of the Gunnison National Park in the 2003-2004 Non-native Plant Inventory.

Invasive species	Common Name
Anthemis sp	Chamomile
Arctium minus	Burdock
Bromus tectorum	Downy brome
Cardaria draba	Hoary cress
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea maculosa	Spotted knapweed
Centaurea repens	Russian knapweed
Cirsium arvense	Canada thistle
Cirsium vulgare	Bull thistle
Convolvulus arvensis	Field bindweed
Cynoglossum officinale	Houndstongue
Elaeagnus angustifolia	Russian olive
Euphorbia esula	Leafy spurge
Hyoscyamus niger	Black henbane
Iva xanthifolia	Marshelder
Lepidium latifolium	Perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Linaria vulgare	Yellow toadflax
Onopordum acanthium	Scotch thistle
Rumex crispus	Curly dock
Tamarix ramosissima	Saltcedar
Ulmus pumila	Siberian elm
Verbascum thapsus	Common mullein

General categories of areas to be inventoried had been identified previously in the Intermountain Support Office Project Proposal and Implementation Plan (USDI-NPS 2001) based on what was considered to be the most likely invasive plant habitat, with priority given to areas of present or anticipated Park development and high visitor use. Areas of likely weed seed introduction as well as sites identified as significant known or potential weed seed sources or "vector areas"

were also given priority. Areas actually inventoried in Black Canyon of the Gunnison National Park in 2003-2004 included everything in the original Implementation Plan, plus additional areas added after consultation with Danguole Bockus, Ecologist for Black Canyon of the Gunnison National Park. Lands inventoried included accessible portions of the canyon river bank, access routes, roads, campgrounds, hiking trails, and at least one burned area.

The focus of this inventory project was NPS lands. However, in some cases a limited number of additional lands near or immediately adjacent to the Black Canyon of the Gunnison National Park border were inventoried. This occurred if crew members found an infestation of a high-priority weed species straddling across the Park boundary and wanted to determine its full extent; or if in traveling to or from the Park the crew discovered a "contamination source" of one or more threatening species immediately adjacent to the Park boundary. For example, crews discovered an infestation of *Centaurea diffusa* occurring approximately 3 miles outside the Park boundary on the road shoulder.

Park natural resource staff and the NCPN Vegetation Ecologist worked closely with USU crews to provide pre-existing weed distribution information. They also provided information about weed control efforts currently underway, and the best access routes to targeted areas. All of this information was used in planning the 2003-2004 field inventory, and in gathering and analyzing data. NCPN and BLCA staff also helped to ensure that data were assembled and provided to the network in a useable format.

DATA CATEGORIES

The data categories included in this inventory were discussed at length and agreed upon by NCPN and USU project leaders prior to initiation of the project. A complete description of the data categories and value options appears in Table 2. The GPS data dictionary developed to electronically capture data elements while in the field is presented in Appendix B. Data collection categories and definitions comply with the minimum mapping data standards established by North American Weed Management Association (NAWMA 2003) and include most of the core elements contained in the NPS Intermountain Region Weed Mapping Guidelines (Benjamin 2001, USDI-NPS 1995). Appendix C indicates the relationship of NCPN data fields to NAWMA standards and IMR Weed Mapping recommendations. A rationale is presented for any deviations from the IMR-recommended data fields.

Data elements were collected by one of several methods: automatically recorded or manually entered into GPS units in the field (GPS-entered); transcribed from field notes; obtained from previously existing GIS data sets during post-processing (GIS-derived), or added manually in the office during post-processing (office). GIS-entered data included the location and size of each infestation, percent canopy cover, phenology of the weedy species, woody growth stage (if a woody species), presence of site disturbance, hydrology, dominant native species present, date, time, and any additional pertinent notes about the site. Data entered in the office during post-processing included ecological status, Park code, record numbers, detection confidence for inventory area polygons, scientific name, ITIS code, lifeform of species, county, state, and country. Additional data elements (e.g. datum, UTM zone, source of data) that pertain to the spatial data set as a whole are provided as metadata files (e.g., datum, UTM zone).

Table 2. Description of data fields used in 2003-2004 Inventory of Invasive Non-Native Plants in Black Canyon of the Gunnison National Park.

Data Field	Description	Options / Values	Priority	Entry
Species Name	Latin name of species	Pick-list to be provided by Park staff	Required	GPS
Species Code	IT IS		Required	Office
Additional Names	Common name of the species			Office
Date	Date species observed		Required	GPS
Observer	Name of person observing population	First initial of person's last name used in data file name	Required	GPS
Location ID	Unique identifier for species population ("Record #")		Required	GPS
Park Code	Four-letter abbreviation of Park	BLCA	Required	Office
Country	Name of country (e.g. USA)		Required	Office
State	Two-letter state abbreviation		Required	Office
County	County name		Required	Office
UTMN	UTM northing coordinate for population		Required	GPS
UTME	UTM easting coordinate for population		Required	GPS
Elevation	Elevation in meters (and feet)	Meters (or feet)	Required	GPS
Size of Infested Area	Size of population (if a point feature). Based on average diameter of weed infestation.	- 1 to few plants - 0.1 acre - 0.25 acre - 1 acre - 2.5 acres - 5 acres	Required only for points.	GPS
Gross Area		Gross estimate of land area occupied by a weed species	Required in specific situations.	GPS
Cover of infested area	Estimated percent of area infested with weed	trace (<1%) low (1 to 5%) moderate (6 to 25%) high (26 to 50%) majority (51-100%)	Required.	GPS
Distribution	Characterization of density	To be determined by PI		GPS
Phenology	Life stage of majority of population. Use most progressive life stage if population appears evenly split.	- vegetative - bud - flower - immature fruit - mature fruit - seed dispersing - dormant	Required	GPS

Table 2 continued.

Data Field	Description	Options / Values	Priority	Entry
Woody Growth	Predominant growth stage of species. Use for woody weed species only (elm, tamarisk, Russian olive, etc.) If stages are mixed, use most advanced stage. (valuable for planning control efforts)	- seedling - sapling - mature - old-growth	Optional	GPS
Lifeform	Lifeform of species.	-tree -shrub -graminoid -forb	Required	office
Ecological Status	Qualitative description of the level of infestation that identifies ability of site to recover to natural state once the weeds have been removed.	1. No weeds -The management emphasis is preventing weed encroachment. 2. New and/or small infestations - These infestations have good potential for eradication because they are small and there is a good understory of desirable plants. 3. Large scale infestation with 30% or greater understory of residual grasses and good potential productivity – Management of these sites in a way that selects for the recovery of the residual native grasses and shrubs has good potential for control but not eradication of the weeds. May be more that one noxious weed species, but the underlying biologic integrity of the unit is good. 4. Large-scale infestations with few or no (less than 30% cover) desirable grasses in the understory. Infestation often dense and/or multiple weed species. Control will require intense treatment and probably revegetation. Control may be possible but not eradication. In some areas, the infestation may have changed the character of the land so much that attempts for rehabilitation are cost prohibitive.	Required	Field and Office
Dominant Species	Species Latin name for dominant species at site (up to four species can be recorded)	Two to three dominant species need to be provided at each point (list of dominant species provided by Park). If single or few plants, use dominant species in 1/10 acre area.	Required	GPS
Buffer	Buffer needed to encompass population if GPS'ed as a line or polygon feature	Enter number in feet	Required for lines, optional for polygons	GPS

Table 2 continued.

Data Field	Description	Options / Values	Priority	Entry
Hydrology	General hydrologic setting of site. If further specificity is needed in Park, add items as subcategories to existing terms (e.g., wetland - seep).	- upland (above and away from floodplains) - riparian (along rivers or stream channels) - perennial: stream flows continuously in time. - intermittent: stream flows only at certain times of the year (typically on seasonal basis) when it receives water from springs or from melting snow. - ephemeral: stream flows only in direct response to precipitation. Ephemeral streams generally lack obligate riparian vegetation. - wetland (saturated soil for majority of growing season) - playa lakebed (poorly drained depressions)	Required	GPS
Disturbance	Evaluate disturbance at population site	1 - no disturbance apparent 2 - light to moderate disturbance 3 - site heavily disturbed	Required	GPS
Notes	Additional comments	Can include compass bearing for photos, description of non-weed features, etc.	Optional	GPS and field notes
Area ID	Unique identifier for inventory area		Required	GPS
Disturbance Comments	Comments on type and extent of disturbance noted in inventory area. If area is undisturbed, note as such.	-Agriculture/Livestock Grazing -Construction/Development -Fire -Fire Suppression -Flooding -Wind -Geothermal -Animal Disturbance (e.g. gopher mound, buffalo wallow -Irrigation/Ditches -Mining and Quarries -Oil and Gas Exploration/Production -Habitat Improvement Project -Recreation/Visitor Use -Right-of-Way -Construction/Maintenance -Utility -Construction/Maintenance -Trail/Outfitter/ORV use	Required	Field notes

FIELD PROCEDURES

Some of the terms used in this and subsequent sections of the report have been created by the authors to describe new or modified methods and standards developed by USU for conducting invasive weed inventories on wildlands. Terms unique to this report are defined as follows:

Search Target (ST): Refers to invasive plants that are the object of a field search. ST descriptions must always include species, growth stage, and MDTS.

Minimum Detection Target Size (MDTS): The smallest infestation size (single plant or patch) of the least-visible targeted invasive species that searchers are confident of detecting and identifying at a stated level of probability under actual field conditions using their stated protocols. In this project the MDTS was set at 0.01-acre.

Effective Detection Swath Width (EDSW): The maximum width of a linear walking search pattern in which an on-the-ground searcher is confident of visually detecting at least 90 percent of all invasive plant infestations of the stated minimum target size. EDSW must be adjusted according to factors influencing target visibility, such as species, stage of growth, topography, and associated vegetative cover, in order to maintain the 90 percent minimum detection standard. Data dictionary choices for effective detection swath widths in this project were 25, 50, 100, 150, 200, 250, and 300 yards.

Patch Separation Resolution (PSR): The minimum distance between single weeds or patches of weeds that are considered to be separate infestations. Plants separated by the PSR distance or more are mapped as separate infestations. Plants separated by less than the stated PSR are usually mapped as a single infestation. The PSR for this project was 50 yards.

Detection Confidence (DC): The percentage of the total number of infestations that crew members estimate they were able to find in a searched area, based on the probability of seeing patches of the established minimum detection target size of the least visible target species in that terrain. Detection confidence is essentially meaningless without also stating the search target associated with that DC. The minimum required DC set for this project was 90 percent based on a MDTS of 0.01 acre for plants of the least visible target species in a mature or flowering stage of growth.

Between-Feature Positions (BFP): A series of location points recorded automatically by Trimble GPS units indicating the daily search routes traveled by each crew member. The distance interval for collecting BFP's in this project was set to correspond to the average effective detection swath width for each area inventoried.

The inventory in Black Canyon National Park was conducted between August 5 – September 12, 2003, and August 14 -19, 2004 (Table 3). Sites inventoried included the Warner Route, Tomichi Route, Gunnison Route, S.O.B. Route, Long Draw, Slide Draw, Red Rock Canyon, East Portal, East Portal Road, North and South Rim Roads and campgrounds, Green Mountain Trail, and the Son-of-a-Gun Burn.

For purposes of planning and data analysis the inventoried lands were divided into thirteen areas (Table 3). The order in which areas were inventoried was determined by the USU crew leader. Potential invasive plant habitat within each targeted inventory area was considered prior to planning each day's travel route. Field crew members were expected to search along the planned inventory routes, spending more time in priority areas and areas of concentrated invasive plant habitat.

When arriving at a site, crews would determine the best search methods and GPS settings needed to achieve the required level of detection confidence for the established minimum target size. Terrain, vegetation cover, expected visibility of target weed species, and crew size were all factored into setting effective detection swath widths and other mapping techniques and standards used for each site.

Field searches were conducted at as fine of a scale as required to be confident that 90 to 100 percent of all invasive plant infestations 0.01 acre or larger within each inventory area were detected. Search swath widths were adjusted as needed based on variations in terrain, walking speed, associated vegetation, and target species. Areas in the head of Red Rock Canyon or in the Son-of-a-Gun Burn were generally open and visibility was good, allowing relatively broad EDSW's (typically 50 to 75 yards). In areas where vegetation cover was heavy or in the six narrow access routes into the inner canyon, EDSW's were sometimes less than 25 yards. Whenever inventorying areas wider than a single swath width, multiple parallel passes of a lone crew member (or multiple crew members walking parallel transects or contours) were searched as contiguous or slightly overlapping strips to avoid coverage gaps. Because the river could not be crossed in the canyon bottom the crew used binoculars to visually scan the opposite bank for suspected target species. Weeds observed across the river were mapped using the Trimble GPS offset feature. Daily inventory routes of each crew member were recorded and mapped using the BFP tracking function of the GeoExplorer GPS units (whenever GPS satellite reception was possible). BFP tracking distance settings were adjusted as needed to correspond closely to the EDSW distance for each area.

Each inventoried area within Black Canyon of the Gunnison National Park was assigned a detection confidence value based on the crew's estimated ability to see infestations of 0.01 acre in size of the least visible target species, taking into account terrain, vegetation cover, and the size and growth stage of the targeted plant species. Detection confidence was broken into three categories: Low (1 to 50 %), Medium (51 to 89 %), and High (90 to 100%).

As inventory units were traversed, locations of all target species were documented by the USU crew using Trimble GeoExplorer 3 global positioning system (GPS) units and GeoExplorer XM GPS units with 2- to 5-meter accuracy. Crews also recorded the location and documented the identity of any other non-target species they encountered if that species has a known history of invasiveness in other regions in the West. GPS configuration settings used in this project are listed in Appendix D. Additional equipment used by crew members included laser rangefinders,

Table 3: Invasive plant inventory areas, inventory dates, crew members, and acres inventoried during 2003-2004 in Black Canyon of the Gunnison National Park.

Area Number	Area Description	Dates Inventoried	Crew Members*	Acres Inventoried**	Corresponding Inset Map Names and Letter Codes ***
1	Red Rock Canyon	09/12/03	KA, JS, RR	68.4	Red Rock Canyon – A
2	East Portal	09/11/03	KA, JS, RR	107.7	East Portal – G
3	Tomichi Route	09/09/03	KA, JS, RR	21.1	Kneeling Camel – E
4	Gunnison Route	08/05/03	KA, SD	17.7	Chasm View – C Kneeling Camel – E
5	South Rim Road, East Portal Road	09/10/03	KA, JS, RR	329.2	Warner Point – B Chasm View – C Kneeling Camel – E East Portal Road - F
6	North Rim Road	08/16/04	KA, SD	295.5	Chasm View – C Grizzly Gulch – D Kneeling Camel – E
7	North Vista Trail	08/18/04	KA	103.5	Warner Point – B Chasm View – C
8	S.O.B. Route	08/17/04	KA, BA	41.2	Warner Point – B Chasm View – C
9	Warner Route	08/18/04	MB, SD	78.3	Warner Point – B
10	Long Draw	08/16/04	BA, MB	7.6	Chasm View – C
11	Slide Draw	08/16/04	KA, SD	28.0	Kneeling Camel – E
12	Son-of-a-Gun Burn	08/17/04	MB, SD	61.5	Red Rock Canyon – A
13	Trail to Son-of-a-Gun Burn	08/17/04	MB, SD	14.0	Red Rock Canyon – A
	TOTALS			1173.7	

* Crew abbreviations: BA = Bridget Atkin, JS = Janna Simonsen, KA = Kim Andersen, MB = Melanie Ballard, RR = Ruth Richards, SD = Steve Dewey

** An average of 38.9 and 37.5 acres inventoried per person per 10-hr day in 2003 and 2004, respectively.

*** Indicates the key to mapped areas presented later in Figure 2.

compasses, binoculars, topographic maps, calculators, and radios. Appendix E contains a photograph and complete list of equipment used in this study. Field locations were recorded by GPS as UTM coordinates, and were later differentially corrected in the production of final digital products. The crews recorded invasive plant occurrence data on hard-copy (USGS 7.5-minute topographical maps) whenever GPS satellite reception was not possible (such occurred often in the narrow canyon bottom) or in cases of GPS equipment malfunction. All data from field maps were converted to digital format.

Invasive plant infestations 1 acre or less in size were mapped as point features. The size of each infestation recorded as a point feature was estimated visually (using a laser rangefinder) and placed in the size category most closely matched to its actual area: 1) 1 to few plants (0.001 acre), 2) 0.01 acre, 3) 0.1 acre, 4) 0.25 acre, 5) 0.5 acre, 6) 1.0 acre, 7) 2.5 acres, or 8) 5 acres. Canopy cover of each infestation was estimated visually and placed in a category of either: 1) trace = less than 1 percent, 2) low = 1 to 5 percent, 3) moderate = 6 to 25 percent, 4) high = 26 to 50 percent or 6) majority = 51 to 100 percent. As a general rule, scattered plants with individuals or clusters separated by less than 50 yards were considered a single infestation and were mapped as a single feature (point). Individual or groups of plants separated by more than 50 yards were mapped as separate infestations. (Refer to definition of PSR.)

Crew members have the option to record infestations between 1 and 5 acres in size as points, polygons (either actual areas or gross areas), or line features, depending on which feature they feel would best represent the situation. However, essentially all infestations within this size range were recorded as point features in Black Canyon of the Gunnison National Park. Polygon or line features recorded within this size range were generally converted in the office to point features in order to facilitate viewing on GIS-generated maps. The only exception was an extensive linear infestation of *Convolvulus arvensis* mapped along the North Rim Road.

Extensive weed infestations (greater than 5 acres in size) are usually mapped either as "actual" or "gross" area polygons (see 2003 NAWMA Weed Mapping Standards for definitions). "Actual" area polygons are created by walking around the perimeter of an infestation while automatically recording location points using the GPS polygon feature. Gross areas are used only in situations in which an invasive species is too abundant and widespread to inventory thoroughly, and yet its general distribution is considered important to note in map form. To create a "gross" area, crew members draw on field maps and/or describe in field notebooks the borders of a large area observed to be infested. Then the percentage of land within the overall gross area boundary that is infested by the weed and the average canopy cover within the infested portions are estimated visually. Estimates may be based on a remote visual inspection of the area from a strategic vantage point (such as from a low-flying aircraft, or viewed by binoculars from a ridge or hilltop), an on-the-ground walking survey of a representative portion of the area, or a thorough search of the entire area to inventory less abundant species. The only large infestation in BLCA mapped as an actual area was that of *Bromus tectorum* in the upper portion of Red Rocks Canyon. The gross area method was used in BLCA for infestations of *Carduus nutans, Bromus tectorum, Ulmus pumila* and *Cirsium arvense* in the Son-of-a-Gun burn.

In deciding on the dominant vegetation cover, crews identified the two most prevalent or most dominant native species in the immediate vicinity of the weedy infestation. The full list was not

a part of the data dictionary due to its size, but a paper copy (Appendix F) was carried and referred to by each crew member while working in the field. The vegetation list was compiled by Tamara Naumann, Botanist at Dinosaur National Monument, for an inventory conducted by USU in 2002-2003, and it was decided to use the same list for this project. Native species were coded with a 2-digit number and these codes were entered into the data dictionary. The list was not a complete list, and crews had the option to add additional native species if they encountered them in the field.

POINTS OF INTEREST

The locations of some non-weed points of interest were recorded by field crews. These points include springs, seeps, Park boundaries, and sites of possible archeological interest. Points of interest were collected at the discretion of individual crew members. The information collected was delivered to NCPN, but not included within this report.

GENERAL PHOTOGRAPHS

Representative photos are included in this report showing some of the species and habitats inventoried, as well as a sampling of photographs of field crews doing inventory work. Photographs were taken of each new weed species found in the Park. Close-up photographs were intended to serve as a type of voucher specimen for weed species encountered, and landscape photos of weeds are expected to assist in relocating small isolated infestations for future control. The location of each weed infestation documentation photo was recorded as a GPS "photo point". In the case of landscape photographs of a weed and/or its surrounding habitat, the UTM coordinates represent the location of the photographer, and the direction that the camera was facing is noted as a compass bearing (magnetic north reference). The locations of photos taken to show general types of terrain and habitat, or crew activities usually were not documented with GPS points. Photographs were taken with a digital camera, or with 35-mm slide film and later digitized. Pertinent photographs are included with this report (see Appendix G). Digital copies of all photographs were submitted to NCPN as part of the final deliverables.

VOUCHER SPECIMENS

Specimens were to be collected to document new or otherwise unique occurrences of invasive species encountered within Black Canyon of the Gunnison National Park. Two voucher specimens of *Centaurea maculosa* were collected in BLCA. One specimen was collected at the Amphitheatre near the South Rim campground. The second specimen of *Centaurea maculosa* was collected along the road shoulder on the North Rim. A specimen of *Centaurea repens* was also collected along the shoulder of the North Rim Road. A sample of *Cirsium arvense* was collected in on a gravel bar in the inner canyon downstream from the S.O.B. route. *Ailanthus altissima* was collected from the Son-of-a-Gun Burn area. A specimen of *Centaurea diffusa* was collected on the road shoulder approximately 3 miles outside the Park boundary. Duplicate voucher specimens were processed for deposit in herbaria at USU and Black Canyon of the

Gunnison National Park. The specimens deposited at USU is considered "on loan" from NPS and documented in a loan agreement. Specimens were curated and managed following NPS service-wide protocols. The specimens collected as part of this project are affixed with labels containing information on species, collector, collection date, collection site, and NPS record number. Specimen data also is provided in electronic format.

FIELD DATA PROCESSING

At the end of each day, field crews marked and dated all inventoried areas on USGS 7.5' topographic maps to assist in determining project progress and thoroughness of coverage. The GPS between-feature positions recorded each day were used for reference when marking the topographic maps. Each crew member kept a daily log of where they searched, what species they encountered, disturbances noted, thoroughness of coverage, and any additional information that they felt might be of importance to the project. Data were downloaded from GPS units onto a laptop computer each day using Pathfinder Office GIS software. Edits (such as eliminating any duplicate features) were made to the data, and any additional information (such as infestations drawn by hand on field maps or other data not recorded with a GPS unit) were added at this time. Four sub-folders were created within the main project folder on the computer hard drive. These were for: 1) unedited raw GPS rover files, 2) edited GPS rover files, 3) differentially corrected edited GPS rover files, and 4) GIS shapefiles created from the differentially corrected rover files (for export and use in ArcView). Separate disks were used for raw and edited rover files.

Raw data consisted of rover files transferred directly from GPS units to the computer, and stored without any editing or modification. They were named using a 6-digit code (month-day-hour) preceded by a single letter (corresponding to the first letter in the crew member's last name), and ending in ".ssf." For example, "A081913.ssf" would be the file name for raw GPS data collected by Kim Andersen beginning in the thirteenth hour (24-hr local time) on August 19.

