Bryce Canyon National Park



2004 Invasive Non-Native Plant Inventory

Northern Colorado Plateau Inventory and Monitoring Network

Final Report

May 2005

Prepared by

Steven Dewey and Kimberly Andersen

Utah State University

Cover photo:

Bromus inermis spreading into the East Creek meadows. Photo by K. A. Andersen.

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FINAL REPORT

Inventory of Invasive Non-native Plants
Conducted during 2004 in Portions of Bryce Canyon 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 Bryce Canyon National Park. Results from other Parks are documented in separate Park-specific project reports.

BACKGROUND AND JUSTIFICATION

Numerous recent studies demonstrate that invasive non-native plant species pose one of the greatest threats to national 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. Bryce 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 Bryce Canyon 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 5-person crew in 2004 to inventory designated areas within Bryce Canyon National Park. Crew qualifications are documented in Appendix A.

SELECTION OF TARGET SPECIES AND INVENTORY AREAS

Twelve species were identified as high-priority targets in the BRCA inventory (Table 1), and searched for systematically by all inventory crew members. Any other non-native species

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

Invasive species	Common Name
Bromus inermis	Smooth brome
Bromus tectorum	Downy brome
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea maculosa	Spotted knapweed
Centaurea repens	Russian knapweed
Centaurea virgata v. squarrosa	Squarrose knapweed
Cirsium arvense	Canada thistle
Cirsium vulgare	Bull thistle
Elaeagnus angustifolia	Russian olive
Onopordum acanthium	Scotch thistle
Tamarix ramosissima	Saltcedar

recognized as relatively new to BRCA and potentially invasive on wildlands in the West were documented if found. Forty-seven species were listed in the 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.

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 Bryce Canyon National Park in 2004 included everything in the original Implementation Plan, plus additional areas added after consultation with Kristin Legg, Chief of Resources for Bryce Canyon National Park. Lands inventoried primarily consisted of plateaus, burned areas, riparian areas, roads, and hiking trails.

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 Bryce Canyon 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 size. In other cases searches were extended if crew members suspected a possible "contamination source" of one or more species immediately adjacent to the Park boundary. This occurred primarily in the Yellow Creek, Pump House, and Horse Hollow inventory areas.

Park natural resource staff and the NCPN Vegetation Ecologist worked closely with USU and NPS 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 2004 field inventory, and in gathering and analyzing data. NCPN and BRCA 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).

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,

Table 2. Description of data fields used in 2004 Inventory of Invasive Non-Native Plants in Bryce Canyon 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	BRCA	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

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 2004 inventory in Bryce Canyon National Park was conducted from August 8 – August 14 and involved a five-person crew (Table 3). Sites inventoried included Yellow Creek, Sheep Creek Flats, the Mixing Circle, the Pump House, the East Meadows, Tropic Canyon and its side drainages, Water Canyon, Horse Hollow, Mutton Hollow, Corral Hollow, the southwest Park boundary, the two Park campgrounds, the Rim Trail, and the Navajo Loop Trail.

For purposes of planning and data analysis the inventoried lands were divided into 14 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 East Meadows, Sheep Creek Flats,

and the southwest Park boundary were generally open and visibility was good, allowing relatively broad EDSW's (typically 50 to 100 yards). In areas such as stream corridors or where vegetation cover was heavy such as in portions of Tropic Canyon near Glory Cove, EDSW's were usually narrower, 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. In situations of extremely steep or otherwise inaccessible terrain where vegetation could be identified clearly from a distance, crew members sometimes used binoculars to visually scan the area for suspected target species. Daily inventory routes of each crew member were recorded and mapped using the BFP tracking function of the GeoExplorer GPS units. BFP tracking distance settings were adjusted as needed to correspond closely to the EDSW distance for each area.

Each inventoried area within Bryce Canyon 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, 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) in any situation where GPS satellite reception was not possible (such as in narrow canyons) 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 typically 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, line, or polygon). Plants or groups of plants separated by more than 50 yards were mapped as separate infestations. (Refer to definition of PSR.)

Crew members were given 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

Table 3: Invasive plant inventory areas, inventory dates, crew members, and acres inventoried during 2004 in Bryce Canyon National Park.

Area Number	Area Description	Dates Inventoried	Crew Members*	Acres Inventoried**	Corresponding Inset Map Names and Letter Codes ***
1	Sheep Creek Flat Meadows	08/09/04	MB, KA, RR	329	Yellow Creek – D
2	Yellow Creek	08/09/04	BA, HH	134	Yellow Creek – D
3	East Yellow Creek	08/09/04	BA, HH	89	East Yellow Creek – E
4	East Meadows	08/11/04	BA, KA, MB, HH, RR	990	Inspiration Point – B Paria View - C
5	Pump House	08/12/04	BA, MB, HH	77	Inspiration Point - B
6	Mixing Circle, Sunset Campground	08/11/04, 08/12/04	BA, KA, MB, HH, RR	290	Inspiration Point – B
7	North Campground, Visitor Center	08/08/04, 08/12/04	BA, HH	230	Inspiration Point – B
8	Rim Trail	08/13/04	KA	88	Inspiration Point – B
9	Tropic Canyon and associated drainages	08/10/04, 08/13/04	BA, KA, MB, HH, RR	837	Tropic Canyon – A
10	Above Water Canyon	08/13/04	BA, HH	138	Tropic Canyon – A
11	Mutton Hollow, Corral Hollow	08/14/04	BA, MB, HH	253	Yovimpa Point – F
12	Horse Hollow	08/14/04	HH	108	Yovimpa Point - F
13	Southwest Boundary	08/12/04	KA, RR	450	Yovimpa Point - F
14	Navajo Loop Trail	08/13/04	KA, RR	38	Inspiration Point – B
	TOTALS			4051	

* Crew abbreviations: BA = Bridget Atkin, KA = Kim Andersen, MB = Melanie Ballard, RR = Ruth Richards, HH = Hillary Hudson.
** An average of 133.2 acres inventoried per person per 10-hr day in 2004.
*** Indicates the key to mapped areas presented later in Figure 2.

they felt would best represent the situation. However, essentially all infestations within this size range were recorded as point features in Bryce Canyon National Park.

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 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 Bryce Canyon National Park. A Voucher specimen of *Marrubium vulgare* was collected along the southeast side of the road, between the Ranger Station and Bryce Canyon Lodge. A Voucher specimen of *Carduus nutans* was collected in a burned area at the southern end of the East Creek Meadows. Duplicate voucher specimens were processed for deposit in herbaria at USU and Bryce Canyon 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, "A051913.ssf" would be the file name for raw GPS data collected by Kim Andersen beginning in the thirteenth hour (24-hr local time) on May 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 May 19 would be May19-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: May19-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 were created to show the total area inventoried during the 2004 project and the location of smaller-scale (1:30,000) 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 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 the 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 4,051 acres in Bryce Canyon National Park during the summers of 2004 (Table 3), an amount representing approximately 11.3 percent of the entire 35,835-acre Park. An average of 133.2 acres was inventoried per person per 10-hr day in 2004.

The location and size of the fourteen areas inventoried in 2004 are represented in Figure 1. 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 2 serves as an orientation map for the smaller 1:30,000 scale weed-distribution "Inset" maps found in Appendices H and I. Inset maps are distinguished by letters A - F, 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. Six inset maps are required to cover all fourteen inventory areas, and large inventory areas may span over several subunit maps. For example, different sections of the East Meadows (Inventory Area 4) appear on Inspiration Point and Paria View inset maps B and C.