Edited data files were created from raw files that were viewed in Pathfinder Office and checked for accuracy. Features were added or deleted in the process of editing to eliminate any duplicate reporting (two crew members finding the same infestation), and to add locations drawn on field maps (as when satellite signals could not be obtained). Any locations added in the editing process were noted as "hand mapped" in the notes section and are denoted as "Non-GPS" under the differential correction section. Notes were sometimes expanded during the editing process to include more detailed information about the surrounding habitat. Gross area features also were added during this process. File names were changed after editing to avoid confusion with the raw files. Edited files were named as a 3-letter month and 2-digit day abbreviation, followed by a dash and the first letter of the crew member's last name. If a crew member collected more than one file for that day, a number would follow the crew identification letter. For example, the edited version of the second file of GPS data collected by Kim Andersen on August 19 would be Aug19-A2.ssf.

The data from edited GPS rover files were then differentially corrected. Features that were added or deleted in the editing process were not differentially corrected; nor were points for which corresponding base station data were not available. Generally, the closest base station to the inventory area was used. However, if use of a slightly more distant base station resulted in a

higher percentage of successfully corrected points, it was used in preference to a closer station. Corrected files retained the same name as their edited counterparts, but used the file extension “cor” rather than "ssf". Example: Aug19-A2.cor.

Shapefiles were created from exported data by exporting the differentially corrected files from Pathfinder Office into ArcView. The shapefiles were created from the various categories in the data dictionary such as point-weed shapefile, line-weed shapefile, area-weed shapefile, photo-point shapefile, and between-feature point shapefile. Three kinds of files were created from each “.cor” file. These are “.shp”, “.shx”, and “.dbf.” Example: pt-weed.shp, pt-weed.shx, pt-weed.dbf

POST-SEASON DATA PROCESSING

At the end of the field season, the project crew leader again reviewed the data in Pathfinder Office software to ensure all were present and complete. Data files were compared to entries in the field notebooks and maps served to ensure that all species were included in the data set and inventory areas were complete. Data were then exported from Pathfinder Office as shapefiles. Exported files were compiled into specific shapefiles for each type of data collected. The shapefiles created for this project were named according to the year of the data, the type of file, and the shape of the data collected. For example, points of weeds data collected in 2004 are compiled into one shapefile labeled as 04pt-weed.shp. Between-feature points from 2004 are labeled 04psnpnt.shp. Shapefiles were then imported into ArcView GIS 3.3 for map-making and data analysis. When shapefiles were imported into ArcView, additional data fields were added to comply with the task agreement. These fields include scientific name, ITIS code, life form of the species, county, state, country, and Park code. Individual record numbers, including the four-letter Park code, were assigned to each weed infestation location entry. It was decided to enter this information after the field season to minimize the amount of time spent collecting non data in the field and maximize the acres inventoried. The data were checked again for any duplication of entries. Any gaps in the sequence of record numbers are due primarily to elimination of duplicated entries.

Polygons of areas inventoried within the various drainages of the Park were created in ArcView 3.3 using the between-feature positions that tracked each crew member's daily route. Individual areas represent the units used in planning and executing inventories. Each inventory unit is identified by a unique area number, and is described using names of associated canyons or other geographical features. Information provided for each inventory area includes area size (acres), dates of the inventory, the persons involved, Park code, county, state, and country. In addition, each area was assigned a detection confidence level indicating the crew’s estimated ability to detect 0.01-acre patches of targeted weed species based on the vegetation types and the terrain. Each area also was given an ecological status rating which is a qualitative estimate of the ability of a site to recover to a natural state once the weeds have been removed. The levels of ecological status are defined in Table 2. The crew leader assigned this number based on crew field notes and/or personal on-site inspections of the areas.

The shapefiles were used to create maps using ArcView software. Large-scale maps (1:100,000) were created to show the total area inventoried during the 2003-2004 BLCA project and the location of smaller-scale (1:18,000) inset maps used to present weed distribution information. Each small-scale inset map is identified by a letter, as well as the name of prominent feature found on that section of map. The distribution maps also illustrate weed-free areas within inventoried units and may help managers prioritize areas for weed prevention efforts. Queries and summations of the weed acreages were conducted in ArcView and are included in the Results and Discussion portion of this report.

Individual maps were exported and saved as .jpeg files. Any data tables were exported and saved as Microsoft Excel spreadsheets. Metadata were compiled for the final 2003-2004 dataset by Utah State University using ArcGIS ArcCatalog software. The metadata were provided to the Northern Colorado Plateau Network in an electronic format as part of the final project deliverables. All shapefiles, spreadsheets, raw, edited, and differentially corrected data files as well as digital photographs were also provided to NCPN as part of the final deliverables.

QUALITY ASSURANCE

Numerous measures were taken to ensure the quality of data collected by weed mapping crews. Quality assurance began by hiring only highly qualified individuals. In addition to in-person interviews, a written exam was administered to each applicant to evaluate their skills in weed recognition, taxonomic terminology, map reading and orienteering, GPS/GIS terms and applications, math, wilderness survival, and first aid. Crew members completed an intensive 1- to 2-week pre-season training course consisting of classroom presentations and field exercises to familiarize them with all inventory procedures and policies, and to improve all skills related to the job. Each crew member was provided with a copy of the training manual.

During the first few weeks of each field season, and periodically thereafter, the Crew Supervisor (CS) and/or the Principal Investigator (PI) worked individually with each crew member to ensure that all skills had been mastered and that procedures were consistent among all crew members. The CS reviewed the crew's downloaded data and project log entries at the end of each day. Any gaps in search patterns that were significantly wider than the effective detection swath width were identified, revisited, and inventoried.

Periodically during the field season, the CS and/or PI conducted inservice training in the form of weed I.D. quizzes or demonstrations, reviewing targeted and other invasive weed species at various stages of growth. Each time any new weed species was found, the identity was verified by the CS and/or PI. Throughout both seasons the PI and CS conducted random field inspections of areas already inventoried by individual crew members. Data collected by the PL and CS were compared with data collected by individual crew members to evaluate detection thoroughness and data accuracy (species, location, size, canopy cover, stage of growth, associated vegetation, etc.). At the end of the season both the CS and PI reviewed the data again.

New field methods and standards such as effective detection swath widths, minimum detection target size, patch size resolution, MDTS-based between-feature position settings, and detection confidence guidelines (all described previously) that were developed for this project each

contributed significantly to the overall quality and repeatability of the data, particularly with regard to collection of weed distribution and abundance data.

RESULTS and DISCUSSION

Field Crews inventoried 1,174 acres in Black Canyon of the Gunnison National Park during the summers of 2003-2004 (Table 3), an amount representing approximately 3.6 percent of the entire 32,950-acre Park. An average of 38.2 acres was inventoried per person per 10-hr day in 2003-2004.

The location and size of the areas inventoried in 2003-2004 are represented in Figure 1. Lands inventoried in 2003 are shown in orange and lands inventoried in 2004 are shown in red. Figure 2 shows the same lands divided into the thirteen individual areas referred to for planning and reporting purposes. The identification number, name, and acreage of each inventory area are listed in the legend. Each inventory area is also color-coded for ease in identification. Figure 3 serves as an orientation map for the smaller 1:18,000 scale weed-distribution "Inset" maps found in Appendices H and I. Inset maps are distinguished by letters A - G, plus the name of a distinct geographic feature found within its boundaries. The corresponding inventory area numbers from Figure 1 are included in the legend in parentheses behind each inset map name. Seven inset maps are required to cover all thirteen inventory areas, and large inventory areas may span over several subunit maps. For example, different sections of the South Rim Road and East Portal Road (Inventory Area 5) appear on four different inset maps (insets B, C, E, and F).

Invasive plants infested a total of 197.837 acres within the mapped areas (Table 4), an amount equal to 16.8 percent of the land inventoried. Of the 24 initial targeted species, crews found only *Arctium minus, Bromus tectorum, Carduus nutans, Centaurea diffusa, Centaurea maculosa, Centaurea repens, Cirsium arvense, Cirsium vulgare, Convolvulus arvensis, Iva xanthiflora, Linaria vulgare, Tamarix ramosissima, Ulmus pumila,* and *Verbascum thapsus.* No infestations of *Anthemis sp., Cardaria draba, Cynoglossum officinale, Elaeagnus angustifolia, Hyoscyamus niger, Lepidium latifolium, Linaria dalmatica, Onopordum acanthium,* or *Rumex crispus* were discovered within the thirteen inventoried areas. Non-target species found and mapped were *Ailanthus altissima, Marrubium vulgare, Melilotus officinalis, Rubus discolor,* and *Salsola kali.*

The most abundant target species found in the Park was *Bromus tectorum.* The crew recorded 94.351 acres of this species, comprising 48 percent of the total infested acreage inventoried. Individual infestations of *Bromus tectorum* were generally less than 0.25 acres in size in most areas inventoried. However, it was so abundant in upper Red Rock Canyon and the Son-of-a-Gun burn that these infestations were inventoried as gross areas and mapped as polygons. After discussion with the Park Ecologist part way through the 2004 season, it was decided to discontinue inventorying *Bromus tectorum* due to its recognized abundance. *Carduus nutans* was the second most abundant target species found in the Park and comprised approximately 28 percent of the total infested acreage. *Cirsium arvense* was the third most common target species, making up 7 percent of the total infested acreage. The remaining infestations (17 percent of the total infested acreage) consisted of the other eleven targeted species and five additional non-native species that were mapped.

Not all non-native species that were found were mapped. For example, species such as *Tragopogon dubius* and *Chenopodium album* were noted in many areas but were ignored due to their previously recognized presence in the Park. *Lactuca serriola, Dactylis glomeratus,* and

Table 4: Acres infested by invasive plant species within inventoried areas of Black Canyon of the Gunnison National Park and adjacent lands in 2003-2004.

Species	2003	2004	2-Yr Total	Infested Acres (Inside Park)	Infested Acres (Outside Park)
Ailanthus altissima	---	0.003	0.003	0.003	---
Arctium minus	2.550	0.114	2.664	2.554	0.110
Bromus tectorum	39.502	54.849	94.351	91.011	3.340
Carduus nutans	3.690	51.333	55.023	54.033	0.990
Centaurea diffusa	---	1.000	1.000	---	1.000
Centaurea maculosa	---	0.111	0.111	0.111	---
Centaurea repens	---	0.707	0.707	0.707	---
Cirsium arvense	5.780	9.030	14.810	13.930	0.880
Cirsium vulgare	1.630	0.216	1.846	0.916	0.930
Convolvulus arvensis	0.810	7.305	8.115	7.885	0.230
Iva xanthiflora	---	0.252	0.252	0.252	---
Linaria vulgare	0.460	---	0.460	0.460	---
Marrubium vulgare	0.010	---	0.010	0.010	---
Melilotus officinalis	0.150	---	0.150	0.150	---
Rubus discolor	1.150	---	1.150	1.000	0.150
Salsola kali	---	0.762	0.762	0.762	---
Tamarix ramosissima	0.110	1.752	1.862	1.862	---
Ulmus pumila	---	0.581	0.581	0.581	---
Verbascum thapsus	9.440	4.540	13.980	9.930	4.050
Totals	**65.282**	**132.555**	**197.837**	**186.157**	**11.680**

Asparagus sp. were also present in many areas but ignored.

Deciding which non-target weeds to map was left to the discretion of individual crew members, based on their assessment of the potential threat and relative abundance of each species. Crews were consistent in searching for and recording all infestations of *Ailanthus altissima*, *Marrubium vulgare*, and *Rubus discolor*. Because not all crew members may have chosen to map *Melilotus officinalis* and *Salsola kali*, the acreage values and corresponding distribution maps for these species should be considered to represent sample surveys rather than complete inventories. As earlier stated, *Bromus tectorum* was not fully inventoried in 2004 and the acreage values for this species represent a sample of the total amount found within the mapped areas of the Park.

Appendix H contains maps showing the overall distribution and relative abundance of all mapped weeds (no species distinction) within the boundaries of inventoried areas. Appendix I contains maps of individual species occurrences and weed-free areas within all inventoried portions of Black Canyon of the Gunnison National Park. Following is a summary of the weed situation within individual inventory units of Black Canyon of the Gunnison National Park:

Figure 1. Total area inventoried for non-native invasive plant species in Black Canyon of the Gunnison National Park during 2003 and 2004.

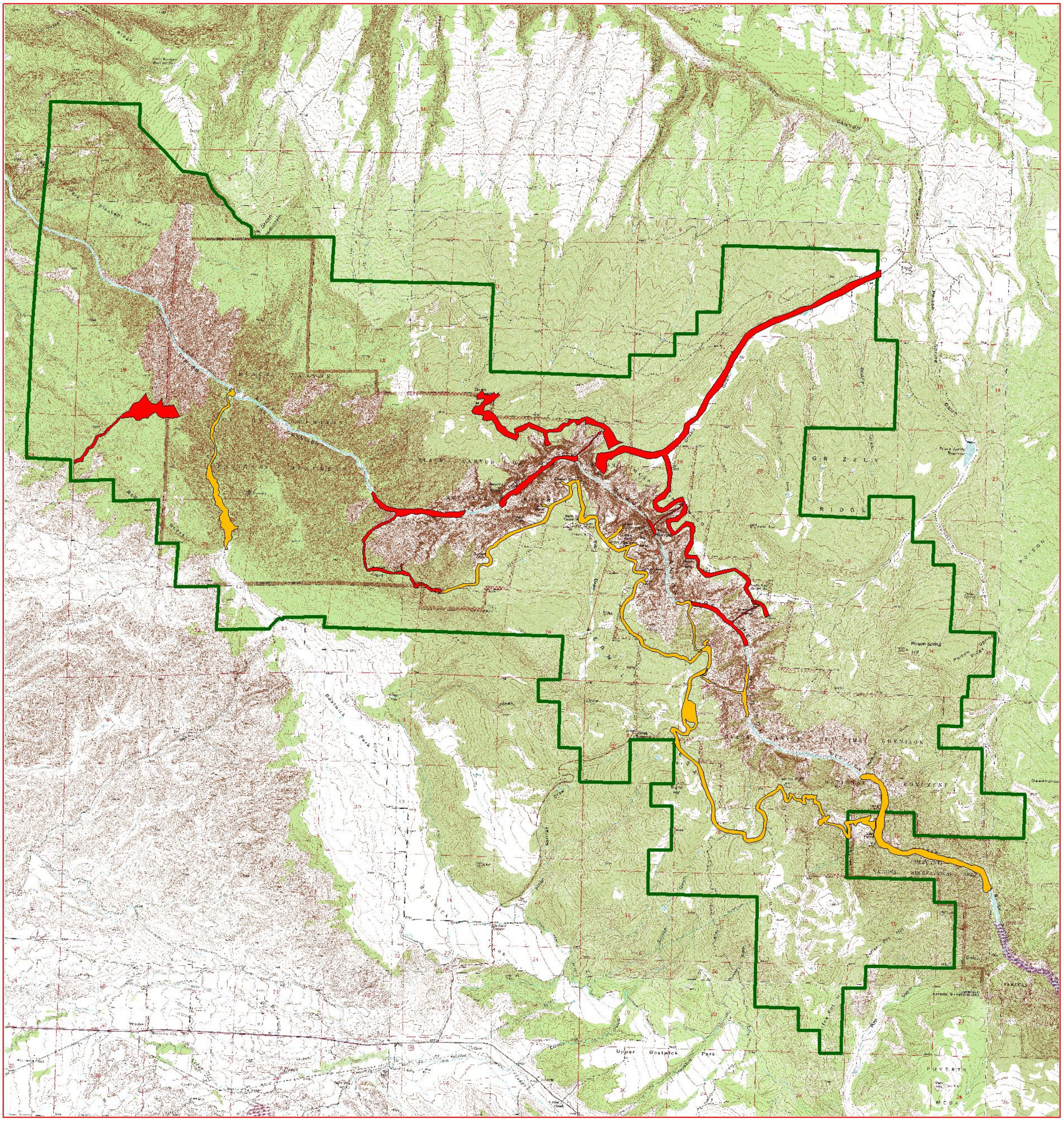
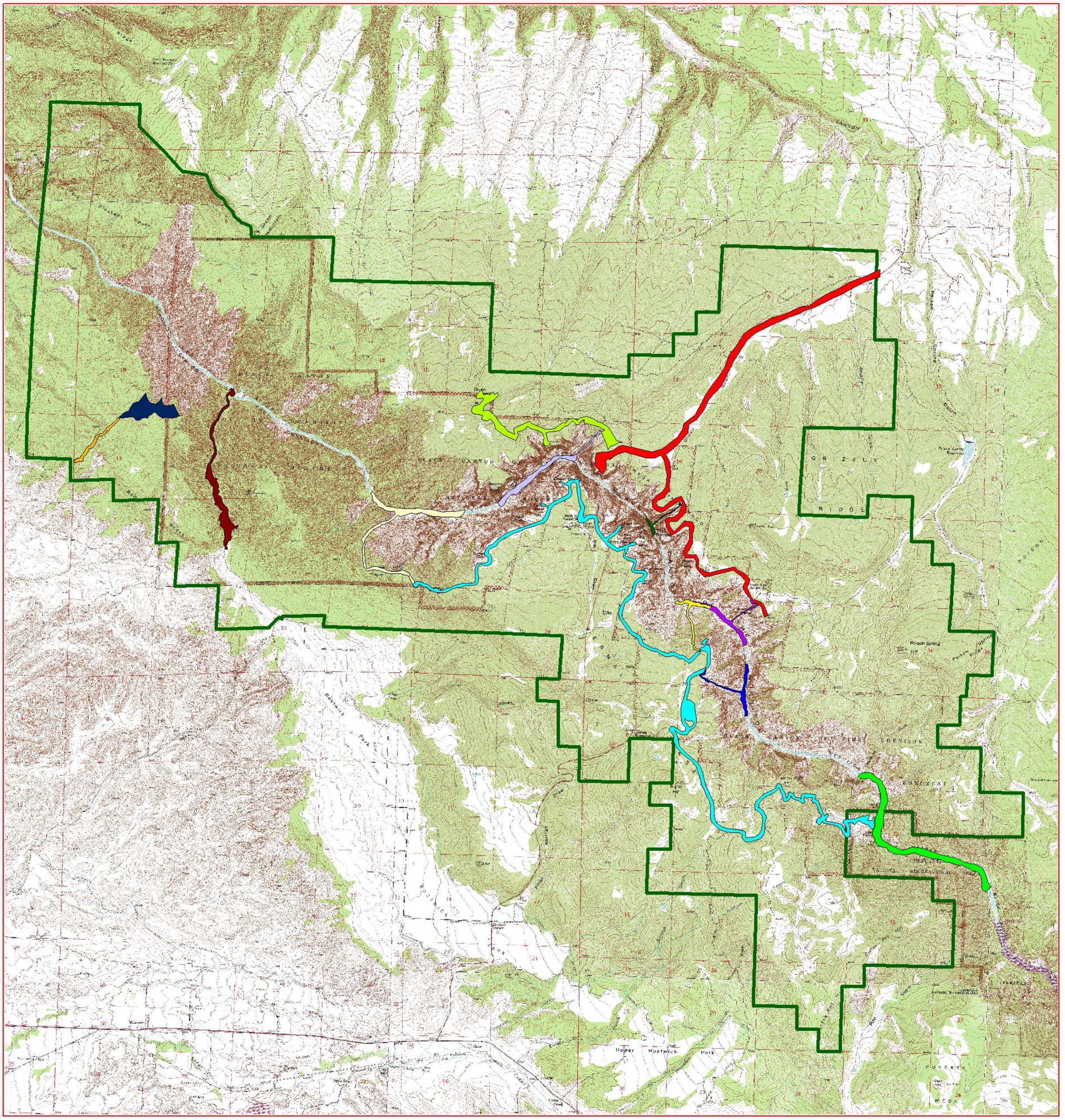


Figure 2. Identification number and acreage of individual areas inventoried for non-native invasive plant species Black Canyon of the Gunnison Naitonal Park during 2003 and 2004.



Area Inventoried (2003)

- Area 1 - Red Rock Canyon (68.4 acres)
- Area 2 - East Portal (107.7 acres)
- Area 3 - Tomichi Route (21.1 acres)
- Area 4 - Gunnison Route (17.7 acres)
- Area 5 - South Rim & East Portal Roads (329.2 acres)

Area Inventoried (2004)

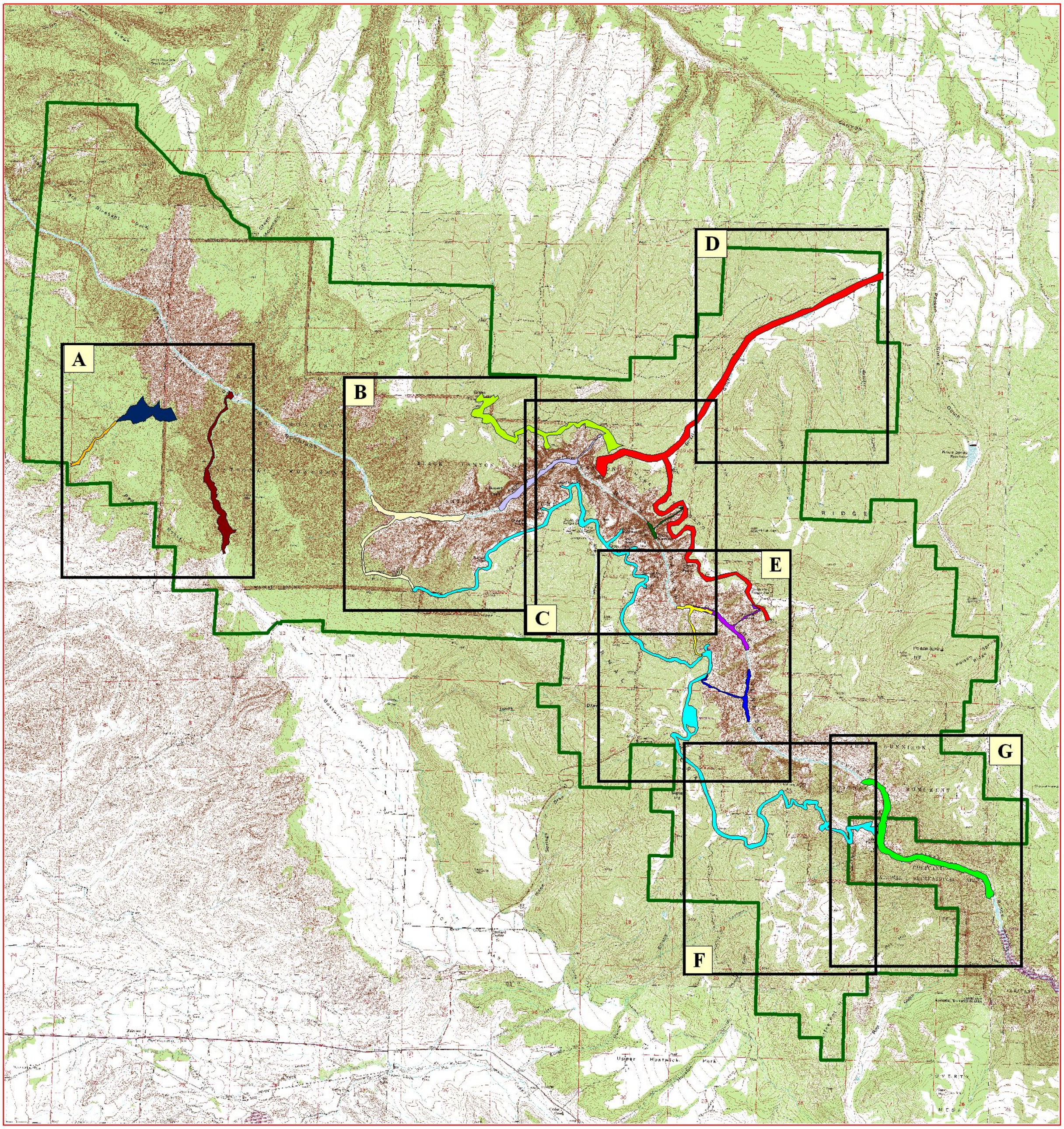
- Area 6 - North Rim Road (295.5 acres)
- Area 7 - North Vista Trail (103.5 acres)
- Area 8 - S.O.B. Route (41.2 acres)
- Area 9 - Warner Route (78.3 acres)
- Area 10 - Long Draw (7.6 acres)
- Area 11 - Slide Draw (28.0 acres)
- Area 12 - Son-of-a-Gun Burn (61.5 acres)
- Area 13 - Trail to Son-of-a-Gun Burn (14.0 acres)
- Park boundary

1:100,000 Scale

N

Black Canyon of the Gunnison National Park
2003-2004 Invasive Non-Native Plant Inventory
Utah State University
Northern Colorado Plateau Network

Figure 3. Insets indicating the location, letter code, and name of the seven 1:18,00 scale maps used in Appendix tables to show weed distribution within individual inventoried areas.