Invasive plants infested a total of 54.098 acres within the mapped areas (Table 4), an amount equal to 1.34 percent of the land inventoried. Of the 12 initial targeted species, crews found only *Bromus inermis*, *Bromus tectorum*, *Carduus nutans*, *Cirsium vulgare*, *Elaeagnus angustifolia*, and *Tamarix ramosissima.* No infestations of *Centaurea diffusa*, *Centaurea maculosa*, *Centaurea repens*, *Centaurea virgata v. squarrosa*, *Cirsium arvense*, or *Onopordum acanthium* were discovered within the 14 inventoried areas. Non-target species found and mapped were *Convolvulus arvensis*, *Dactylon glomeratus*, *Euphorbia esula*, *Halogeton glomeratus*, *Marrubium vulgare*, *Melilotus officinalis*, *Phleum pratense*, *Salsola kali*, *Tragopogon dubius*, and *Verbascum thapsus.*

The most abundant target species found in the Park was *Bromus inermis*. The crew recorded 29.459 acres of this species during the project, 4.236 acres of which were located outside the Park boundary. *Bromus inermis* comprised 57 percent of the total infested acreage inventoried. Infestations of *Bromus inermis* were generally less than 0.1 acres in size, often consisting of dense patches found scattered in open meadows. *Bromus tectorum* was the second most abundant target species found in the Park and comprised approximately 25 percent of the total infested acreage. *Tamarix ramosissima* was the third most common target species, making up 6 percent of the total infested acreage. The remaining infestations (12 percent of the total infested acreage) consisted of the other three targeted species and the ten additional non-native species that were mapped.

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

Table 4: Acres infested by invasive plant species within inventoried areas of Bryce Canyon National Park and adjacent lands in 2004.

Species	Infested Acres (Inside Park)	Infested Acres (Outside Park)	Total
Bromus inermis	25.223	4.236	29.459
Bromus tectorum	4.902	8.111	13.013
Carduus nutans	0.003	---	0.003
Cirsium vulgare	0.009	---	0.009
Convolvulus arvensis	0.122	---	0.122
Dactylis glomerata	0.129	---	0.129
Elaeagnus angustifolia	0.002	0.253	0.255
Euphorbia esula	---	1.000	1.000
Halogeton glomeratus	0.001	---	0.001
Marrubium vulgare	0.101	---	0.101
Melilotus officinalis	3.961	---	3.961
Phleum pratense	0.122	---	0.122
Salsola kali	2.130	0.002	2.132
Tamarix ramosissima	0.420	2.792	3.212
Tragopogon dubius	0.332	0.003	0.335
Verbascum thapsus	0.244	---	0.244
Totals	**37.701**	**16.397**	**54.098**

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 *Convolvulus arvensis, Marrubium vulgare, Euphorbia esula, Verbascum thapsus,* and *Phleum pratense*. Because not all crew members may have chosen to map *Dactylon glomeratus, Halogeton glomeratus, Melilotus officinalis, Salsola kali, Tragopogon dubius,* the acreage values and corresponding distribution maps for these species should be considered to represent sample surveys rather than complete inventories.

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 Bryce Canyon National Park. Following is a summary of the weed situation within individual inventory units of Bryce Canyon National Park.

Sheep Creek Flats (Area Number 1; Inset Map D)

The inventoried area in the Sheep Creek Cooperative Demonstration Area was fairly open, consisting primarily of a mixture of grassland fields and juniper woodlands. Some grassland areas were composed of a mixture of *Artemesia tridentata* and native grasses, but the majority of the fields were comprised of *Agropyron cristatum*. The inventoried fields were surrounded by juniper-covered hills that served as the borders for the unit. *Tamarix ramosissima* was the only

Figure 1. Identification number and acreage of individual areas inventoried for non-native invasive plant species in Bryce Canyon National Park during 2004.

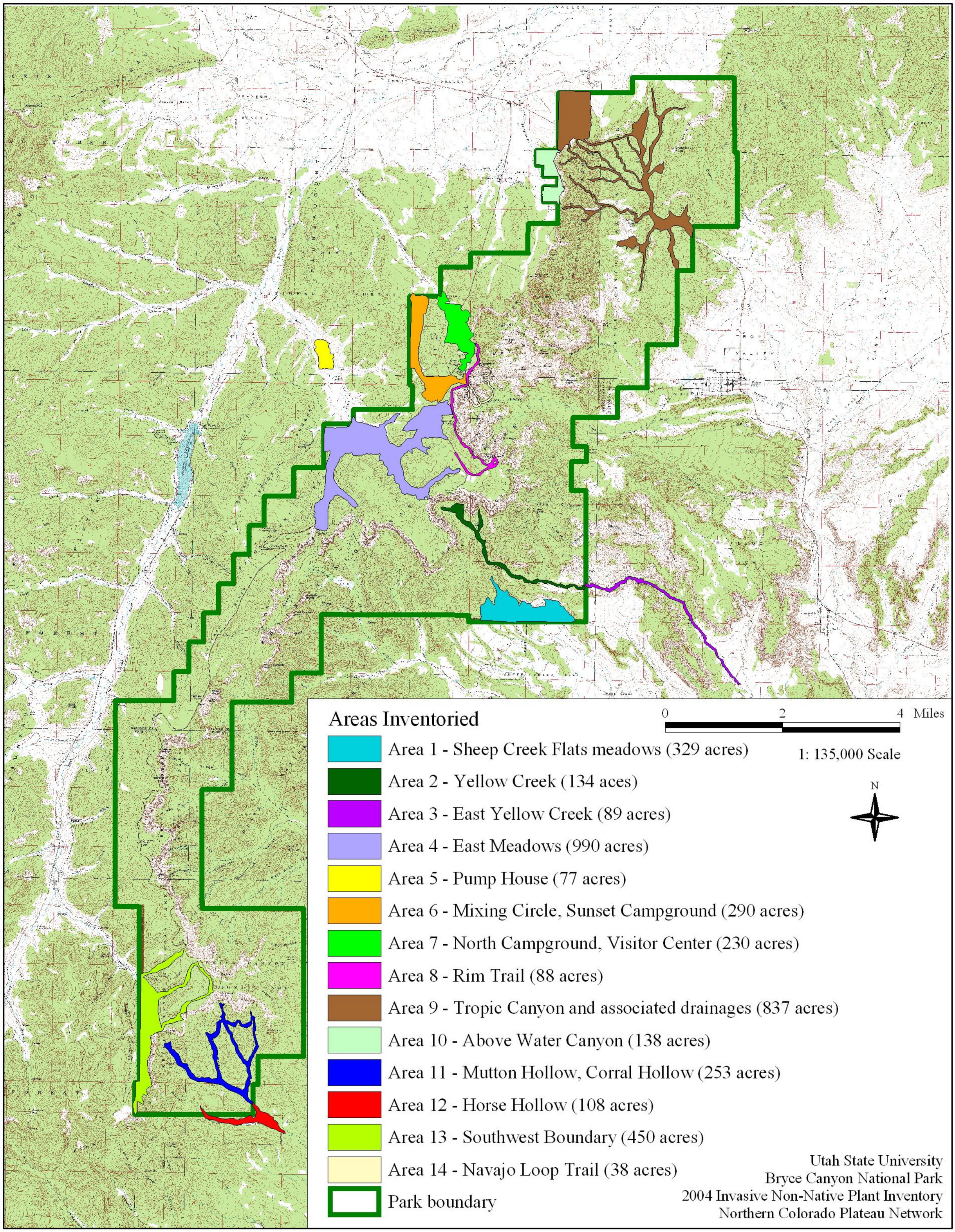