Inset A - Red Rock Canyon (Areas 1, 12, 13)

Inset B - Warner Point (Areas 5, 7, 8, 9)

Inset C - Chasm View (Areas 4, 5, 6, 7, 8, 10)

Inset D - Grizzly Gulch (Area 6)

Inset E - Kneeling Camel (Areas 3, 4, 5, 6, 11)

Inset F - East Portal Road (Areas 5)

Inset G - East Portal (Areas 2, 5)

Park boundary

Black Canyon of the Gunnison National Park
2003-2004 Invasive Non-Native Plant Inventory
Utah State University
Northern Colorado Plateau Network

Gunnison Route (Area Number 4; Inset Map E)

The Gunnison Route was inventoried in August of 2003. The river access from this route was fairly limited, but crews walked as far as was possible along the shoreline. *Verbascum thapsus* was the primary target species found along this section of the Gunnison River. Infestations were generally small in size, often consisting of approximately 5-10 flowering plants. Other species recorded along the Gunnison River from this access point include several patches of *Carduus nutans.* Most were past bloom and were already in the seed dispersing phase of growth. The crew also found small patches of *Cirsium arvense* and *Cirsium vulgare*. The infestations of both of these thistles were very small and infrequent at the time of recording.

A small patch of *Linaria vulgare* was found on the south bank several hundred yards upstream from the access point. Two infestations of *Bromus tectorum* were noted along the steep access route into the canyon, but there is likely more present than was inventoried. Although not a target species, several patches of *Melilotus officinalis* were also found and mapped. Other non-native species noted but not mapped include *Lactuca serriola, Asparagus sp.*, and *Bromus inermis*.

The native plant populations appeared relatively undisturbed and intact. Willows, box elder, rabbitbrush, and several native forbs were common along the banks of the Gunnison River. The weed species present did not appear to be a dominant presence along this section of the river. Disturbances noted include human traffic along the river as well as the campsites at the bottom of the route. Visibility was generally good along the Gunnison River. The crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species in this inventory area. The inventoried area was assigned an ecological status level two.

Tomichi Route (Area Number 3; Inset Map E)

This route was inventoried in 2003, and river access from the Tomichi Route was limited to a half-mile stretch. The primary target species found was *Verbascum thapsus* which was scattered along the entire length of the searchable river bank. Crews also found small patches of *Cirsium vulgare* and *Cirsium arvense* scattered along the river. A single patch of *Arctium minus* was found just upstream from the bottom of the access route. *Bromus tectorum* was found scattered along the entire length of the route to the river, as well as scattered along the banks of the river. Crews also recorded two small patches of *Melilotus officinalis*, although it was not a targeted species. Crews noted the presence of *Asparagus sp*., *Erodium cicutarium, Lactuca serriola,* and *Sonchus oleraceus*, but did not map them.

The crew attempted to search the opposite bank of the river with binoculars for targeted species but inclement weather hampered their efforts to map it fully. However, the crew was confident of seeing at least 90 percent of the targeted species infestations 0.01-acre or larger in size. The primary forms of disturbance along the access route and river were associated with rock slides and water flow. The native vegetation appeared intact and healthy while weedy populations were small in size and not beyond a manageable stage. The area was assigned an ecological level of two.

S.O.B. Route (Area Number 8; Inset Maps B, C)

Approximately one mile of the river corridor accessible from S.O.B. route was inventoried in 2004. The access route itself was free of all target species except *Bromus tectorum* which was widely scattered. The primary target species found along the river was *Verbascum thapsus*. Infestations of *Verbascum thapsus* ranged from 0.001 to 0.5 acres in size, and from trace to high canopy cover. Three small patches of *Cirsium arvense* also were found along this stretch of the Gunnison River. These infestations were found growing on sand bars. Species noted but not mapped along the river include *Bromus tectorum, Dactylis glomeratus, Melilotus officinalis, Sonchus oleraceus,* and *Asparagus sp*.

Visibility was generally very good along the shoreline of the river. Sections of the banks contained boxelders and willows as well as a healthy population of poison ivy. The crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species. Disturbances include food traffic from hikers and fishermen, as well as several campsites along the bank. The campsites themselves contained a moderate amount of trash and litter from previous use. The area was assigned a level two for ecological status.

Warner Route (Area Number 9; Inset Map B)

The Warner Route and the riverbanks accessible from the route were inventoried in 2004. The primary species found along the Gunnison River in this area was *Verbascum thapsus*. Patches were discovered and mapped on both sides of the river, and sizes ranged from 0.001 to 0.25 acre. Crews also found small patches of *Carduus nutans, Cirsium arvense,* and *Cirsium vulgare* scattered along the river. Infestations of *Tamarix ramosissima* were seen on the banks across from the crew and were mapped by offsetting. *Tamarix* infestations were typically 0.25 acres in size and comprised of mature trees. Three 0.001-acre patches of *Ulmus pumila* also were found along this section of the Gunnison River. All *Ulmus* trees were still in the sapling stage of growth. *Bromus tectorum* was noted along this section of river as well as on the access route but infestations were not mapped.

Visibility was generally good and the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species. No obvious human-related disturbances (other than those associated with the access trail and riverside camp sites) were noted at the time of the inventory. An ecological status level two was assigned to the inventory unit.

Long Draw Route (Area Number 10; Inset Map C)

The Long Draw access and approximately 0.25 mile of river were inventoried in 2004. *Verbascum thapsus* was found scattered along the mile-long access route, and infestations were typically 0.1-acre in size. Once at the bottom of the route, the crew found two small patches of *Cirsium arvense* and one small patch of *Carduus nutans*. No other target species were found. The crew did note the presence of *Bromus tectorum, Tragopogon dubius* and *Melilotus officinalis* in this inventory area.

Visibility was very good along the route into the inner canyon as well as along the river. The crew was highly confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species. No obvious human-related disturbances were noted, and an ecological status level two was assigned to the inventoried area.

Slide Draw Route (Area Number 11; Inset Map E)
The Slide Draw access route and a 0.75-mile stretch of accessible river were inventoried in 2004. The primary target species found was *Verbascum thapsus* which was scattered intermittently along the riverbank. Patches were generally small, consisting of only a few plants in each infestation. The crew also found 3 small patches of *Carduus nutans* along the river. Other targeted species found include 2 patches of *Cirsium arvense,* 2 patches of *Arctium minus*, and a single patch of *Cirsium vulgare*. None of the infestations of the 4 different species was larger than 0.1-acre in size.

The crew noted the presence of *Bromus tectorum, Bromus inermis, Dactylis glomeratus, Sonchus oleraceus, Melilotus officinalis,* and *Erodium cicutarium* but did not map these species. No obvious disturbances were noted aside from hiking trails, and the crew was confident of finding 90 percent or more of the targeted species at least 0.01-acre in size. The crew assigned the area an ecological status of two.

South Rim Road, East Portal Road (Area Number 5, Inset Maps B, C, E, F, G)
The South Rim and East Portal roads were inventoried in 2003 from the cab of a slow-moving truck. All overlooks along the South Rim road were also included in the road inventory as well as the South Rim Campground. The primary species found throughout this inventory unit was *Bromus tectorum* Which occurred almost continuously along the road shoulder of the South Rim Road as well as the East Portal Road and the South Rim campground. *Verbascum thapsus* and *Cirsium arvens*e were also found scattered along the shoulder of both roads. *Verbascum thapsus* was particularly common along the lower half of the East Portal Road, while *Cirsium arvense* was chiefly found along the first mile of the East Portal Road. *Carduus nutans* occurred frequently along the East Portal Road, with only two patches found on the South Rim Road. The campground contained all three species.

Three small patches of *Convolvulus arvensis* were found on the East Portal Road. Another patch of *Convolvulus arvensis* was found in the South Rim Campground. A fifth patch was discovered at the Chasm View Overlook. A small 0.01-acre patch of *Cirsium vulgare* was found on the East Portal Road. A second patch of *Cirsium vulgare* was found near Lions Springs. A small patch of *Arctium minus* was discovered at Lions Spring during the road inventory. The only *Marrubium vulgare* was found at the Chasm View Overlook, and it was pulled upon discovery. The only infestations of *Centaurea maculosa* in the Park south of the river were found in the Amphitheatre near the South Rim campground.

Species seen but not mapped include *Bromus inermis, Dactylis glomeratus, Lactuca serriola, Erodium cicutarium, Tragopogon dubius, Salsola kali,* and *Sonchus oleraceus*.

Visibility was generally good and the crew was confident of seeing at least 90 percent of all 0.01-acre or larger infestations of the species targeted. Inclement weather may have hampered the crew's ability to see smaller patches of those species. Disturbances from vehicle and foot traffic were evident in all areas included in this inventory unit. However, the native plant community looked relatively intact in most places. The East Portal Road was much more

infested by invasives than the South Rim Road. The roads and campground in this inventory unit were given an ecological status of two.

East Portal (Area Number 2; Inset Map G)

The Gunnison River corridor was inventoried on foot from Crystal Dam in Curecanti National Recreation Area to the mouth of Deadhorse Gulch. Crew members walked both sides of the river below the Gunnison Diversion Dam, but could access only the south side of the river upstream from that dam. The north side of the river above the Gunnison Diversion Dam was searched from the south bank using binoculars, and infestation locations were recorded using the Trimble GPS offsetting method. The East Portal area was particularly weedy. *Verbascum thapsus* was the most common species found along this stretch of the Gunnison River. It was found almost continuously along the entire stretch of riverbank, also inhabiting both the road shoulders and many gravel bars. *Cirsium vulgare* and *Cirsium arvense* were also very common along the riverbanks, although *Cirsium vulgare* appeared heaviest near the Gaging Station. *Carduus nutans* and *Bromus tectorum* also appeared frequently along the entire stretch of riverbank inventoried. However, *Bromus tectorum* appeared heaviest near the housing and picnic areas.

A few small populations of *Arctium minus* were discovered along the riverbanks, particularly near the Gaging Station. Other species found in moderate amounts include *Rubus discolor* and *Convolvulus arvensis*. *Rubus discolor* was found primarily above the Gunnison River Diversion Dam. The crew was not positive in its identification of Rubus discolor and it is possible that this is not a correct discovery. Three small patches of *Linaria vulgare* were found between the Gaging Station and Deadhorse Gulch. A single patch of *Tamarix ramosissima* was also found across the river from the Gaging Station. This 0.01-acre patch was comprised of dormant mature trees. Species seen but not mapped include *Bromus inermis, Chenopodium album, Tragopogon dubius, Sonchus oleraceus, Erodium cicutarium, Lactuca serriola,* and *Salsola kali*.

The visibility was good along the banks of the river and other portions of this inventory unit. Even though it is more difficult to see individual plants with binoculars from the other side of the river than when actually walking that bank, the crew was still confident of being able to see at least 90 percent of all 0.01-acre infestations of the targeted species.

This area appears to receive a constant amount of disturbance. The area is heavily used by fishermen, hikers, and picnickers. The road also appeared to be fairly busy during the time of the inventory. The banks of the river contained box elders and some willow, but many of the other plant species present were weedy in nature. The area was assigned an ecological status level three.

North Rim Road (Area Number 6; Inset Maps C, D, E)

The North Rim road was inventoried in 2004 from the cab of a slow-moving truck. As in the South Rim Road inventory, the search was conducted by 2 persons, with the driver observing the left road shoulder and the passenger searching the right shoulder. *Convolvulus arvensis* and *Carduus nutans* were extremely common along the North Rim Road between the Park boundary and the Ranger Station. A linear feature was used to map *Convolvulus arvensis* due to its continued presence along this particular stretch of road. *Carduus nutans* was found commonly

in the meadows extending out on either side of the road. Several populations of *Salsola kali* were also recorded along the North Rim Road. These populations were more common near the Ranger Station and the Park boundary. Some patches of *Cirsium arvense* were discovered along the North Rim Road between the Ranger Station and the Park boundary.

Three newly invading species found along the North Rim Road were *Iva xanthiflora, Centaurea repens*, and *Centaurea maculosa*. Three small infestations of *Iva xanthiflora* were found along the road shoulder near the Park boundary. *Centaurea repens* was found along the road shoulder in small patches between the Ranger Station and the Park boundary as well as in the campground. A small patch was also found above Slide Draw. Two small patches of *Centaurea maculosa* were also discovered along the road. One was observed near the Ranger Station and the second was found near the Park boundary at the turn off for Grizzly Gulch. One small patch of *Verbascum thapsus* was found near a stock pond.

Species not mapped but seen include *Bromus tectorum, Chenopodium album, Tragopogon dubius*, and *Lactuca serriola*. Visibility was generally very good along the road shoulders and the crew was confident of seeing at least 90 percent of the 0.01-acre or larger infestations of the targeted species. No obvious disturbance was noted aside from vehicle traffic. The native plant community appeared relatively healthy. There was still a high diversity of native grasses and shrubs along the meadows bounding the road. The area was assigned an ecological status of two.

North Vista Trail (Area Number 7; Inset Maps B, C)

The North Vista / Green Mountain Trail was inventoried in 2004. No targeted species were noted along the entire length of the hiking trail. The crew did note the presence of *Bromus tectorum, Chenopodium album,* and *Erodium cicutarium*. Visibility was very good along the trail and the native plant community appeared to be very healthy and intact. No obvious disturbances were noted aside from the foot traffic along the trail itself. The area was assigned an ecological status level of one due to the lack of targeted species and the minute amounts of other non-native species. Detection confidence for 0.01-acre and larger infestations of targeted species was greater than 90 percent.

Son-of-a-Gun Burn and Trail Access to Burn (Area Numbers 12, 13; Inset Map A)

A relatively recent wildfire located on the south rim of Black Canyon just west of Red Rocks Canyon is called the Son-of-a-Gun burn. That site and the access trail to it were inventoried in 2004 by a crew of 2 persons. The area was so extensively infested with *Cirsium arvense, Carduus nutans, Ulmus pumila,* and *Bromus tectorum* that the crew decided to map each of these species as gross areas. Of the 58 acres encompassed by this gross area boundary, it was estimated that approximately 95 percent was infested with *Bromus tectorum* (54.8 acres), 80 percent with *Carduus nutans* (46.2 acres), 15 percent with *Cirsium arvense* (8.7 acres), and 1 percent with *Ulmus pumila* (0.58 acres). The average canopy cover within infested portions of the gross area for each of these 4 species was estimated to be in the category of majority (51-100 percent), moderate (6-25 percent), moderate, and low (1-5 percent), respectively.

Within the burned area the crew found 21 patches of *Centaurea repens,* 10 small infestations of *Verbascum thapsus,* 4 spots of *Arctium minus,* 3 plants of *Ailanthus altissimum,* and a single *Cirsium vulgare*. Three infestations of *Salsola kali* were mapped, but this represents only a

partial survey of that species within the burned area. Species seen but not mapped include *Tragopogon dubius*.

A possible occurrence of *Chondrilla juncea* had been reported in an earlier vegetation survey of the burned area, so the USU crew looked specifically for this species in their inventory. No *Chondrilla juncea* was found in 2004, but a stemmy native species somewhat resembling pre-bloom *Chondrilla* was observed (photos in Appendix G). It is felt that perhaps this native species was mistaken for *Chondrilla juncea* in the earlier survey.

Visibility was excellent throughout the entire burned area and the crew was confident of having seen all 0.01-acre or larger infestations of the targeted species. Heavy seasonal use by big game, evidence of fire fighting activity, and the fire itself were the most obvious forms of disturbance in this inventory area. Because of the high degree of invasive plant infestation the area was assigned an ecological status of three.

Red Rocks Canyon (Area Number 1; Inset Map A)

Red Rocks Canyon was inventoried in 2003 from the road access point in Section 29 to the Gunnison River. *Bromus tectorum* was widespread on hillsides in the upper portion of the canyon and was scattered along the trail in the remainder of the canyon. Other species found abundantly throughout the canyon include *Cirsium arvense, Carduus nutans,* and *Arctium minus.* Dense infestations of the latter three species were found along the trail and stream all the way to the Gunnison River. *Verbascum thapsus* was a frequent invader in the upper portion of Red Rocks Canyon, but less common in the lower portion. *Convolvulus arvensis* was found infrequently along the stream throughout the canyon as well.

A single patch each of *Tamarix ramosissima, Rubus discolor*, and *Cirsium vulgare* were found in the canyon. The group of three tall *Tamarix* trees was found in the upper portion of the canyon nearly 2 miles from the Gunnison River. The single patches of *Rubus discolor* and *Cirsium vulgare* were found roughly in the middle of the canyon near the stream.

Species seen but not mapped include *Salsola kali, Chenopodium album, Lactuca serriola, Sonchus oleraceus,* and *Tragopogon dubius*. Disturbances from cattle, hikers, and the stream were all evident during the inventory. The stream contains water from an irrigation ditch above, and likely carries seeds of several invasive plant species into Red Rock Canyon.

Visibility was generally good throughout the inventory area. High water levels prevented the entire crew from being able to inventory the entire canyon together. One person was able to map the entire length of the canyon to the Gunnison River. She estimated she was able to see at least 75 percent of all 0.01-acre infestations of the targeted species in the lower portion of the canyon. The remainder of the crew inventorying the upper portion of the canyon was confident of having seen at least 90 percent of all 0.01-acre or larger infestations. The area was assigned an ecological status of three.

CONCLUSIONS / RECOMMENDATIONS

The primary objective of this project was to document the distribution and relative abundance of targeted non-native invasive plant species across the range of habitats and areas of management concern within Black Canyon of the Gunnison National Park. It is anticipated that the information obtained from this inventory will be useful in the Park's ongoing efforts to improve strategic planning and to increase the efficiency and effectiveness of all field operations associated with invasive plant management.

It is acknowledged that Black Canyon of the Gunnison National Park is already implementing many effective weed control strategies and practices, for which they are to be commended. The USU crew frequently encountered evidence of control efforts on infestations they mapped. For example, the crew ran into the Park's weed control crew several times in 2003. At one point, the control crew was actively controlling the infestations of *Linaria vulgare* at East Portal. The control crew was also seen controlling *Arctium minus* and *Carduus nutans* in Red Rock Canyon. It was evident that several patches of *Carduus nutans* had been controlled with herbicides along the North Rim Road in 2004.

If it does not already exist, the Park is urged to develop a comprehensive written management plan for invasive plant species in BLCA, similar to the plan currently being finalized by Utah State University for Dinosaur National Monument. If there currently is a written plan, the Park is encouraged to review and improve it on a regular basis. An excellent reference that will aid the Park in crafting specific control methods is the "Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas" developed by The Nature Conservancy (Tu et al. 2001).

Regularly scheduled weed inventories of all managed lands should be an ongoing part of any weed management plan emphasizing early detection and rapid response. Inspections of all high-visitation areas should be performed at least annually, whereas inventories of the most remote sites or habitats least suitable for weed establishment or spread might need to be performed only once every 5 to 10 years. A rotating schedule should be developed by Black Canyon of the Gunnison National Park to inventory portions of their land each year, so that within a reasonable number of years all of the Park could be inspected. The key is to schedule inventories often enough to detect all new weed infestations before they exceed a size considered feasible for eradication. Early detection of invasive weeds through regular searches and mapping is just as essential to successful weed management as the early detection of wildfires is to effective fire management.

Tied to an ongoing inventory effort, Black Canyon of the Gunnison National Park also should consider establishing permanent monitoring sites (if it hasn't already done so) to evaluate the impact and spread of weeds, and to evaluate the effectiveness of its weed management approaches. Long-term studies provide valuable insight into the effectiveness of current management techniques and quantify whether management goals have been accomplished. Monitoring standards and protocols exist in the federal agencies and provide guidelines as to selecting appropriate sites and proper techniques for gathering information. Several excellent publications on monitoring methods and standards are currently available for reference

(Coulloudon et al. 1999, Elzinga et al. 1998, Kuchler et al.1988, Silsbee et al. 1991, USDI-USGS 1994, Winward 2000).

If it has not already occurred, Black Canyon of the Gunnison National Park is encouraged to become an active member of a local Cooperative Weed Management Area. Weed management goals can be achieved more effectively when managed in cooperation with partner organizations also trying to achieve the same goals. The following excerpt taken from the National Park Service's own 2002 publication "Inventory and Monitoring for Invasive Plants Guidelines" further emphasizes the importance of this concept, particularly as it relates to invasive weed inventories:

> "Although the Park's primary responsibility is to itself and to upholding the mission for which is was established, Parks have a role and responsibility in promoting and supporting collaborative information exchange among local weed and natural resource management professionals. It is in the self-interest of the Park (in fulfilling its mission) and the agency (as a cooperating federal land management agency) to do more than simply share data passively or opportunistically. To the extent a Park can place the distribution and abundance of its invasive plants in the context of a larger landscape, the Park's efforts to identify management objectives and allocate resources efficiently will be improved as the scale of that landscape grows in size."

Dinosaur National Monument is currently a member of a Cooperative Weed Management Area, as are some other NCPN Parks. If interested in more information and advice, we suggest contacting Tamara Naumann, Park Botanist at DINO.

Species prioritization is an important part of strategic weed management planning, especially when limited budgets don't allow all weed problems to be addressed equally. As a general rule when weed abundance exceeds weed control resources, the least abundant highly invasive species should be given highest priority, with the ultimate objective being their eradication whenever possible. Species that are somewhat more abundant but still highly manageable should be controlled as aggressively as possible, with containment being the initial goal, followed by a significant reduction in acreage. Populations of invasive or otherwise undesirable non-native species presently beyond the hope of containment or reduction in acreage should not be ignored, but should not be the object of significant expense until all higher-priority situations have been adequately addressed. Relatively inexpensive methods such as policy and procedural changes aimed at preventing or minimizing further spread (protecting non-infested areas), release of biological control agents, or use of cultural methods are generally recommended for weed species in this category.

Applying this strategy to Black Canyon of the Gunnison National Park would mean that species such as *Ailanthus altissima, Arctium minus, Carduus nutans, Centaurea maculosa, Centaurea repens, Cirsium arvense, Cirsium vulgare, Convolvulus arvensis, Iva xanthiflora, Linaria vulgare, Marrubium vulgare, Rubus discolor, Tamarix ramosissima, Ulmus pumila, and Verbascum thapsus* should be given the highest control priority of the species mapped, and should be targeted for prompt Park-wide eradication. No species appeared to fit into the second

category of "contain and reduce". Plants that we would place in the third management category (lowest priority) include *Bromus tectorum* which was widespread throughout the Park.

The Park will likely need additional inventory information before deciding in which management category to place *Asparagus* sp., *Bromus inermis, Chenopodium album, Dactylis glomeratus, Erodium cicutarium, Salsola kali, Melilotus officinalis, Sonchus oleraceus,* and *Tragopogon dubius*. These non-native species appeared scattered throughout the Park, but our assessment is based on an incomplete survey rather than a full inventory of these species. If further study reveals that these species truly are relatively scarce in the Park, we suggest that they be targeted for eradication, even though they were not originally considered high-priority species.

The second objective of this project was to identify potential sources of weed introduction and significant vectors involved in weed spread in the Park. Humans are the most likely vectors for new introductions of invasive plant species into Black Canyon of the Gunnison National Park and all other Parks of the Northern Colorado Plateau Network, and areas of highest human visitation are also the areas where new invaders might be expected to appear first. Millions of visitors come from all over the world to enjoy the unique beauty of the Northern Colorado Plateau region, and over 175,450 per year visit Black Canyon of the Gunnison National Park alone. Every person potentially brings with them errant seeds of an exotic invasive plant lodged in the tread of a tire or hidden in the dried mud of a hiking boot. For example, the majority of new weed species inventoried in Black Canyon of the Gunnison National Park were found along roadways. The infestations of *Centaurea maculosa* were found along the North Rim road and the South Rim Amphitheatre. Likewise, the only known patch of *Marrubium vulgare* was found at the Chasm View Overlook. The patch of *Centaurea diffusa* near the Park's south boundary is also a roadside infestation. The ever-increasing number of visitors, combined with the distant and diverse geographical areas from which they come, all combine to make National Parks highly and uniquely vulnerable to exotic plant invasions. Frequent inspection of high-visitation sites within each Park is essential to the "early detection and rapid response" strategy of invasive plant management. Roadways, parking areas, visitor centers, picnic sites, campgrounds, view points, trails, and all other high-visitation sites should be searched regularly (at least yearly) at a time when new plants would be visible. Park visitors should be informed of the potential damage caused by invasive plants, and ways they can help minimize the chances of introduction and spread. This might be done in the form of written information distributed at the Park's Visitor Center, through displays or a video program, and evening fireside presentations to visitors made by NPS personnel.

Routine Park operations represent another significant source of potential weed invasions. Road maintenance, fire fighting, and even weed control operations can result in the unintentional introduction or spread of invasive weeds within Parks. Specific procedures should be developed and implemented to minimize the spread of weed seeds by Park employees and/or the creation of unprotected disturbed sites that can be ideal for weed establishment. An excellent example of effective weed prevention methods can be seen in protocols developed for the recent multi-crew EPMT deployment exercise conducted at Arches National Park (USDI-NPS 2004) (Appendix J). Additional weed prevention protocols have been developed by the Forest Service (USDA-Forest Service 2001).

Natural vectors such as wind, water, and wildlife do play a role in weed seed dissemination within the National Parks, and cannot be overlooked. However, they probably play a much less significant role overall, compared to human-related vectors. Control of isolated new weed infestations along the river bank and canyon access routes could prevent rapid spread associated with water movement. For example, the control of *Tamarix ramosissima* and *Cirsium vulgare* within Red Rock Canyon could prevent new infestations from appearing throughout the remainder of that otherwise uninfested canyon. Control of the few infestations of *Linaria vulgare* found at the base of the Gunnison Route and at East Portal could likewise prevent new infestations into the inner canyon. Control of *Centaurea maculosa* and *Centaurea repens* along the road shoulders would prevent the spread of these aggressive invaders to the areas of the Park still uninfested. Traditional annual migration routes of deer, elk, or other large animals should be considered a high-probability area for weed seed transport and introduction. Emphasis also should be placed on areas disturbed by wildfire -- both because of the potential for new introductions of invasive plant species by fire fighters and equipment, and because of the potential for rapid spread of newly established weeds within such highly disturbed sites.

All NCPN Parks that were inventoried in 2003 and 2004 are in the enviable situation of still having the majority of their lands free of invasive weeds. In Black Canyon of the Gunnison National Park, 83.2 percent of the inventoried acres were free of all targeted species. And, because areas selected for this inventory were generally considered the sites most likely to be infested, it can be assumed that those BLCA lands not inventoried have an even higher proportion of weed-free acres. Furthermore, 100 percent of all inventoried lands were completely free of at least nineteen invasive weed species of great concern to the region (Appendix K).

An important new trend in weed management is the concept of identifying areas that are currently free of one or more species of invasive plants, and officially designating them as “Weed Prevention Areas” (WPA). Land units designated as WPA's are given a higher priority for prevention efforts, early detection, and rapid control (eradication) of any new invaders. In our opinion, all areas within Black Canyon of the Gunnison National Park that are currently "clean" should be identified as WPAs, and Park management should take all appropriate measures to keep invasive weeds from spreading into them. Protecting and preserving lands in this weed-free condition is much more cost-effective than restoring extensive areas already badly infested by invasive weeds and therefore should be the highest weed management priority for the all Parks in the Northern Colorado Plateau Network. Programs based on prevention, early detection, and rapid response to eradicate all new invaders on presently weed-free lands will be needed to accomplish this objective.

The WPA concept is an excellent way to emphasize the fact that the majority of NPS lands are still clean and healthy with respect to the threat of invasive plants. The total number of acres in WPA's with a Park could help to justify increased budgets for prevention practices. Increasing the number of weed-free acres in a Park should be recognized as a highly significant accomplishment, and land managers should be encouraged to make the necessary efforts to convert lightly infested lands to WPA's as quickly as possible (by aggressively controlling and eradicating those few plants keeping these areas from being declared "weed free"). WPA's also

present an opportunity for Parks to help the general public feel more involved as visitors see more clearly the focus of the preventive measures they are being asked to adopt.

The final objective of this project was to test and refine data collection and field inventory techniques that might be used by NCPN in future invasive plant inventories. As part of our effort to meet that objective, USU provided training in weed mapping techniques at several state weed conferences as well as at the regional Western Society of Weed Science Weed Management Short Course held in Montana annually. An overview of the USU weed mapping program was also presented to over 60 EPMT personnel from around the country during a week-long field training exercise held in Arches National Park in 2004. In addition, several documents were published containing detailed information about USU inventory procedures and techniques (Andersen et al. 2003, Andersen and Dewey 2005, Ballard et al. 2003, Dewey and Andersen 2004a, Dewey and Andersen 2004b, Dewey and Andersen 2005a; Dewey and Andersen 2005b, Dewey and Andersen 2005c).

ACKNOWLEDGEMENTS:

We express appreciation to Pam Benjamin at the NPS Intermountain Support Office in Denver, CO, and Angie Evenden and Margaret Beer at the Northern Colorado Plateau Network in Moab, UT, for their vision and efforts in initiating this inventory project. Thanks to Angie and Margaret for their thorough reviews of our data and reports, and to Aneth Wight for always being able to solve our GIS problems. We are grateful to Ian Torrence and Liz Ballenger for their help in logistical planning and coordination with individual Parks. Thanks to the contacts in each Park and Monument (Danguole Bockus, Tamara Naumann, Denise Louie, Sean Haile, Kristen Legg, Tom Clark, and Dave Worthington,) who went out of their way to accommodate the requests of our crews. Above all, we thank the dedicated and hard-working USU and NPS crew members who frequently encountered potentially dangerous situations and conditions, and endured considerable physical hardship while hiking hundreds of miles in the intense summer heat and rugged backcountry of southern Utah to collect this information.

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Appendix Tables and Figures

Appendix A. Crew Qualifications and Project Quality Assurance for the 2003-2004 Invasive Non-native Plant Inventory in Black Canyon of the Gunnison National Park.

The Utah State University wildland weed mapping team has considerable experience conducting the type of survey required in this NPS project. Previous weed surveys conducted by USU include:

1997	Mt. Naomi Wilderness Area, Cache County, UT
1998	Wellsville Mountains Wilderness Area, Cache and Box Elder Counties, UT
1999	Franklin Basin Recreation Area, USFS Logan Ranger District, Cache County UT
2000	Rich County Public Lands (BLM, USFS), UT
2001	Hardware Ranch WMA, UDWR, Cache County, UT
2001	Bud Phelps WMA, UDWR, Cache County, UT
2002	Hawkins Fire, USFS, Bannock County, ID
2002	Canyon Fire, USFS, Franklin County, ID
2002	Cherry Creek Fire, USFS, Bannock County, ID
2002	West Fork Fire, BLM, Bannock County, ID
2002	Dinosaur National Monument, Green River District, UT

Kim Andersen (crew leader) and Melanie Ballard (assistant crew leader) have considerable experience working on the USU crew in past years. Kim has a Bachelor of Science degree in Fisheries and Wildlife from the College of Natural Resources and is currently working towards a Master's Degree in Weed Science. Melanie has a Bachelor of Science degree in Plant Science. Kim began work on the USU crew in 1999, and has been crew leader since 2000. Melanie started on the crew in 2002. Both Kim and Melanie have additional experience with invasive weed GPS mapping projects in National Parks (Grand Teton and Yellowstone). Ruth Richards has a Bachelor of Science degree in Crop Science and is currently working towards a Master's Degree in Weed Science. She has worked on the crew in 2003 and 2004. Janna Simonsen has worked as a biological technician for the Wasatch-Cache National Forest since 1999 conducting vegetation analyses and range monitoring studies using GPS/GIS technologies. Janna has a BS degree from USU in Environmental Studies. Hillary Hudson has a Bachelor's degree and has worked on an Exotic Plant Management Team in California from 2003 to 2004. She has also worked as a national park ranger in the Maze District of Canyonlands National Park. Eric Lamalfa is a student at USU in the Plant Science department. Liz Ballenger has a Bachelor's degree in Biology from the College of Wooster and a Master's Degree in Ecology from the University of Michigan. Heather Rickleff has a Bachelor's degree in Outdoor Recreation and Resource Management from Indiana University.

All USU weed survey crew members were required to pass a written exam in weed identification and mapping skills before being hired. Each also had passed an upper-division university course in weed identification, biology, and management, and/or has extensive practical experience in wildland plant identification. Once hired, USU and NPS crew members also attended a 3-week classroom and outdoor training course in late April and early May in wildland weed mapping

techniques taught by Dr. Dewey at Logan and Zion National Park during 2003. A similar training course was offered to the USU crew in 2004. Crew members were provided with weed identification field guide book, taxonomic keys, and pressed reference specimens of all targeted weeds. During the course of the summers USU crew members were quizzed periodically with fresh plant specimens provided by the crew leader and/or Dr. Dewey. Dr. Dewey also spent several days in the parks working with individual crew members under field conditions. To further authenticate findings, Dr. Dewey and/or the crew leader re-visited representative areas in each park that had been previously mapped by the USU crew, using the most recent crew-generated weed infestation maps to compare them against their own field observations.

Appendix B. Standard GPS Data Dictionary used in the 2003-2004 Invasive Non-native Plant Inventory in Black Canyon of the Gunnison National Park.

NPS-2004
Inventory of invasive weeds in NCPN

pt-weed Point Feature, Label 1 = Species Code 1 = IT IS code Code 2 = Plant Code

Species	Menu, Required, Normal	
Asparagus sp.	[42782]	[ASPAR]
Bells of Ireland	[32569]	[MOLA]
Bindweed, field	[30705]	[COAR4]
Blackberry, Himalayan	[24852]	[RUDI2]
Brome, downy	[40524]	[BRTE]
Brome, smooth	[40502]	[BRIN2]
Burdock	[36546]	[ARMI2]
Camelthorn	[508549]	[ALMA12]
Chamomile	[36330]	[ANTHE]
Cress, hoary	[23072]	[CADR]
Dock, curly	[20937]	[RUCR]
Elm, Siberian	[19057]	[ULPU]
Halogeton	[20692]	[HAGL]
Hemlock, poison	[29473]	[COMA2]
Henbane, black	[21454]	[HYNI]
Houndstongue	[31890]	[CYOF]
Horehound	[32561]	[MAVU]
Johnsongrass	[42111]	[SOHA]
Knapweed, diffuse	[36958]	[CEDI3]
Knapweed, Russian	[510530]	[CERE6]
Knapweed, spotted	[36964]	[CEMA]
Knapweed, Squarrose	[533280]	[CETR8]
Lambsquarter	[20592]	[CHAL7]
Loosestrife, purple	[27079]	[LYSA2]
Marshelder	[36041]	[IVA]
Mullein, common	[33394]	[VETH]
Mustard, Sahara	[23064]	[BRTO]
Olive, Russian	[27770]	[ELAN]
Orchardgrass	[193446]	[DAGL]
Pepperweed, perennial	[503379]	[LELA2]
Puncturevine	[29057]	[TRTE]
Reed, giant	[41450]	[ARDO4]
Saltcedar	[22310]	[TARA]
Salsify, western	[38564]	[TRDU]
Spurge, leafy	[28064]	[EUES]
Starthistle, yellow	[36972]	[CESO3]
Thistle, bull	[36428]	[CIVU]
Thistle, Canada	[36335]	[CIAR4]
Thistle, musk	[35787]	[CANU4]
Thistle, Russian	[20655]	[SAKA]
Thistle, Scotch	[38140]	[ONAC]
Timothy grass	[41062]	[PHPR3]
Toadflax, Dalmatian	[33219]	[LIDA]
Toadflax, yellow	[33216]	[LIVU2]
Tree of Heaven	[28827]	[AIAL]
Wheatgrass, crested	[40371]	[AGCR]
Woad, dyer's	[23151]	[ISTI]

OTHER	[XXXX] [XXXX]
% Cover Trace: < 1 % Low: 1 to 5 % Mod: 6 to 25 % High: 26 to 50 % Majority: 51 to 100 %	Menu, Required, Normal, weed canopy within infested area
Size 0.01 acres 0.1 acres 0.25 acres 0.5 acres 1.0 acres 2.5 acres 5.0 acres	Menu, Required, Normal, based on average perimeter diameter
Phenology Vegetative Bud Flower Fruit-immature Fruit-mature Seed dispersing Dormant/senesced	Menu, Required, Normal, weed growth stage
Woody Growth Seedling Sapling Mature Dormant/senesced	Menu, Normal, Normal, growth stage of woody species
Dominant Native Spp.	Text, Maximum Length = 30, 2-digit codes, 2 species, order of prevalence Normal, Normal
Disturbance None Low-Mod (default) High	Menu, Normal, Normal
Hydrology Upland (default) Rip-perennial Rip-intermittent Rip-ephemeral Wetland Playa-lakebed	Menu, Normal, Normal, site hydrology
Notes	Text, Maximum Length = 30 Normal, Normal
Date	Date, Auto generate Create, Month-Day-Year Format Normal, Normal

Time	Time, Auto generate Create, 24 Hour Format Normal, Normal
Ln-weed	Line Feature, Label 1 = Time
Species	Menu, Required, Normal

******See species list under pt-weed.

Line Width (ft)	Numeric, Decimal Places = 0, average width of linear area Minimum = 5, Maximum = 500, Default Value = 20 Required, Normal
Notes	Text, Maximum Length = 50 Normal, Normal
Time	Time, Auto generate Create, 24 Hour Format Normal, Normal
Date	Date, Auto generate Create, Month-Day-Year Format Normal, Normal
Ar-weed	Area Feature, Label 1 = Time GPS-generated polygon
Species	Menu, Required, Normal

******See species list under pt-weed.

Notes	Text, Maximum Length = 50 Normal, Normal
Time	Time, Auto generate Create, 24 Hour Format Normal, Normal
Date	Date, Auto generate Create, Month-Day-Year Format Normal, Normal
Gross-weed	Point Feature, Label 1 = Time, Office-generated polygon
Species	Menu, Required, Normal

******See species list under pt-weed.

Infested (% of Area Infested)	Numeric, Decimal Places = 0, (% of gross area actually infested) Minimum = 1, Maximum = 100, Default Value = 1 Required, Normal
% Cover (IA only) Trace: < 1 % Low: 1 to 5 % Mod: 6 to 25 % High: 26 to 50 % Majority: 51 to 100 %	Menu, Required, Normal, % weed cover in typical infestations

Area ID (# on map)	Numeric, Decimal Places = 0, From infestation ID # noted on field map
	Minimum = 1, Maximum = 100, Default Value = 1

	Required, Normal
Notes	Text, Maximum Length = 50 Normal, Normal
Date	Date, Auto generate Create, Month-Day-Year Format Normal, Normal
Time	Time, Auto generate Create, 24 Hour Format Normal, Normal
Point	Point Feature, Label 1 = Notes
Notes	Text, Maximum Length = 50 Normal, Normal
Line	Line Feature, Label 1 = Notes
Notes	Text, Maximum Length = 50 Normal, Normal
Area	Area Feature, Label 1 = Notes Text, Maximum Length = 50 Normal, Normal
Photo	Point Feature, Label 1 = Notes, Label 2 = Bearing (MN)
Species	Menu, Required, Normal

******See species list under pt-weed.

Bearing (MN)	Numeric, Decimal Places = 0 Minimum = 0, Maximum = 360, Default Value = 0 Normal, Normal
Notes	Text, Maximum Length = 50 Normal, Normal
Date	Date, Auto generate Create, Month-Day-Year Format Normal, Normal
Time	Time, Auto generate Create, 24 Hour Format Normal, Normal
Voucher	Point Feature, Label 1 = Notes
Species	Menu, Required, Normal

******See species list under pt-weed.

Notes	Text, Maximum Length = 50 Normal, Normal

Appendix C. Relationship of NCPN Project Data Elements to IMR and NAWMA Weed Mapping Standards used in 2003-2004 Invasive Non-native Plant Inventory in Black Canyon of the Gunnison National Park.

Relationship of NCPN Weed Mapping Project Database Elements to proposed IMR Weed Mapping Data Elements and NAWMA Standards. Column labeled 'NCPN Data Element Status' indicates whether or not data element were included in NCPN Weed Mapping Database. If data element was included (=YES) an indication is made whether or not the data was field collected or compiled in an office setting.

CATEGORY	*DATA ELEMENTS*	NPS Intermountain Region	NAWMA	NCPN Data Element Status	NCPN Data Source	Comments
AGENCY METADATA	1. Collection Date (yyyymmdd)	Required	Required	YES	Field	
	2. Source of Data (contact of individual who manages data)	Required	Required	YES	Office	Included in metadata only
	3. Scale of Data Source	Required (recommend 1:24000)	Required (recommend 1:24000)	YES	Office	Included in metadata only
	4. Datum of Original Data (N_{27}/N_{83})	Required	N/A	YES	Office	Included in metadata only
	5. Surveyor Name	Optional	Optional	YES	Field	
	6. Site ID (Name or Number)	Optional	Optional	YES	Field	
	7. Quality Control Assessment (Yes/No)	Optional	N/A	(yes)	Office	This will be done but not entered as a data field.
	8. Methodology Used For Inventory (casual observation/formal survey/remote)	Optional	Optional	YES	Office	Included in metadata only
INVASIVE SPECIES INFORMATION	1. Plant Scientific Name (Genus/species) a. Intraspecific Name b. Authority for Name	Required a. Optional b. Optional (Recommend Kartez)	Required a. Optional b. Required (Kartez)	YES	Field	Scientific Name only
	2. ITIS Code (allows for link to NPSpecies)	Required	N/A	YES	Office	ITIS code will allow linkage to authority, common name, state status etc.
	3. Common Name	Optional	Optional	YES	Office	
	4. Plant Code (Based on USDA "PLANTS" web Database)	Optional	Optional	NO		ITIS is cross-walked with PLANTS database.
	5. Species Status a. State listed noxious weed b. Species of concern to park	Optional	Optional	NO		
	6. Species On Priority List For Park (Yes/No)	Optional	Optional	NO		

LOCATION DATA (For Survey Unit and Each Weed Population	1. Country (USA/Canada/Mexico)	*Required*	Required	YES	Office	
	2. State (2-Letter Code)	Required	Required	YES	Office	
	3. County	Required	Required	YES	Office	
	4. Site Location (Lat/Long/ UTM/legal)	Required (UTM preferred)	Required	YES	Field	
	5. USGS 7.5 Quad Name	Optional	Optional	NO		This is readily available in GIS
	6. USGS 7.5 Quad Number	Optional	Optional	NO		This is readily available in GIS
	7. Hydrologic Unit Code (HUC#) for watershed	Required for aquatic invasives only	Required for aquatic invasives only	NO		This is readily available in GIS
	8. NPS LOCATION DATA a. Park Unit (4-letter code) b. Park Subunit c. Network Name d. Region e. Weed Management Area f. Other	a. Required b. Optional c. Required d. Required e. Optional f. Optional	N/A	a. YES b. NO c. YES d. NO e. NO f. NO	Office Office	
CHANGES IN SPECIES POPULATION OVER TIME	1. Infested Area a. Unit of Measure (Acre or Hectare)	Required a. Required	Required a. Required	YES	Field	
	2. Gross Area a. Unit of Measure (Acre or Hectare)	Optional a. Optional	Optional a. Optional	YES	Field	
	3. Canopy Cover (% Aerial) A. Type of Measurement (actual/estimated/mid-pt of cover class)	Required a. Required	Required a. not used	YES	Field	
	4. Distribution (light/moderate/heavy) (density)	Optional	N/A	YES	Field	Note: USU will experiment with defining a useful density characterization here – possibly by species
	5. Phenology (Vegetative/ flower/seed/senesced)	Optional	N/A	YES	Field	
	6. Distance to Water (horizontal & vertical	Optional	N/A	NO		
	7. Management Actions Taken (Manual/Chemical/BioControl/Domestic Livestock) a. Date of Action b. % of Population treated (1-25)(/26-50)(51-75)(76-100)	Optional a. Optional b. Optional	N/A	NO		
	8. Site Undergoing Active or Inactive Management	Optional	N/A	NO		

SITE ENVIRONMENTAL INFORMATION	ABIOTIC DATA	1. Elevation (Avg, max/min) - Unit of Measure (feet/meters)	Optional (highly recommended)	N/A	YES	Field	Also available in GIS
		2. Aspect	Optional (highly recommended)	N/A	NO		Can be derived in GIS
		3. Percent Slope - Actual or estimated	Optional (highly recommended)	N/A	NO		Can be derived in GIS
		4. Slope Position (top 1/3, mid 1/3, low, 1/3, toe)	Optional (highly recommended)	N/A	NO		Not a helpful data field – too variable, also can be derived in GIS
		5. Soil Type	Optional (highly recommended)	N/A	NO		Field crews not knowledgeable about soils. Can be derived from soil maps.
		6. Landform	Optional (highly recommended)	N/A	NO		We tried this last year, too much variation & difficult to interpret. Data quality not sufficient.
		7. Geologic Substrate	Optional (highly recommended)	N/A	NO		Can be derived in GIS from geologic maps.
		8. Climate (Develop Link to Separate Table with Avg. Temp & Precip.)	Optional (highly recommended)	N/A	NO		Tabular and spatial climate data are available for GIS analysis.
	BIOTIC DATA	1. Life Form (Grass/Forb/Shrub/Tree)	Required	N/A	YES	Office	
		2. Ecological Status	Required	N/A	YES	Field and Office	
		3. Values At Risk	Required	N/A	NO		Relationship of weed occurrences to resource values can be derived through GIS analysis as needed.
		4. Vegetation Classification	Optional (highly recommended)	N/A	NO		Vegetation classifications not available yet for NCPN parks
		5. Dominant Associated Species	Optional (highly recommended)	N/A	YES	Field	
		6. Cover Type	Optional (highly recommended)	N/A	NO		Standard cover type classifications not yet being applied in NCPN parks.
		7. Habitat Type	Optional (highly recommended)	N/A	NO		Not applicable to NCPN parks.
		8. Seral Stage	Optional (highly recommended)	N/A	NO		These relationships not described for NCPN parks.
		9. Disturbances *(See Below)	Optional (highly recommended)	N/A	(yes)	Field and office	Describe for broader survey areas, but only generally at polygon or point level

Appendix D. GPS Settings using in 2003-2004 Invasive Non-native Plant Inventory in Black Canyon of the Gunnison National Park.