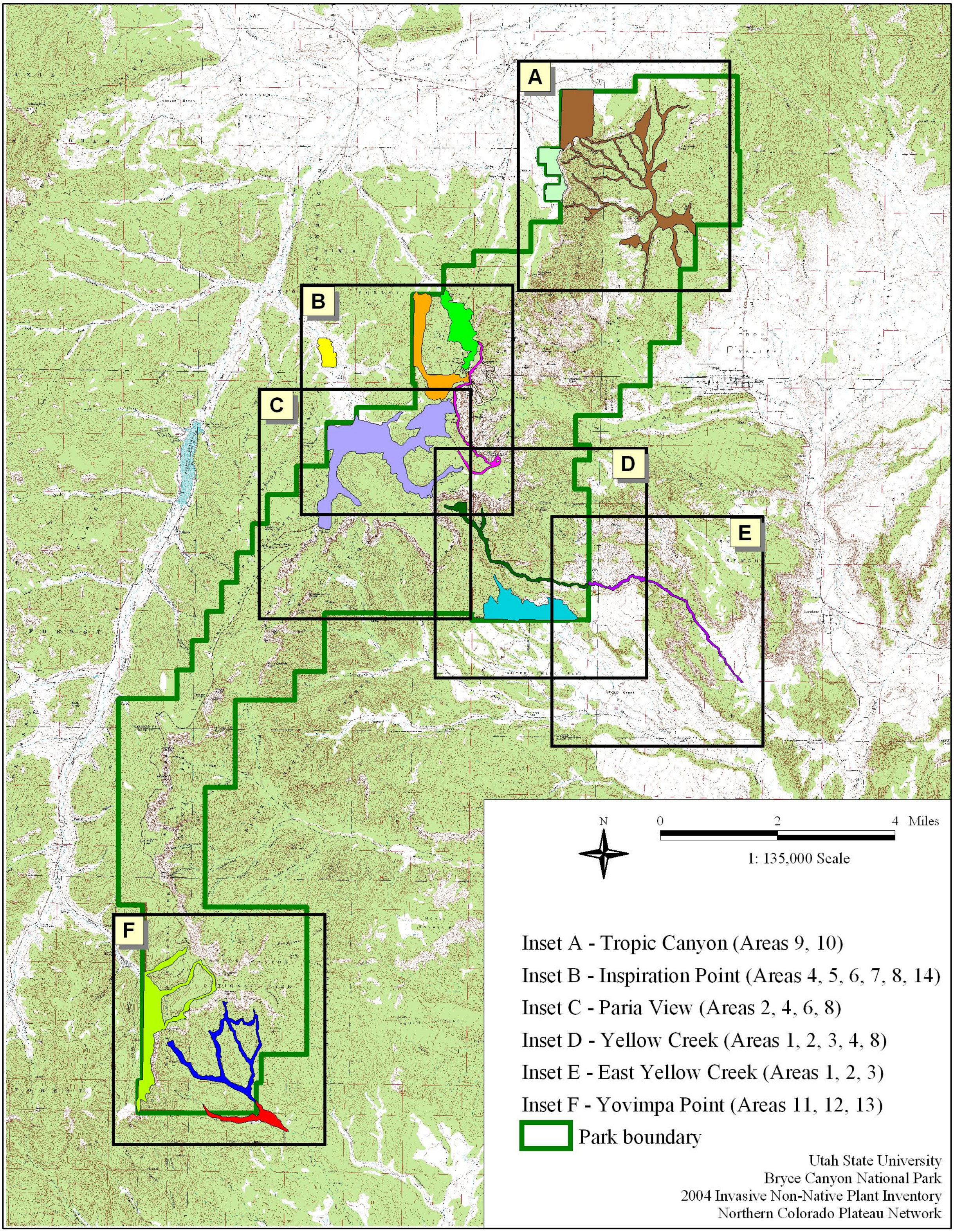