System / Setup

Configurations

Data

Log between features:	Distance, 500 ft, (Set at surveyor's discretion)
Log PPRT data:	No
Log velocities:	No
Antenna height	4 ft
Allow GPS update	Yes
Warning distance:	Never
Filename prefix:	R

GPS

(Advanced mode window)

PDOP mask:	6.0 (Can be higher in areas where satellite reception is difficult, GPS will take best PDOP if set at a higher number)
SNR mask:	4.0
Elevation mask	15 deg
Minimum satellites	4
2D altitude	N/A

Real Time

Mode	Best available
Velocity filter	Off
RTCM age limit	50 s
Station ID	Any

Coordinates

System	UTM
Zone	12 North
Datum	NAD 1927 (Western U.S.)
Altitude reference	MSL
Geoid:	DMA 10x10 (Global)
Coordinate units	Meters
Altitude units	Feet

Units

Distance	Feet
Area	Acres
Velocity	Miles/Hour
Angle	Degrees
North reference	True
Declination	Auto

Formats

Language	English
Offset	Horz/Vert
Degrees	DD-MM-SS-ss
Date	YYYY/MM/DD
Time	12 Hour

Appendix D . GPS Settings using in 2003-2004 Invasive Non-native Plant Inventory in Black Canyon of the Gunison National Park. (cont)

Time Zone	-06.00 (daylight savings, Mtn Zone)
Coordinate order	North/East
COMMS	
Data transfer	Support module (must change to "Serial clip" when using clip)
RTCM input	Off
NMEA output	Off
Port settings	
Input baud rate	N/A
Output baud rate	N/A
Data bits	N/A
Stop bits	N/A
Parity	N/A
Other	
Beep volume	On
NMEA output interval	5s
NMEA messages	
GGA	Yes
VTG	Yes

Data Dictionaries

(Select NCPN-04)

Feature Settings

(Do not adjust. Interval and minimum positions are set in office upon creation of dictionary)

About

(Nothing to set here)

Reset (Do not adjust. It will reset everything to factory defaults)

Appendix E. Photograph and list of equipment used in 2003-2004 Invasive Non-Native Plant Inventory in Black Canyon of the Gunnison National Park.

Equipment



- Trimble Geo3 Explorer GPS units
- Laser Range Finder
- Binoculars
- Clinometer
- Compass
- Calculator
- 2-way Radios
- Cellular Phone
- Field notebook
- Field Sheets
- Uinta Basin Flora and other plant taxonomic keys
- Plant dissection kits
- Hand lens
- Collection bags
- Topographic maps
- Geology maps
- 35-mm camera and slide film
- Surveyor marking ribbon

Appendix F. Dominant Vegetation Types Key used in 2003-2004 Invasive Non-native Plant Inventory, Black Canyon of the Gunnison National Park.

Key Code	Common Name	Scientific Name	Class Type
10	Rocky Mountain maple	Acer glabrum	T
11	boxelder	Acer negundo	T
12	Utah juniper, white cedar, bone-seed juniper	Juniperus osteosperma	T
13	Rocky Mountain juniper, R. Mtn. red cedar	Juniperus scopulorum	T
14	piñon, piñon pine, pinyon pine	Pinus edulis	T
15	ponderosa pine, Western yellow pine	Pinus ponderosa	T
16	Douglas fir	Pseudotsuga menziesii	T
17	narrow-leaf cottonwood, alamo sauco	Populus angustifolia	T
18	Fremont cottonwood, alamo	Populus fremontii	T
19	hackberry, net-leaf hackberry	Celtis reticulata	T
20	Gambel Oak	Quercus gembelii	T
21	Singleaf ash	Fraxinus anomala	T
22	*Add up to #29*		T
30	Basin big sagebrush, chamiso hediondo	Artemisia tridentata	S
31	spreading rabbitbrush	Chrysothamnus linifolius	S
32	rubber or gray rabbitbrush, chamiso blanco	Chrysothamnus nauseosus	S
33	gray horsebrush	Tetradymia canescens	S
34	mountain alder, thin-leaf alder	Alnus incana	S
35	red birch, river birch, water birch	Betula occidentalis	S
36	mountain snowberry	Symphoricarpos oreophilus	S
37	four-wing saltbush, chamiso	Atriplex canescens	S
38	hopsage, spiny hopsage, applebush	Grayia spinosa	S
39	greasewood, black greasewood	Sarcobatus vermiculatus	S
40	red osier dogwood	Cornus stolonifera	S
41	Torrey ephedra, Mormon tea, popotillo	Ephedra torreyana	S
42	green ephedra, Mormon tea, cañutillo	Ephedra viridis	S
43	serviceberry, Saskatoon serviceberry	Amelanchier alnifolia	S
44	Utah serviceberry	Amelanchier utahensis	S
45	dwarf or little-leaf mountain mahogany	Cercocarpus intricatus	S
46	curl-leaf mountain mahogany	Cercocarpus ledifolius	S
47	true or birch-leaf mountain mahogany	Cercocarpus montanus	S
48	chokecherry, capulin	Prunus virginiana	S
49	bitterbrush, antelope bitterbrush	Purshia tridentata	S
50	wild rose, Woods rose	Rosa woodsii	S
51	Salix sp.?	Willow	S
52	tamarisk, tamarix, salt cedar	Tamarix ramosissima	S
53	Mazanita sp.	Arctostaphylos sp	S
54	Three-leaf sumac	Rhus trilobata	S
55	Seep-willows	Baccharis sp	S
56	Apache plume	Fallugia paradoxa	S
57	Cliffrose	Cowania stansburiana	S
58	Shrub oaks	Quercus sp.	S
59	*Add up to #59*		S
60	Bigelow sagebrush	Artemisia bigelovii	DS
61	black sagebrush	Artemisia nova	DS
62	rough brickellbush	Brickellia microphylla	DS
63	mountain low rabbitbrush, green rabbitbrush	Chrysothamnus viscidiflorus	DS
64	broom snakeweed, matchbrush	Gutierrezia sarothrae	DS
65	hairy goldenaster	Heterotheca villosa	DS
66	mountain peppergrass	Lepidium montanum	DS
67	shadscale	Atriplex confertifolia	DS
68	mat saltbush, mat atriplex	Atriplex corrugata	DS
69	winterfat, white sage, winter sage	Ceratoides lanata	DS
70	*Add up to #79*		DS
80	prairie sage, Louisiana sage, estafiate	Artemisia ludoviciana	H

Appendix F. Dominant Vegetation Types Key used in 2003-2004 Invasive Non-native Plant Inventory, Black Canyon of the Gunnison National Park.

Key Code	Common Name	Scientific Name	Class Type
81	arrow-leaf balsamroot	Balsamorhiza sagittata	H
82	Russian thistle, tumbleweed, tumbling thistle	Salsola iberica	H
83	bluebunch wheatgrass	Agropyron spicatum	H
84	slender wheatgrass	Agropyron trachycaulum	H
85	cheatgrass, downy chess, cheat	Bromus tectorum	H
86	Idaho fescue	Festuca idahoensis	H
87	Indian ricegrass, ricegrass	Oryzopsis hymenoides	H
88	needle-and-thread grass	Stipa comata	H
89	Wyoming big sagebrush	Artemisia tridentata var. wyomingensis	S
90	Mountain big sagebrush	Artemisia tridentata var. vaseyana	S
91	Common reed	Phragmites australis	H
92	Horsetail	Equisetum laevigatum	H
93	Cattail	Typha latifolia	H
99	Other		
99	Needlegrass (accidentally used in COLM for short time)	Stipa comata	H

Appendix G. Project Photographs of Weed Species Detected, Inventoried Landscapes, and Crew Working in Black Canyon of the Gunnison National Park During the 2003-2004 Invasive Non-native Plant Inventory.

Weeds Detected



Figure 1. *Centaurea repens* found on the North Rim Road above Slide Draw, (BLCA PR-11).



Figure 2. *Centaurea repens* on the road shoulder above Slide Draw, (BLCA PR-11).



Figure 3. *Centaurea repens* with mature fruit in the Son-of-a-gun burned area, (BLCA PR-20).



Figure 4. *Centaurea repens* infestations in the Son-of-a-gun burned area, (BLCA PR-25).

Weeds Detected

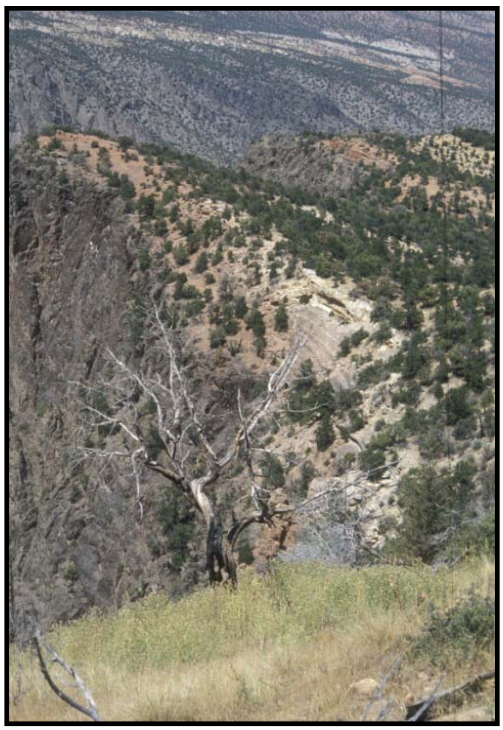


Figure 5. *Centaurea repens* patch in the Son-of-a-gun burned area, (BLCA PR-20).



Figure 6. *Centaurea maculosa* in the South Rim Amphitheatre, (BLCA PR-12).



Figure 7. *Centaurea maculosa* growing in the South Rim Amphitheatre, (BLCA PR-12).



Figure 8. *Ailanthus altissima* found in the Son-of-a-gun burn (Near BLCA PR-23).

Weeds Detected



Figure 9. Mature *Ailanthus altissima* growing in the Son-of-a-gun burn, (BLCA PR-23).



Figure 10. *Ailanthus altissima* in the recent burn, (BLCA PR-23).



Figure 11. *Ulmus pumila* in the Son-of-a-gun burn, (BLCA PR-36).

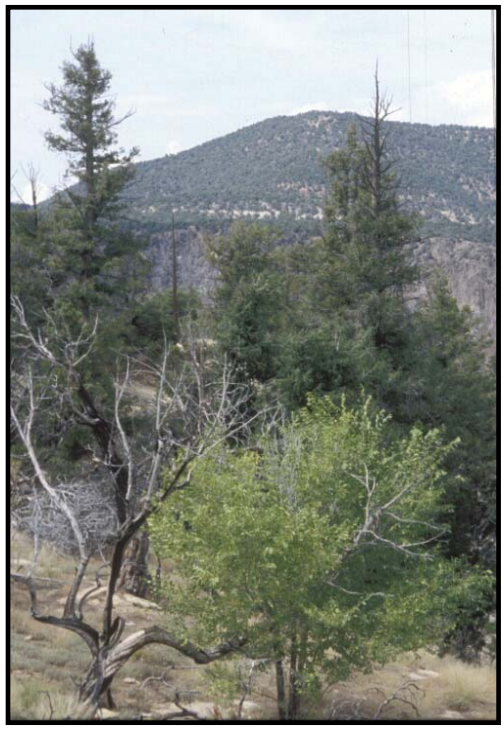


Figure 12. *Ulmus* pumila found in the Son-of-a-gun burn, (BLCA PR-24).

Weeds Detected



Figure 13. *Arctium minus* in flower on shore of Gunnison River, (BLCA PR-3).



Figure 14. *Arctium minus* plant on bank of Gunnison River near East Portal, (BLCA PR-3).



Figure 15. Ruth Richards holding an *Arctium minus* leaf in Red Rock Canyon, 2003.



Figure 16. *Arctium minus* in the Son-of-a-gun burned area in 2004, (BLCA PR-39).

Weeds Detected



Figure 17. *Verbascum thapsus* in flower, (BLCA PR-2).



Figure 18. *Verbascum thapsus* on gravel bar below the diversion tunnel at East Portal, (BLCA PR-2).

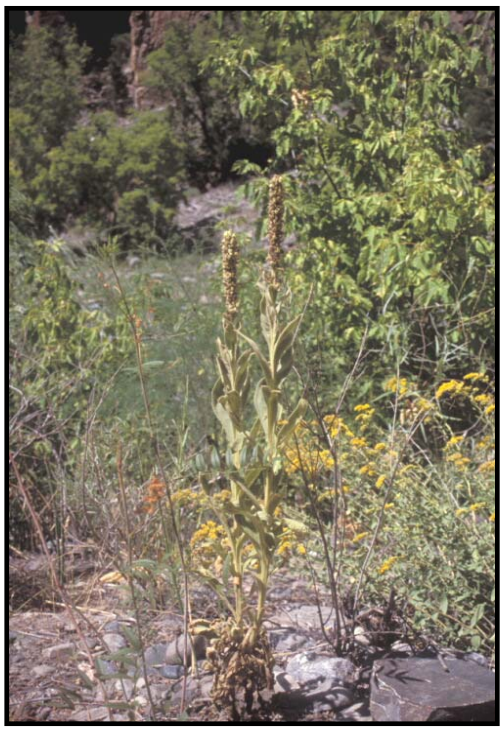


Figure 19. *Verbascum thapsus* along the Gunnison River, (BLCA PR-5).



Figure 20. *Verbascum thapsus* along bank of the Gunnison River below the Gunnison Route. (BLCA PR-5).

Weeds Detected



Figure 21. *Verbascum thapsus* rosette found at the bottom of Long Draw in 2004.



Figure 22. *Verbascum thapsus* on a gravel bar downstream from S.O.B. Draw.



Figure 23. *Verbascum thapsus* in a campsite below Slide Draw, (BLCA PR-33).



Figure 24. *Verbascum thapsus* rosettes in a rock slide below Slide Draw, (BLCA PR-34).

Weeds Detected



Figure 25. *Verbascum thapsus* along the riverbank below the Painted Wall, (BLCA PR-42).



Figure 26. Senesced *Verbascum thapsus* below the Painted Wall, (BLCA PR-42).

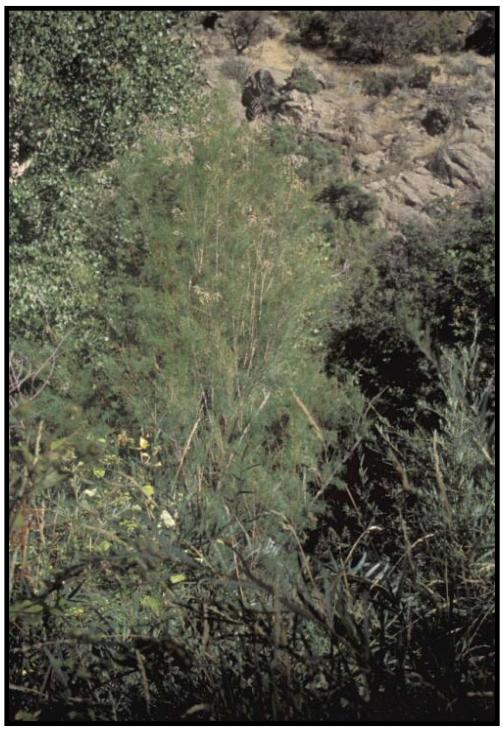


Figure 27. *Tamarix ramosissima* along the creek in Red Rock Canyon, (BLCA PR-4).

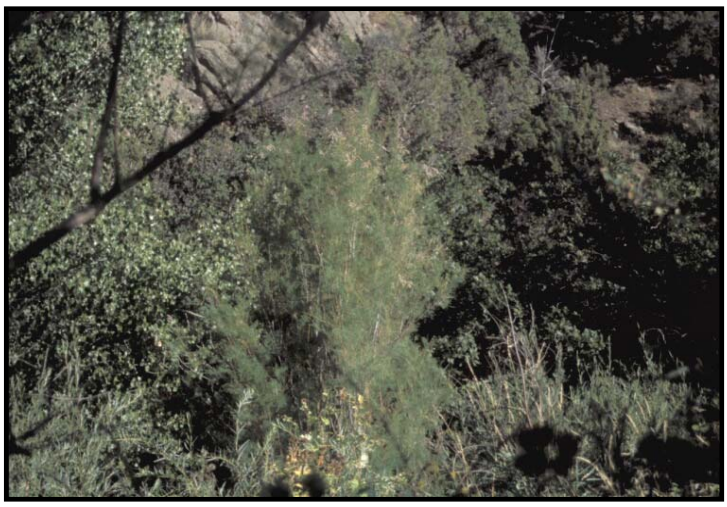


Figure 28. *Tamarix ramosissima* in Red Rock Canyon along the creek, (BLCA PR-4).

Weeds Detected



Figure 29. *Cirsium vulgare* along the bank of the Gunnison River, (BLCA PR-6).



Figure 30. *Cirsium vulgare* along the bank of the Gunnison River below the Gunnison Route, (BLCA PR-6).



Figure 31. *Cirsium vulgare* in flower, (BLCA PR-7).



Figure 32. *Cirsium vulgare* along the Gunnison River near East Portal, (BLCA PR-7).

Weeds Detected



Figure 33. *Cirsium vulgare* in the Son-of-a-gun burned area, (BLCA PR-30).



Figure 34. *Cirsium arvense* rosette, (BLCA PR-43).



Figure 35. *Cirsium arvense* along the Gunnison River, (BLCA PR-9).



Figure 36. *Cirsium arvense* along the Gunnison River below the Gunnison Route, (Near BLCA PR-9).

Weeds Detected



Figure 37. *Cirsium arvense* at campsite B23 on the South Rim, 2004.



Figure 38. *Cirsium arvense* at the bottom of Long Draw, 2004.



Figure 39. *Cirsium arvense* along the Gunnison River below the Painted Wall, (BLCA PR-41).



Figure 40. *Cirsium arvense* in the Son-of-a-gun burned area, (BLCA PR-26).

Weeds Detected



Figure 41. *Cirsium arvense* seed pappuses dispersing in the Son-of-a-gun burned area, 2004.



Figure 42. Seeds of *Cirsium arvense* in the Son-of-a-gun burned area, 2004.



Figure 43. *Iva xanthiflora* found on the North Rim Road, (BLCA PR-13).



Figure 44. *Iva xanthiflora* on the shoulder of the North Rim road, (BLCA PR-13).

Weeds Detected



Figure 45. *Carduus nutans* on gravel bar of Gunnison River, (BLCA PR-8).

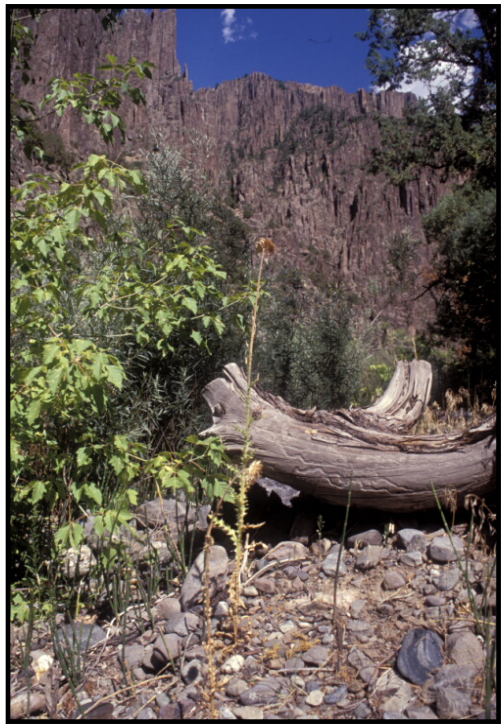


Figure 46. *Carduus nutans* on gravel bar near campground, below Gunnison Route, (BLCA PR-8).



Figure 47. *Carduus nutans* rosette found between East Portal Road and Gunnison River, (BLCA PR-2).



Figure 48. *Carduus nutans* patch in the Son-of-a-gun burn area. (BLCA PR-21).

Weeds Detected



Figure 49. *Carduus nutans* below Slide Draw, (BLCA PR-32).



Figure 50. *Linaria vulgare* flowers, (BLCA PR-10).



Figure 51. *Linaria vulgare* found on the bank of the Gunnison River below the Gunnison Route, (BLCA PR-10).



Figure 52. *Linaria vulgare* found under reed canarygrass on Gunnison River below Gunnison Route, (BLCA PR-10).

Weeds Detected



Figure 53. *Convolvulus arvensis*. Found extensively along the North Rim Road. *



Figure 54. *Melilotus officinalis*. Found along shores of Gunnison River and East Portal Road.*



Figure 55. *Bromus tectorum*. *Bromus tectorum* was found throughout the survey areas, although heaviest in Red Rock Canyon. *



Figure 56. *Bromus tectorum* along the river bank below Slide Draw.

* Photographs not taken in Black Canyon of the Gunnison National Park but are representative of the species found there.

Weeds Detected

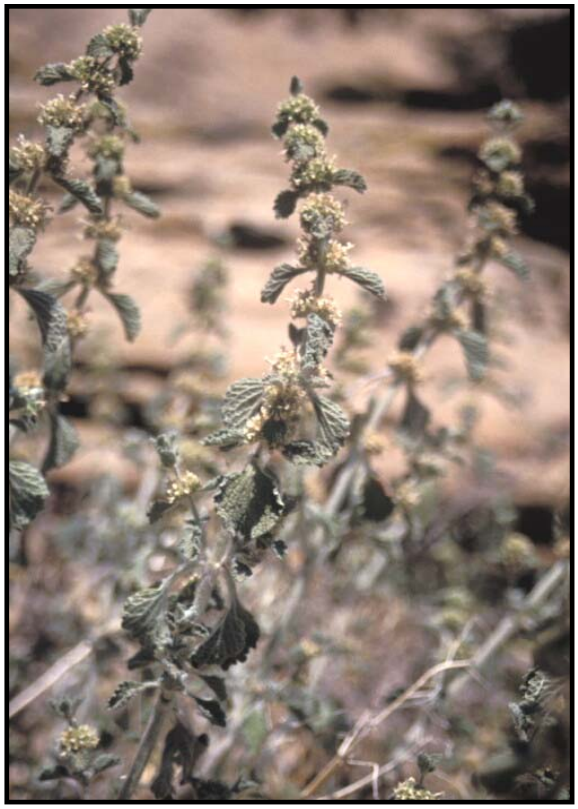


Figure 57. *Marrubium vulgare*. Plants found at Chasm View Overlook.*



Figure 58. *Rubus discolor*. Possible plants found along the Gunnison River at East Portal. *

* Photographs not taken in Black Canyon of the Gunnison National Park but are representative of the species found there.

Black Canyon Landscapes



Figure 59. View downriver from East Portal, 2003.



Figure 60. South Rim Visitor Center, 2003.



Figure 61. View into the canyon from along the Gunnison Route, 2003.



Figure 62. Gunnison River accessed from the Gunnison Route, 2003.

Black Canyon Landscapes



Figure 63. Top of Red Rock Canyon looking north, 2003.

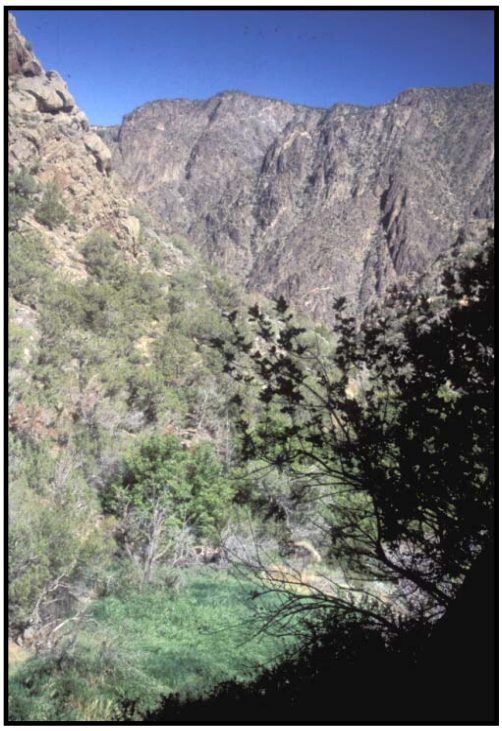


Figure 64. View looking down Red Rock Canyon, 2003.

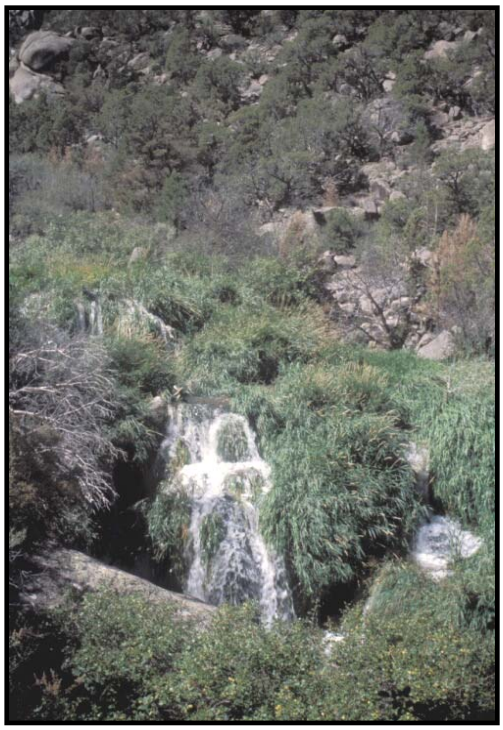


Figure 65. Stream flooding out the trail in Red Rock Canyon, 2003.

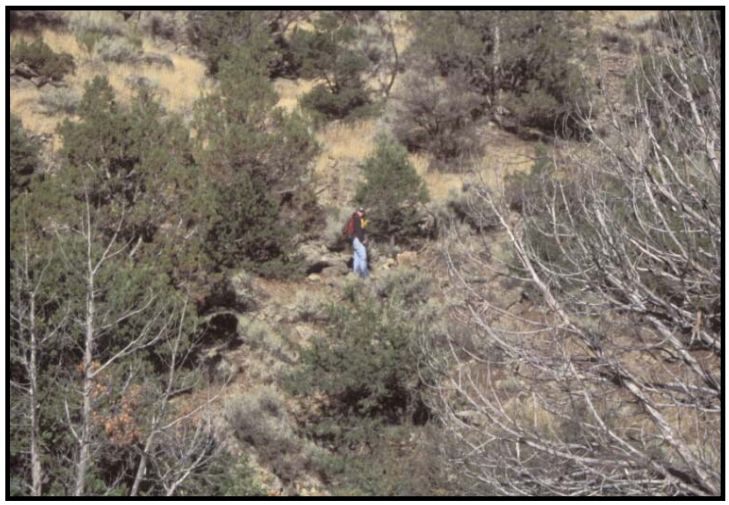


Figure 66. Ruth Richards mapping *Bromus tectorum* in Red Rock Canyon, 2003.

Black Canyon Landscapes



Figure 67. End point down river of Long Draw, 2004.



Figure 68. End point upriver of Long Draw, 2004.



Figure 69. Down river from S.O.B. Draw, 2004.

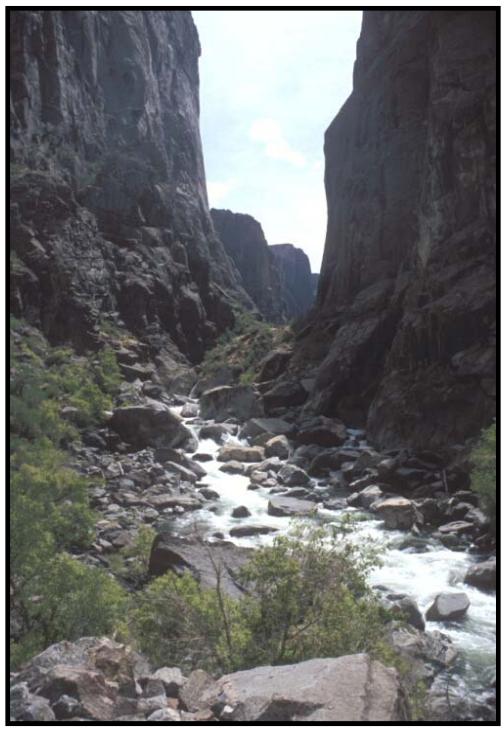


Figure 70. Upriver from S.O.B. Draw, 2004.

Black Canyon Landscapes



Figure 71. Looking upstream from S.O.B. Draw, 2004.



Figure 72. Looking down-canyon from Slide Draw, 2004.

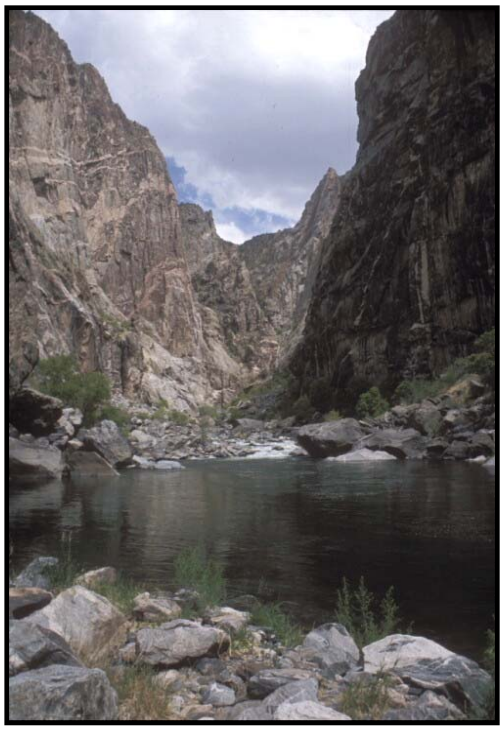


Figure 73. Looking upriver towards S.O.B. Draw from the Painted Wall.

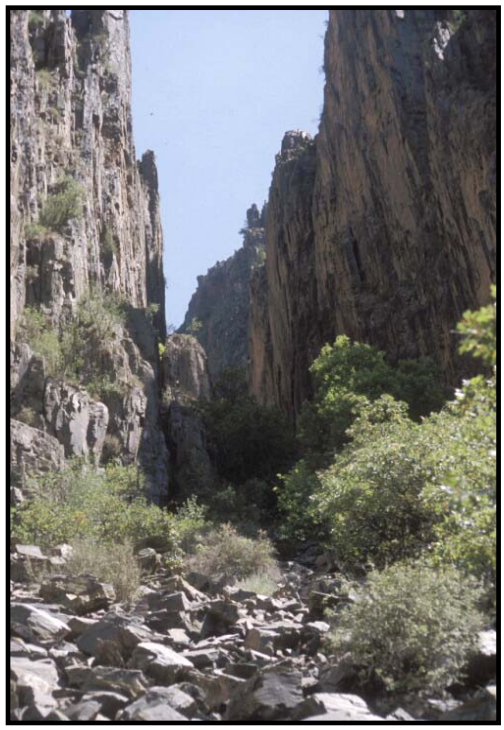


Figure 74. Looking up Slide Draw route from the canyon bottom, 2004.

Black Canyon Landscapes



Figure 75. North edge of the Son-of-a-gun burn, (BLCA PR-22).



Figure 76. South edge of the Son-of-a-gun burn, (BLCA PR-28).



Figure 77. *Tamarix ramosissima*, on gravel bars below the Painted Wall, (BLCA PR-18).

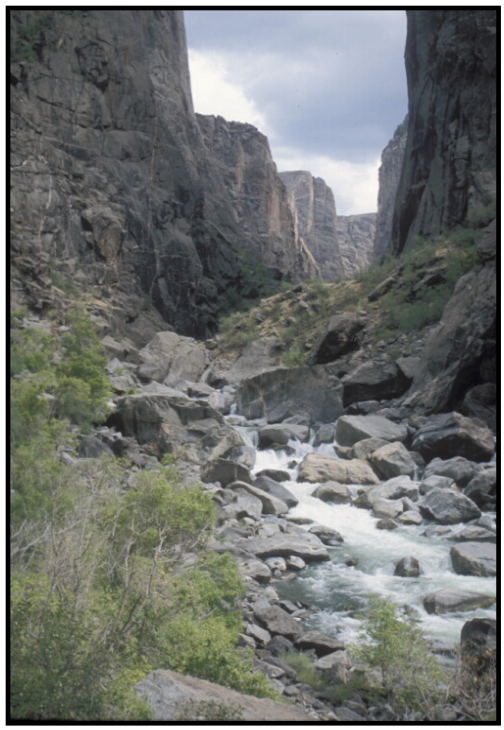


Figure 78. Looking up-canyon from S.O.B. Draw, 2004.

Crew



Figure 79. Janna Simonsen carrying out bag of *Arctium minus* burrs pulled in Red Rock Canyon, 2003.

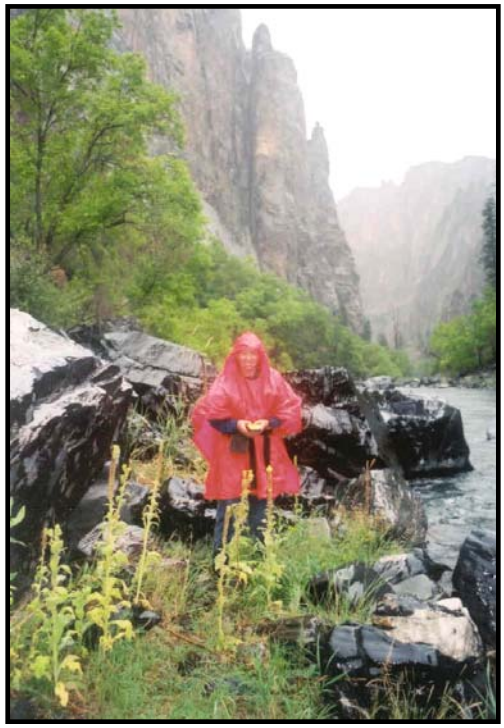


Figure 80. Ruth Richards mapping *Verbascum thapsus* at the bottom of the Tomichi Route, 2003.

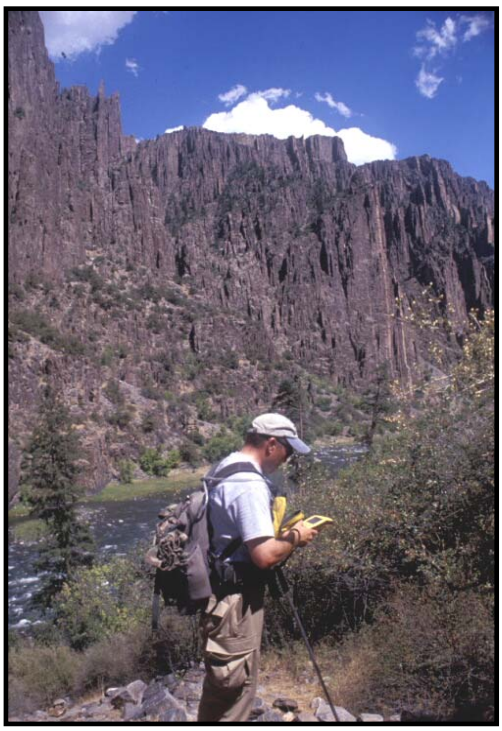


Figure 81. Steve Dewey on the Gunnison Route, 2003.

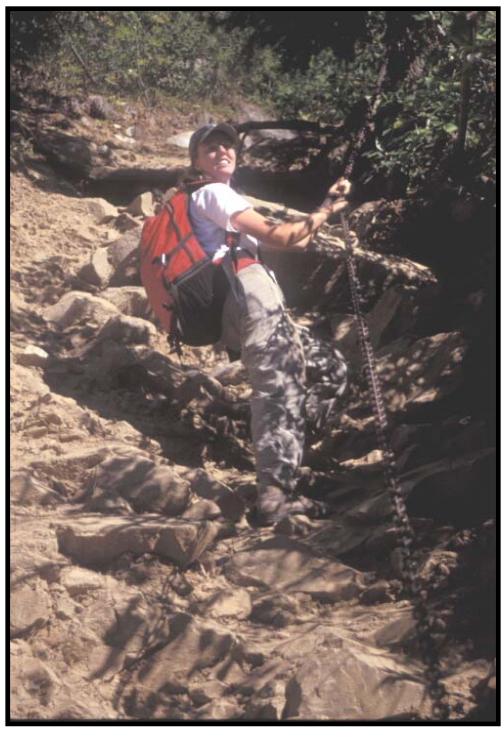


Figure 82. Kim Andersen using the chain along the Gunnison Route, 2003.

Crew



Figure 83. Park Ranger showing Ruth Richards and Janna Simonsen how to use the cable car at East Portal, 2003.



Figure 84. Ruth Richards and Janna Simonsen using cable car to access east shore of Gunnison River at East Portal, 2003.



Figure 85. Steve Dewey mapping *Carduus nutans* along the Gunnison River below the Gunnison Route, 2003.



Figure 86. Kim Andersen, Ruth Richards, and Janna Simonsen leaving the top of the Tomichi Route, 2003.

Crew



Figure 87. Bridget Atkin and Melanie Ballard before starting down Long Draw, 2004.

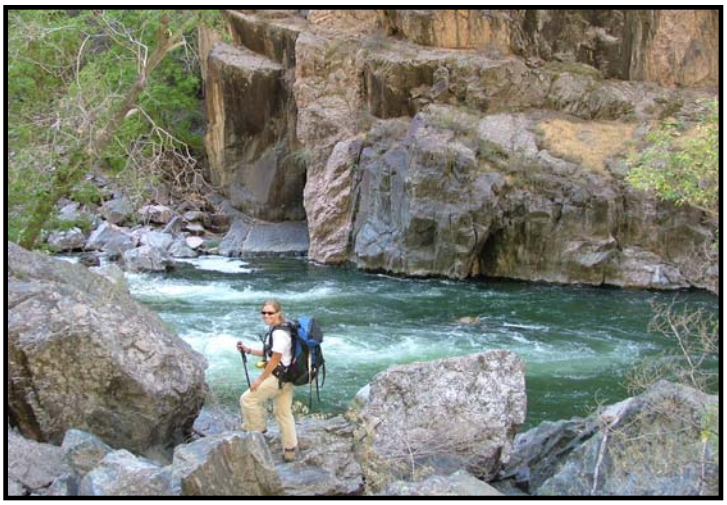


Figure 88. Bridget Atkin at the bottom of Long Draw, 2004.



Figure 89. Kim Andersen mapping *Centaurea maculosa* on the North Rim Road.



Figure 90. Dr. Steven Dewey collecting a voucher specimen of *Centaurea maculosa*.

Crew



Figure 91. Bridget Atkin at the bottom of S.O.B. Draw, 2004.

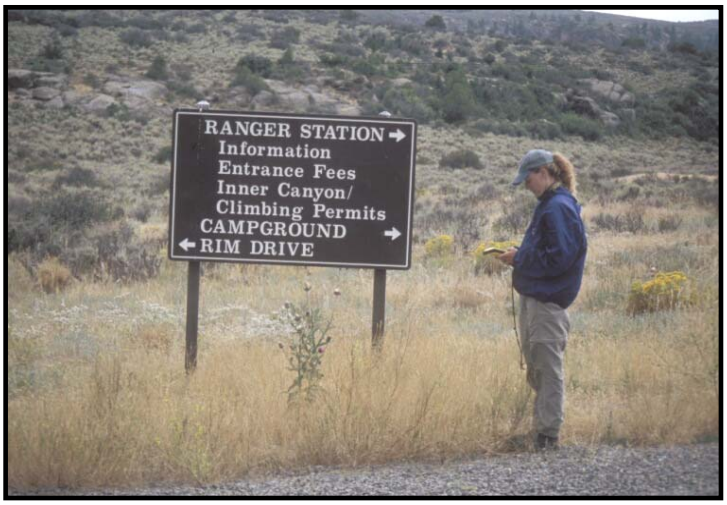


Figure 92. Kim Andersen mapping a *Carduus nutans* plant at the Ranger Station on the North Rim.



Figure 93. Melanie Ballard mapping a 0.01 acre patch of *Carduus nutans* at the head of Long Draw, 2004.

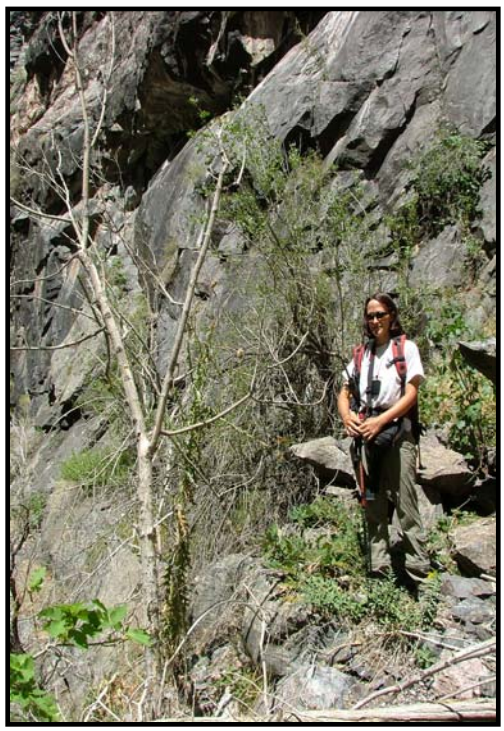
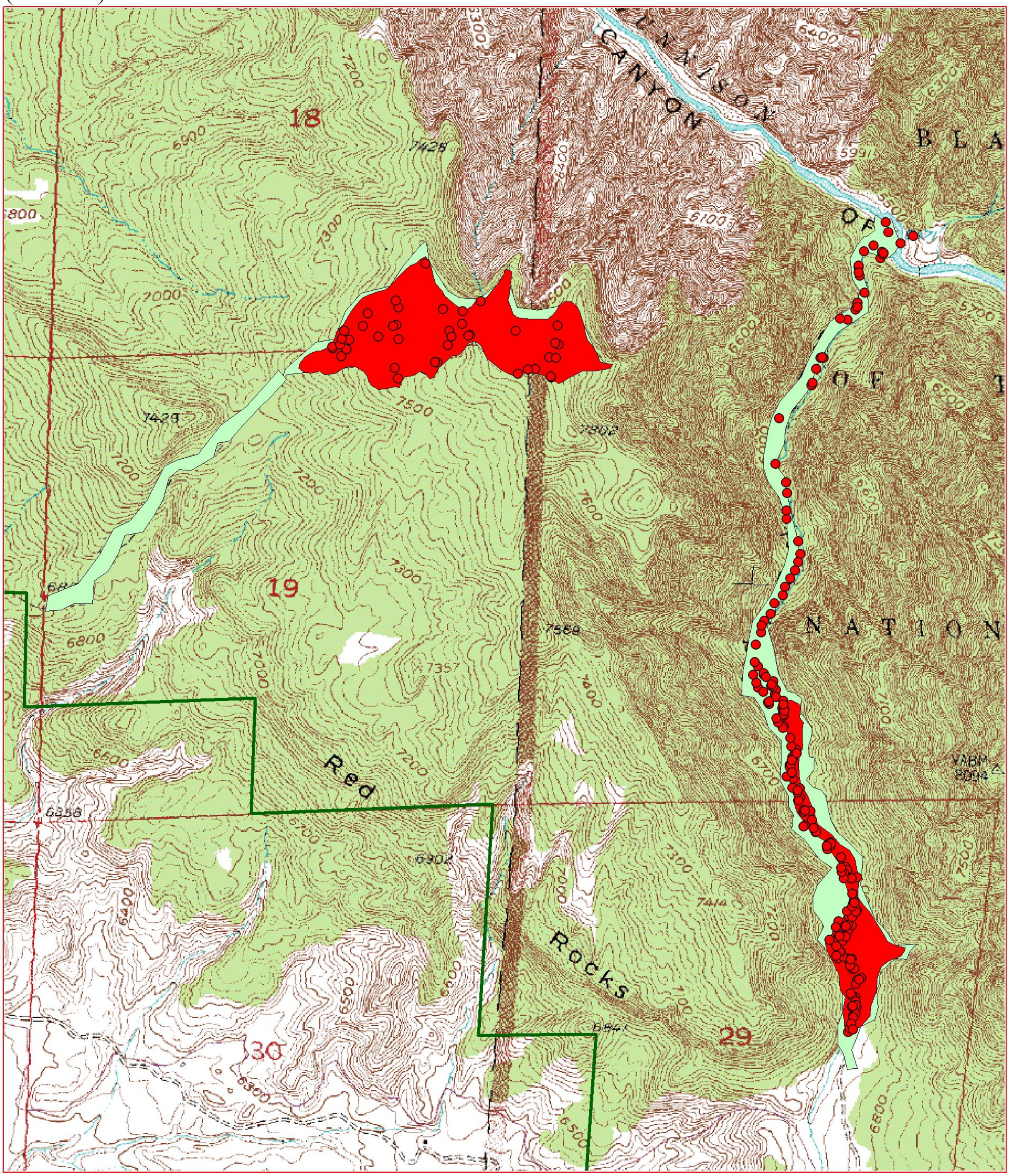


Figure 94. Melanie Ballard at a *Carduus nutans* at the bottom of Long Draw, 2004.

Appendix H. Overall Weed Distribution in Inventoried Areas - Red Rock Canyon (Inset A)



Weed Points

Weed Areas

Area Inventoried

Park boundary

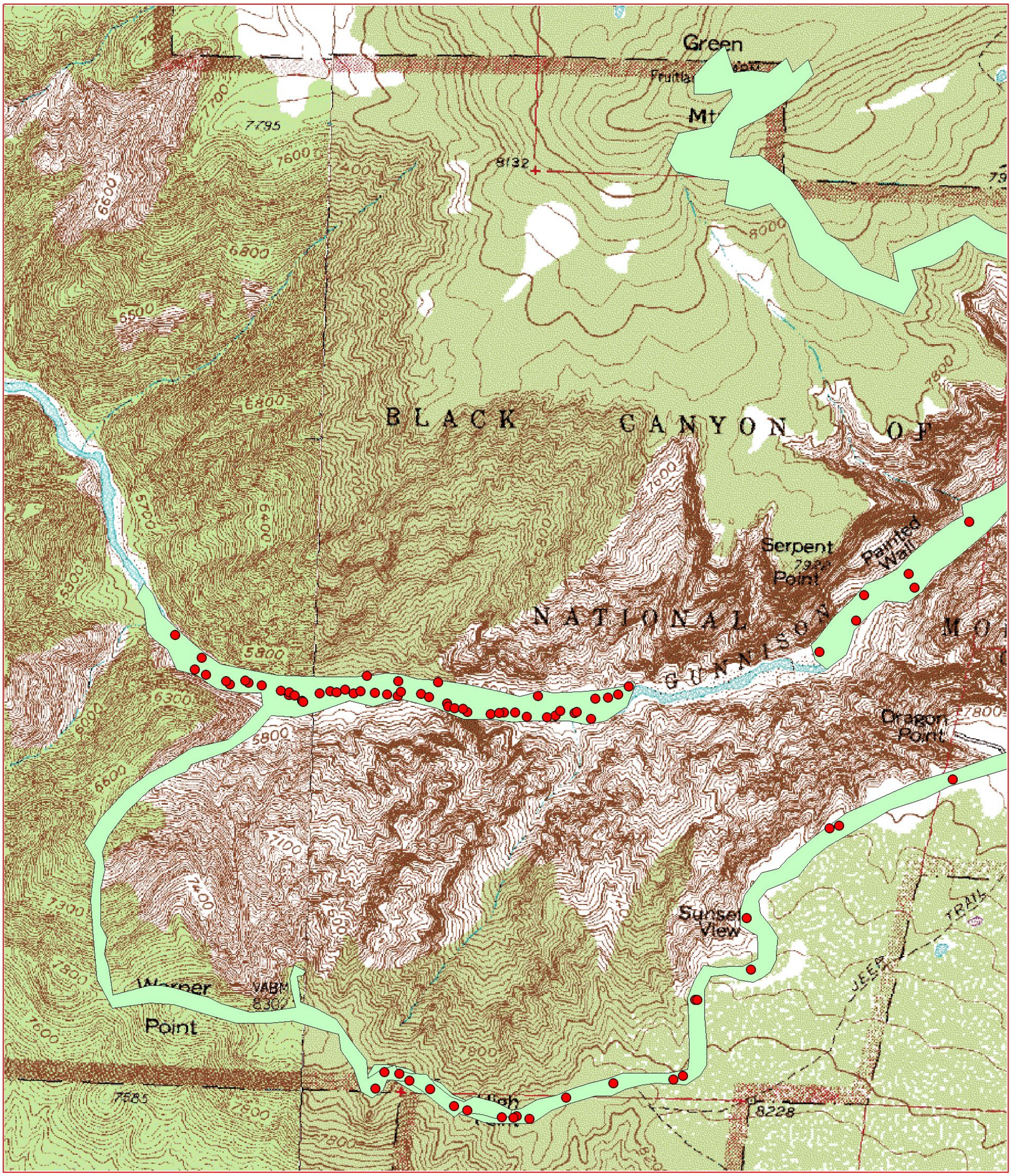
0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset A
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Warner Point (Inset B)



Weed Points

Area Inventoried

0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset B
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Chasm View (Inset C)



0 1000 2000 3000 Feet

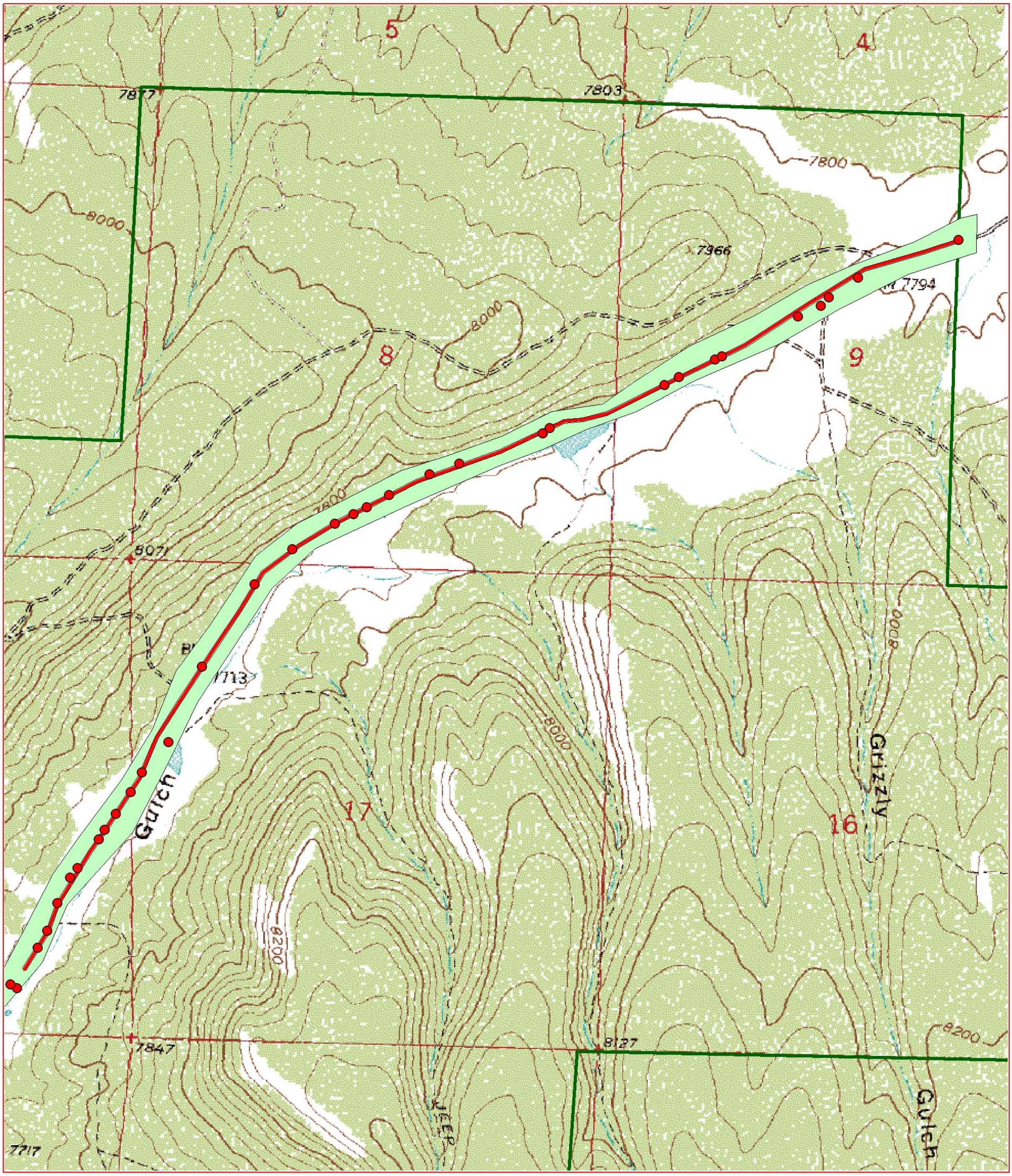
1:18,000 Scale

N

- Weed Points
- Weed Lines
- Area Inventoried

Inset C
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Grizzly Gulch (Inset D)



Weed Points

Weed Lines

Area Inventoried

Park boundary

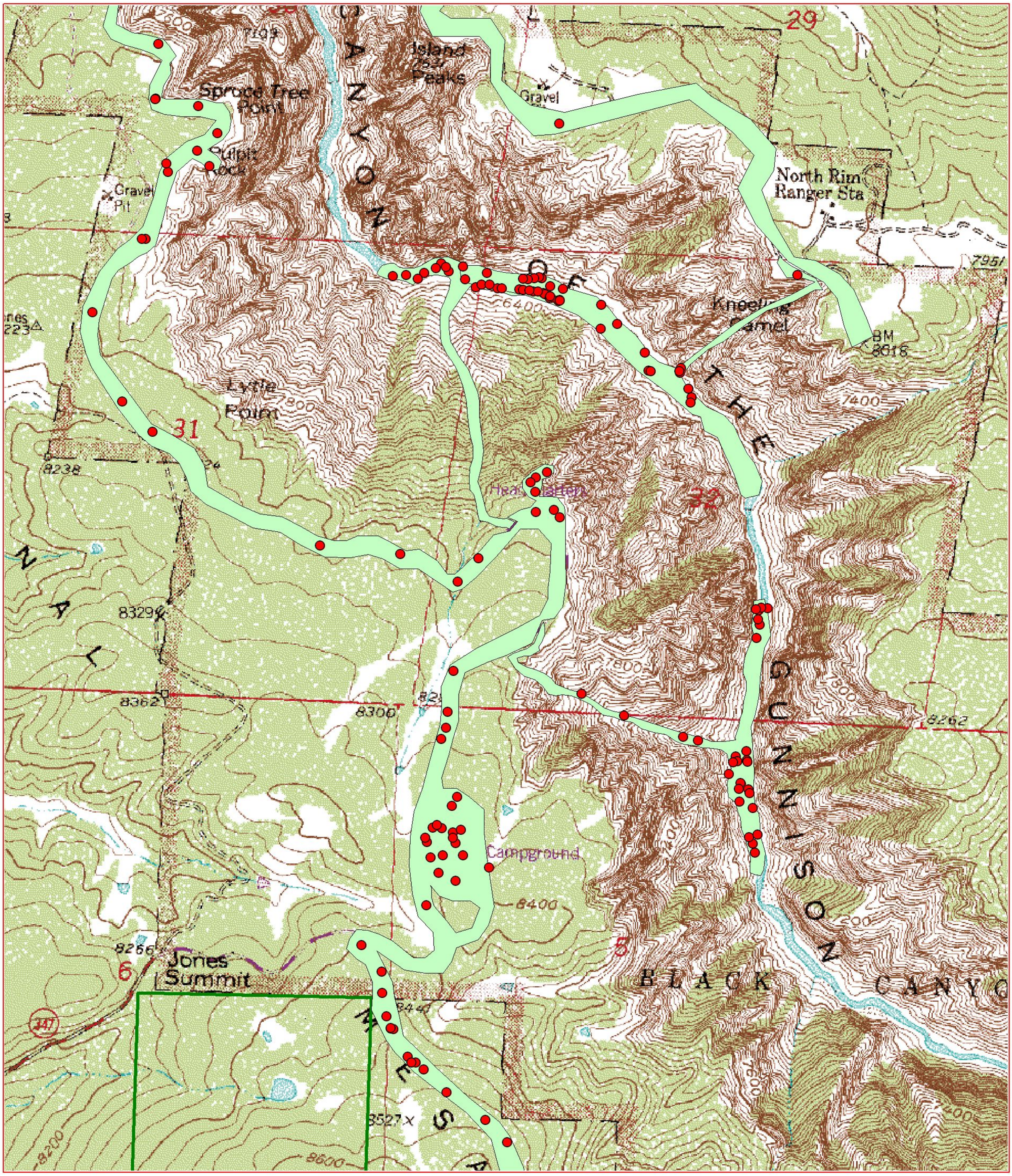
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1:18,000 Scale

N

Inset D
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Kneeling Camel (Inset E)



Weed Points

Area Inventoried

Park boundary

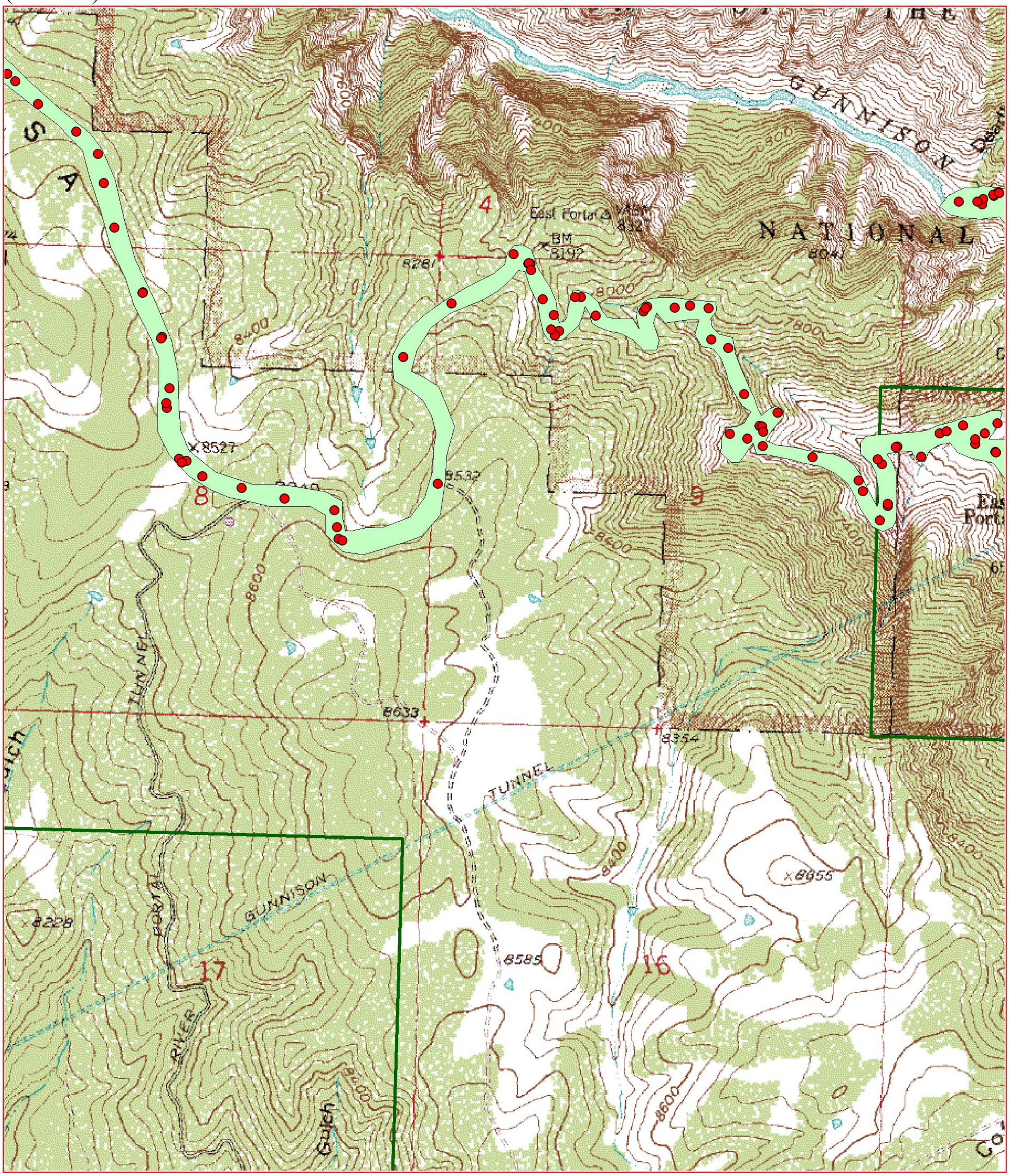
0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset E
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - East Portal Road (Inset F)



Weed Points

Area Inventoried

Park boundary

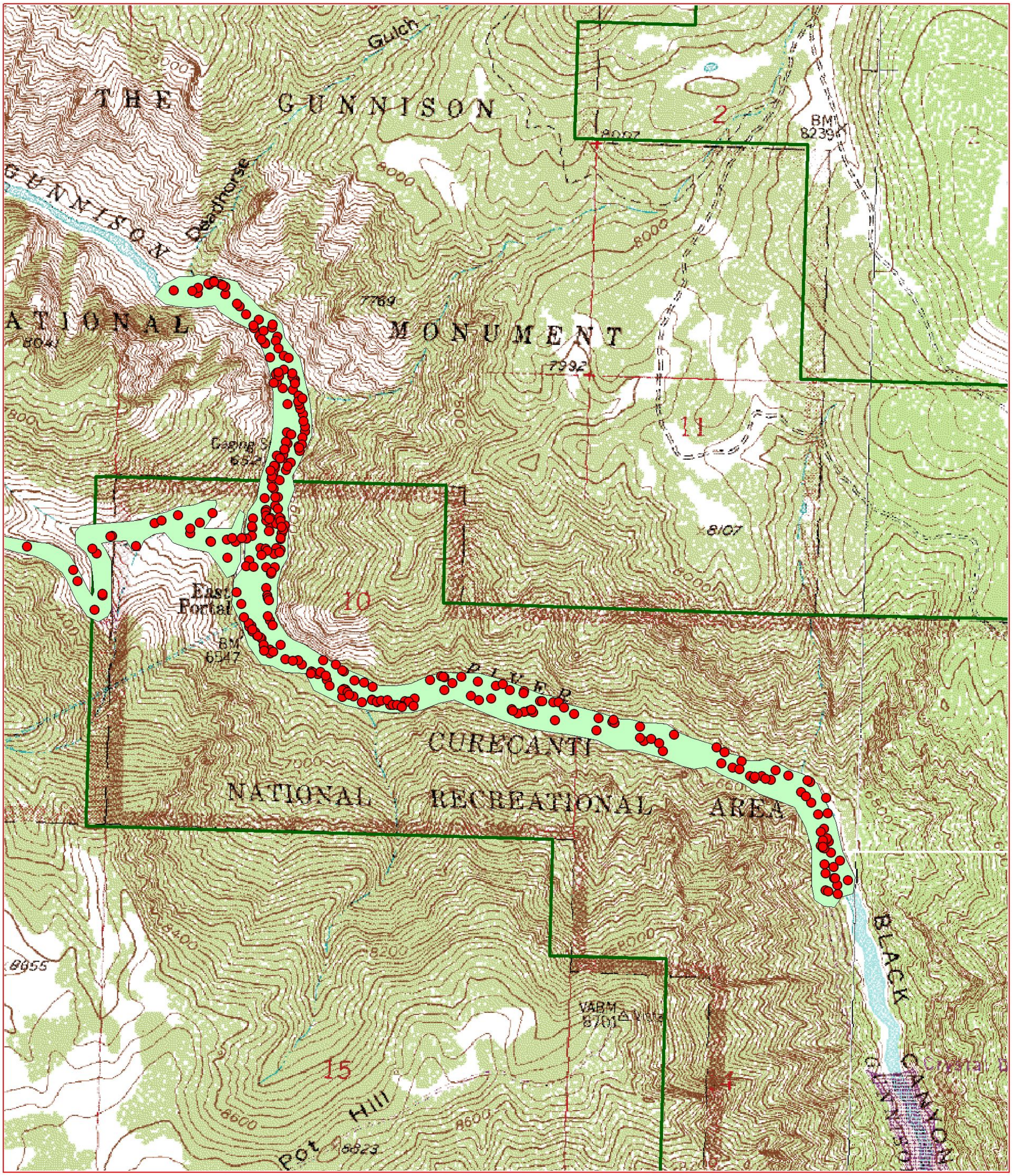
0 1000 2000 3000 Feet

1:18,000 Scale

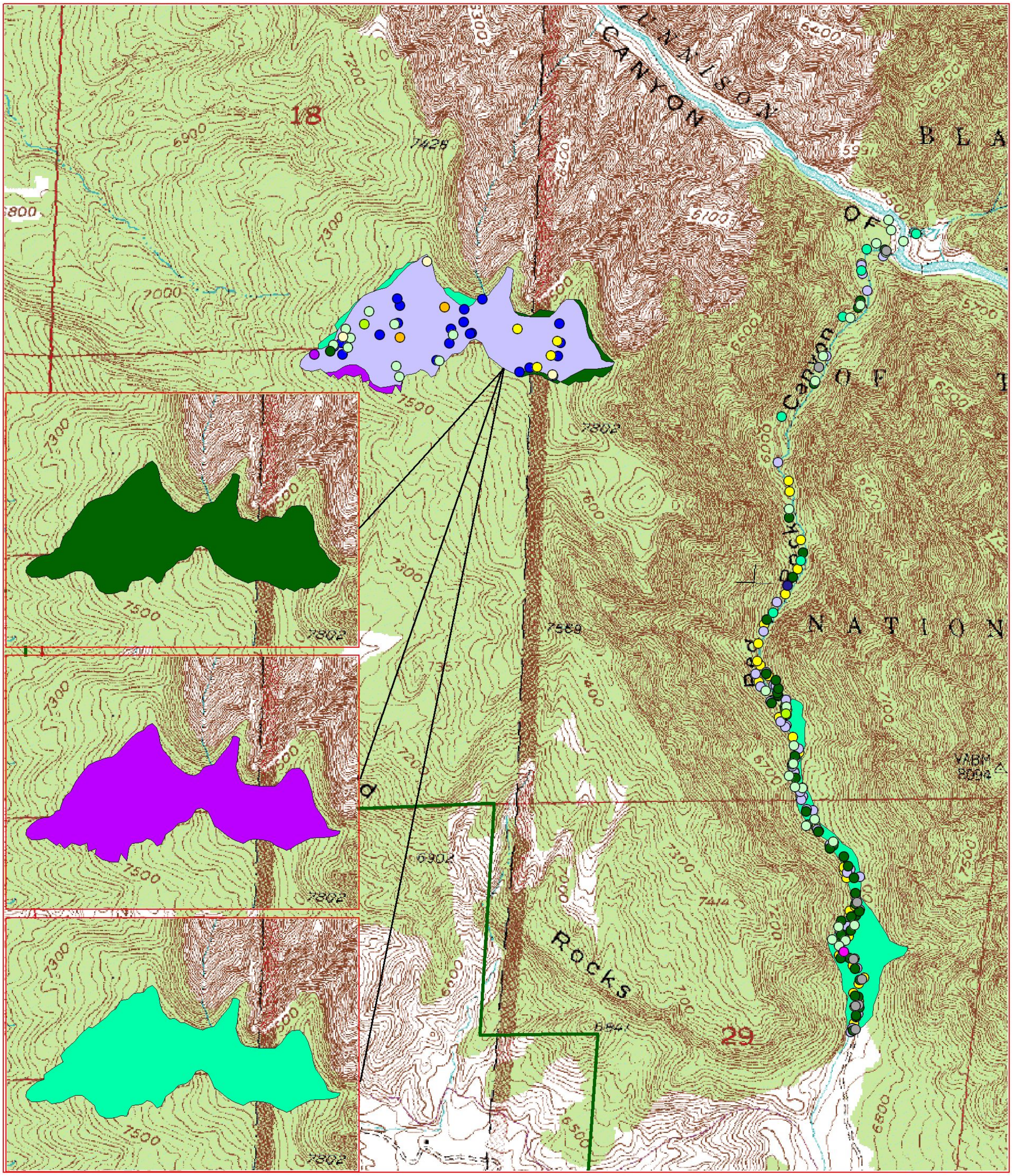
N

Inset F
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - East Portal (Inset G)



Appendix I. Weed Species Detected in Inventoried Areas - Red Rock Canyon (Inset A)



- *Ailanthus altissimum*
- *Arctium minus*
- *Bromus tectorum*
- *Carduus nutans*
- *Centaurea repens*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Rubus discolor*
- *Salsola kali*
- *Tamarix ramosissma*
- *Ulmus pumila*
- *Verbascum thapsus*
- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium arvense*
- *Ulmus pumila*
- Park boundary

0 1000 2000 3000 Feet

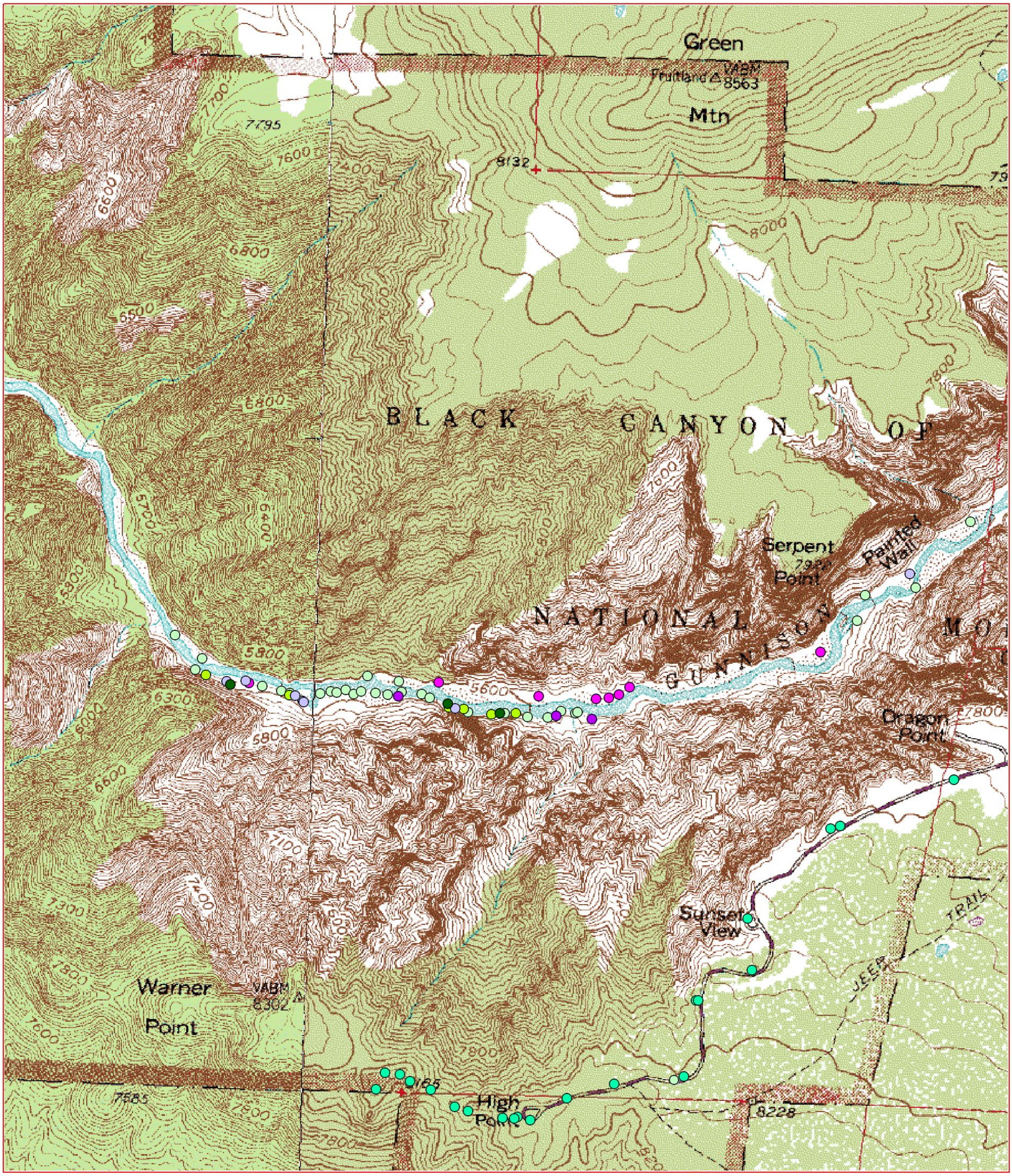
1:18,000 Scale

N

I-1

Inset A
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix I. Weed Species Detected in Inventoried Areas - Warner Point (Inset B)



- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Tamarix ramosissma*
- *Ulmus pumila*
- *Verbascum thapsus*

0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset B
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix I. Weed Species Detected in Inventoried Areas - Chasm View (Inset C)



- *Arctium minus*
- *Bromus tectorum*
- *Carduus nutans*
- *Centaurea maculosa*
- *Centaurea repens*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Convolvulus arvensis*
- *Marrubium vulgare*
- *Salsola kali*
- *Verbascum thapsus*

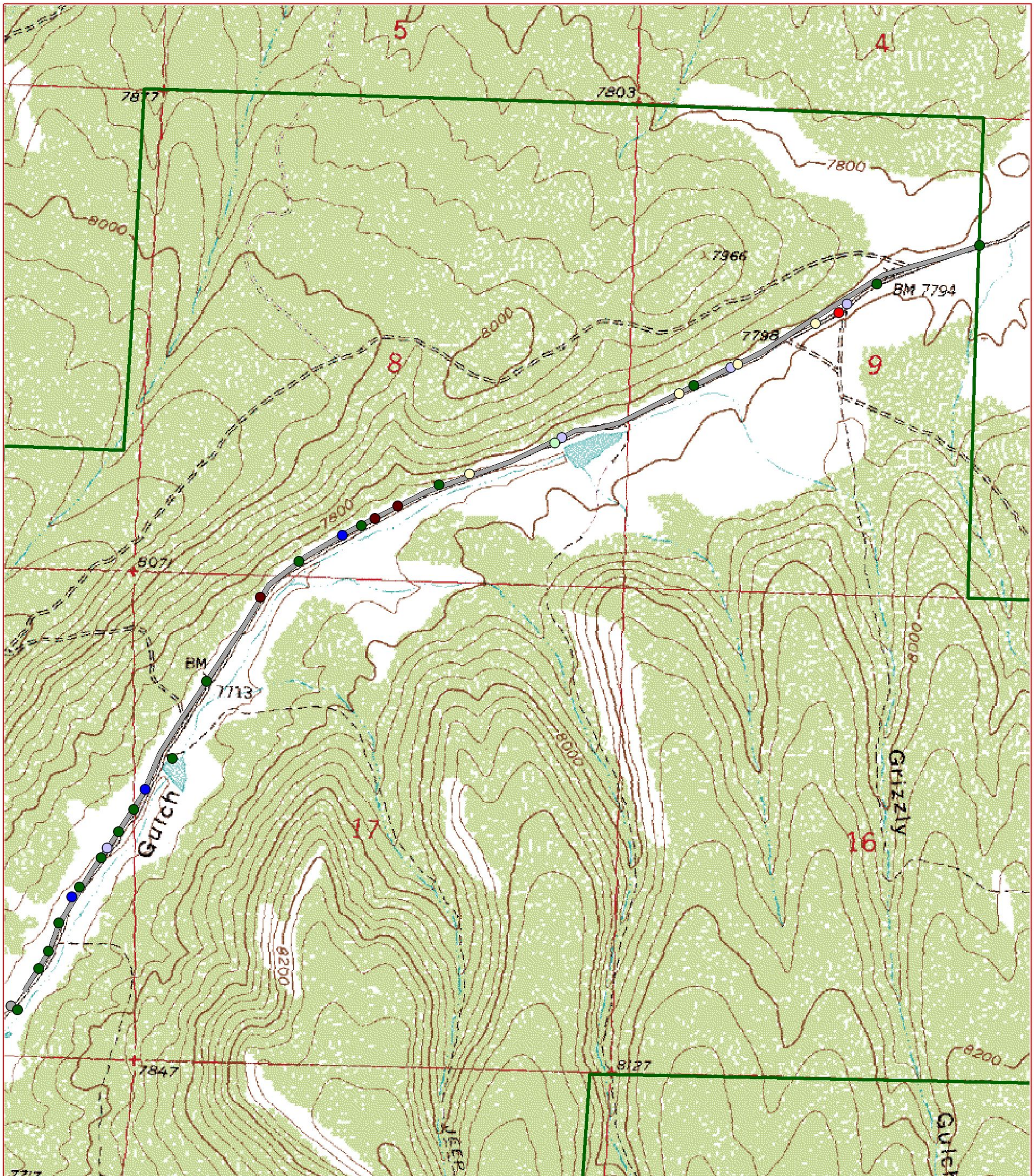
0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset C
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix I. Weed Species Detected in Inventoried Areas - Grizzly Gulch (Inset D)



Appendix I. Weed Species Detected in Inventoried Areas - Kneeling Camel (Inset E)



- *Arctium minus*
- *Bromus tectorum*
- *Carduus nutans*
- *Centaurea maculosa*
- *Centaurea repens*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Linaria vulgare*
- *Melilotus officinalis*
- *Verbascum thapsus*
- Park boundary

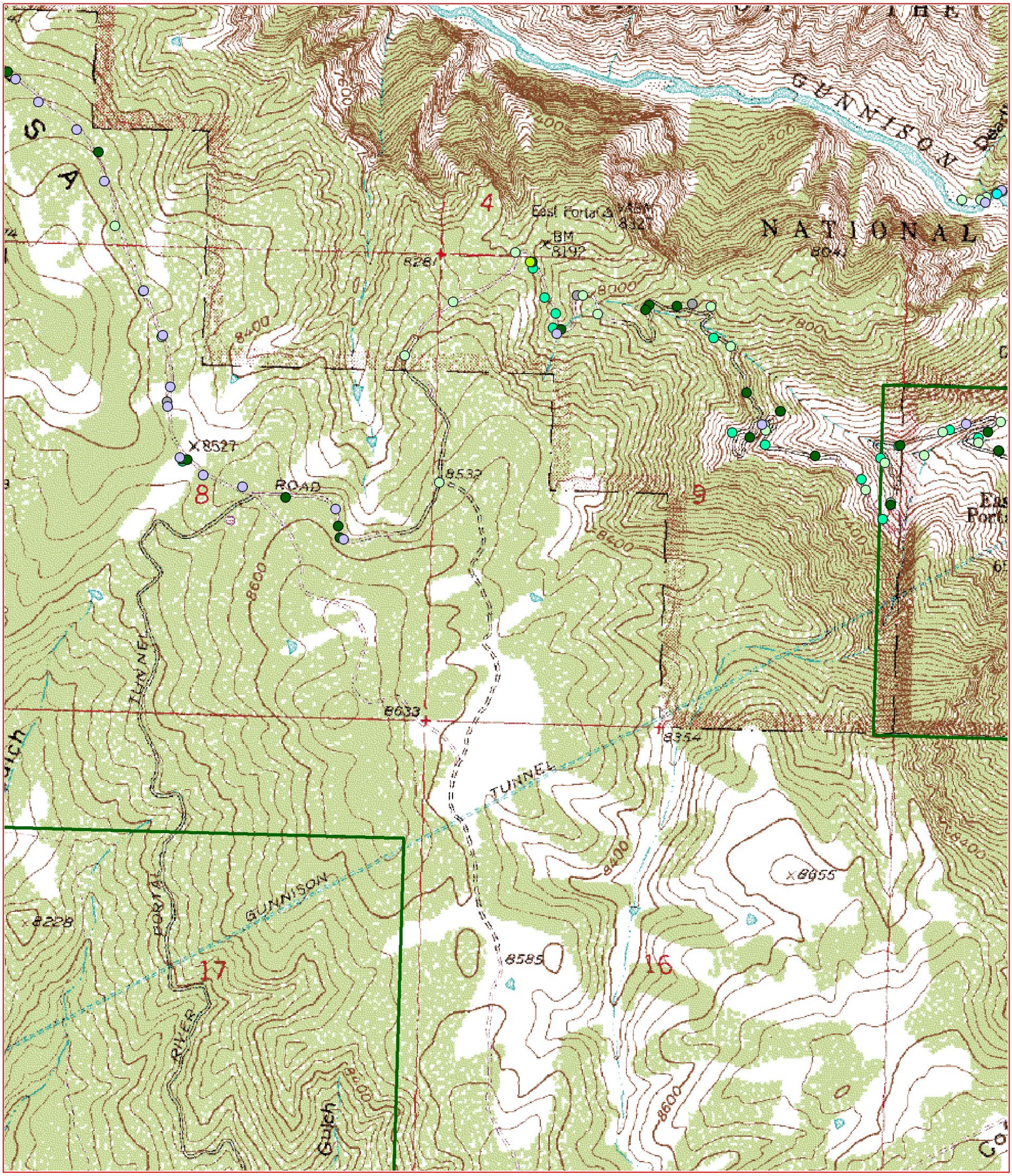
0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset E
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix I. Weed Species Detected in Inventoried Areas - East Portal Road (Inset F)



- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Linaria vulgare*
- *Verbascum thapsus*
- Park boundary

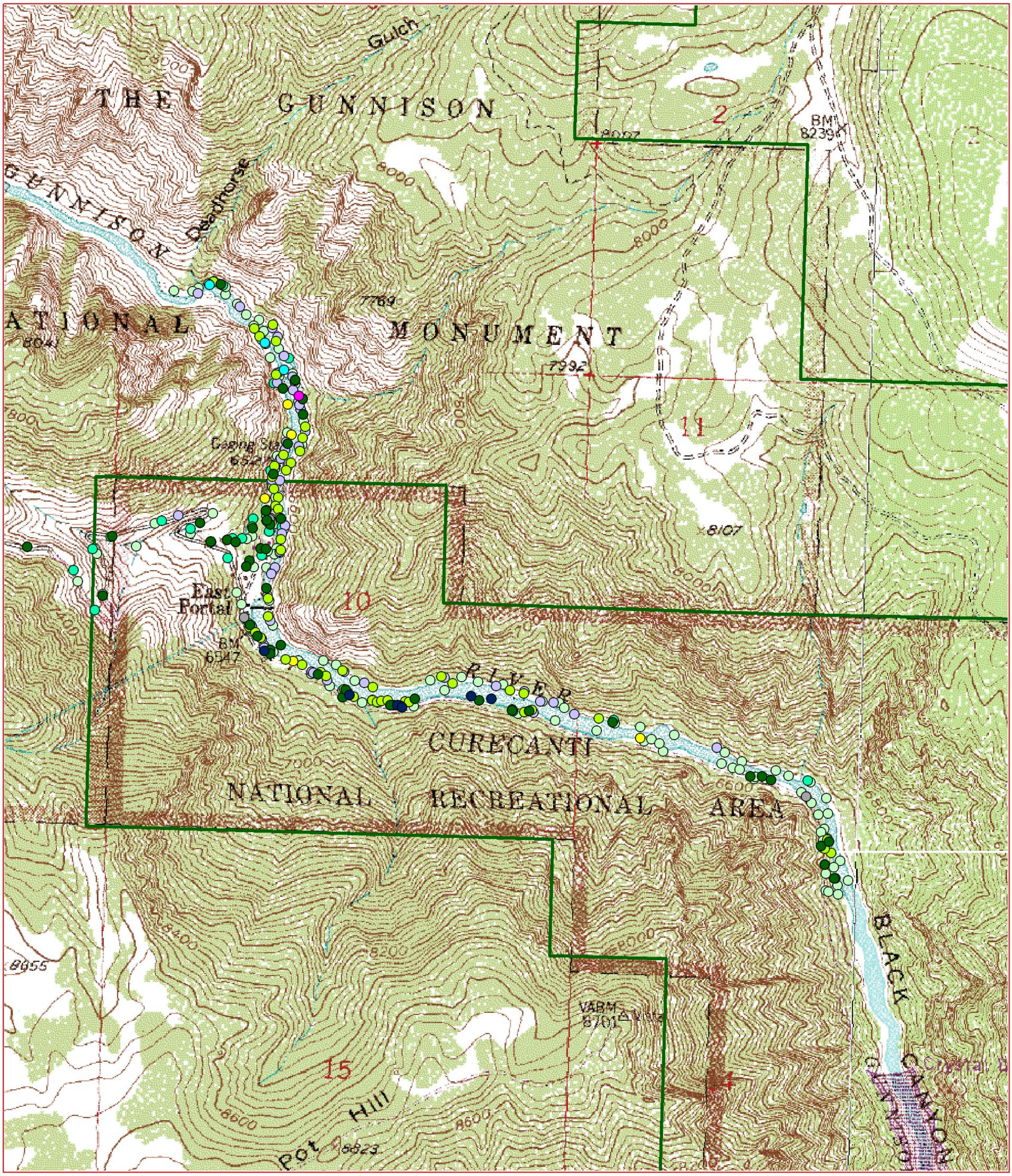
0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset F
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix I. Weed Species Detected in Inventoried Areas - East Portal (Inset G)



- *Arctium minus*
- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Linaria vulgare*
- *Rubus discolor*
- *Tamarix ramosissima*
- *Verbascum thapsus*
- Park boundary

0 1000 2000 3000 Feet

1:18,000 Scale

N

Inset G
Black Canyon of the Gunnison National Park
Utah State University
2003-2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix J. Weed Seed/Propagule Decontamination Procedures, 2004 EPMT Field Training Exercise, Arches National Park

EPMT COURTHOUSE WASH PROJECT

Arches National Park
March 9 – 14, 2004

EPMT Deployment to Arches NP:
The risk of this type of mobilization is that we will bring all types of nasty weeds from all over the country to Courthouse Wash. A recent exotic plant inventory has been conducted within the project area and the only high priority weeds detected were tamarisk and Russian olive. So we will know who to blame if nasty stuff like leafy spurge, miconia, malelueca, kudzu, and spotted knapweed show up (each team has its own signature).

Weed Seed/Propagule Decontamination Procedures:

If you are flying or driving:
Make sure that everything you bring has been cleaned/washed/decontaminated.
Especially be vigilant with gear and clothing you wear in the field at your home units:

- Backpacks
- Boots and shoes
- Socks
- Pants
- PPE

If you are driving be sure to clean/wash/decontaminate:

- Make sure your entire vehicle is power washed before you leave your home unit or go to a local car wash.
- Be extra vigilant while cleaning the undercarriage of the vehicle
- All your equipment
- Chainsaws
- Backpack sprayers
- Saw chaps
- Hard hats
- Gloves
- PPE

Demobilization Decontamination Process:
Same thing in reverse, because I know you don't want tamarisk, Russian olive or cheatgrass in your area!

- Visit a car wash in town
- Lake Mead EPMT will be bringing our steam cleaner power washer to share
- Clean boots in the hotel bath
- Wash clothes in the hotel laundry facilities

Appendix K. Summary of occurrence and inventory status of the 47 non-native species listed in the GPS data dictionary, plus any additional species noted in the 2003-2004 inventory of invasive plants in Black Canyon of the Gunnison National Park.

GPS Species	A	B	C	D	E	GPS Species	A	B	C	D	E
Agropyron cristatum			X			*Lepidium latifolium*				X	
Ailanthus altissima	X					*Linaria dalmatica*				X	
Alhagi pseudalhagi				X		*Linaria vulgare*	X				
Anthemis L.				X		*Lythrum salicaria*				X	
Arctium minus	X					*Marrubium vulgare*	X				
Arundo donax				X		*Moluccella laevis*					X
Asparagus sp.			X			*Onopordum acanthium*				X	
Brassica tournefortii					X	*Phleum pratense*					X
Bromus inermis			X			*Rubus discolor*	X				
Bromus tectorum		X				*Rumex crispus*				X	
Cardaria draba				X		*Salsola kali*		X			
Carduus nutans	X					*Sorghum halepense*				X	
Centaurea diffusa	X					*Tamarix ramosissima*	X				
Centaurea maculosa	X					*Tragopogon dubius*			X		
Centaurea repens	X					*Tribulus terrestris*				X	
Centaurea solstitialis				X		*Verbascum thapsus*	X				
Centaurea virgata				X		*Ulmus pumila*	X				
Chenopodium album			X								
Cirsium arvense	X					**Other:**					
Cirsium vulgare	X					*Erodium cicutarium*			X		
Conium maculatum				X		*Lactuca serriola*			X		
Convolvulus arvensis	X					*Melilotus officinalis*		X			
Cynoglossum officinale				X		*Sonchus oleraceus*			X		
Dactylis glomerata			X								
Elaeagnus angustifolia				X							
Euphorbia esula				X							
Halogeton glomeratus					X						
Hyoscyamus niger				X							
Isatis tinctoria				X							
Iva xanthifolia	X										

A = Present - Full inventory
B = Present – Partial inventory
C = Present – Not Mapped
D = Searched For - Absent
E = No Information