Figure 2. Insets indicating the location, letter code, and name of the six 1:30,000 scale maps used in Appendix tables to show weed distribution within individual inventoried areas.



target species found in this unit. Two saplings were found near the southeast corner of the Park boundary, in an ephemeral creek bed that feeds into Sheep Creek. Non-target species found and mapped in this area were *Salsola kali* and *Tragopogon dubius*. *Salsola kali* was found along the base of the hills bordering the western edge of the fields. A single point of *Tragopogon dubius* was mapped in this general area. Weedy species not mapped but observed included *Agropyron cristatum, Chenopodium album,* and *Lactuca serriola*. *Agropyron cristatum* dominated much of the inventory area and was likely seeded for possible forage, as much of the area had evidence of grazing. Grazing appeared to be the only obvious disturbance in this inventory unit. It was noted that the Park's boundary fence was down along the entire length of the inventory area.

Visibility was generally very good and the crew was confident of finding 90 percent or more of all 0.01-acre infestations of the targeted species in this inventory area. The area inventoried was assigned an ecological status of three as a result.

Yellow Creek (Area Numbers 2, 3; Inset Maps D, E)

Yellow Creek begins approximately three miles inside the Park at Yellow Spring and continues east beyond the Park for several miles. The crew began their inventory at the head of Yellow Creek and continued to approximately one mile outside the Park boundary. The primary weedy species found was *Tamarix ramosissima*, but a striking contrast was noted between its abundance inside and outside the Park. Inside the Park a few infestations of *Tamarix ramosissima* were found scattered along about a half-mile stretch of creek bottom beginning approximately 1.5 miles downstream from Yellow Spring. Those infestations were small in size and consisted of mostly seedlings that showed some signs of treatment. However, *T. ramosissima* infestations became abundant, beginning directly at the Park boundary and forming a nearly continuous band along the lower portions of Yellow Creek. Individual infestations outside the Park ranged in size from 0.001 acres to 0.25 acres and were a mixture of saplings and mature trees.

A single infestation of *Cirsium vulgare* was found within the Park boundary approximately 1.5 miles downstream from Yellow Spring. This infestation consisted of only a few plants and appeared to have been treated.

No other target species were found inside the Park, but several infestations of *Elaeagnus angustifolia* were discovered along a 1-mile stretch of Yellow Creek, beginning less than 200 yards beyond the border. These infestations consisted of mature trees ranging in size from 0.001-acre to 0.25 acres. No signs of treatment were evident. Two 0.001-acre patches of *Salsola kali* also were found along the same section of creek bottom, and a single 0.001-acre patch of *Bromus tectorum* was observed just a few yards outside the Park boundary.

A relatively dense 1-acre patch of *Euphorbia esula* was mapped near Yellow Creek, approximately 3 miles downstream of the Park boundary. A private land owner took the crew to this patch because of concern for its high potential to spread into the Park and other adjacent lands. Cooperative efforts to periodically search the Yellow Creek area for additional infestations of *Euphorbia esula* should be a Park priority.

Non-target species observed but not mapped include *Melilotus officinalis, Tragopogon dubius,* and *Lactuca serriola*. The crew noted that *Melilotus officinalis* was continuous along Yellow Creek outside the Park boundary, but infestations quickly diminished inside the Park.

Visibility was generally good in this unit, and crews felt confident of finding 90 percent or more of all 0.01-acre infestations of the targeted species. Disturbances noted were from flash flooding of Yellow Creek and from cattle. There was evidence of cattle entering the Park through downed fences. The portion of Yellow Creek inside the Park boundary was assigned an ecological status of two while the portions of Yellow Creek outside the Park boundary were assigned a level three.

East Meadows (Area Number 4; Inset Maps B, C)

The meadows along the main road between Inspiration Point and East Creek were included in this inventory unit. The area consisted primarily of open grasslands bordered by ponderosa pine woodlands. The primary target species present was *Bromus inermis*. The majority of *Bromus inermis* was found within 100-200 yards of the main road and appeared to occur as broad strips paralleling the east side of the road. It also was found occasionally on the west shoulder of the road, following East Creek. Due to its apparent non-random distribution, it is suspected to have been either intentionally seeded, or the result of a contaminated reseeding mix.

Three other target species were discovered in the East Creek meadows. A single patch of *Carduus nutans* was found along the road to Bryce Point in a recently burned area. *Carduus nutans* was found at the southern finger of the East Meadows on the south side of a maintenance road. A single patch of *Cirsium vulgare* also was found along this maintenance road. A patch of *Bromus tectorum* was discovered on the east shoulder of the main road.

Two non-target species were recorded in the meadows. A large amount of *Tragopogon dubius* was found along the road shoulder, although each point typically consisted of only 1-2 plants. *Salsola kali* also was found occasionally along the shoulder of the main road. Other non-native species noted but not inventoried include *Lactuca serriola, Agropyron cristatum,* and *Polygonum aviculare.*

The meadows overall were relatively weed-free and the native vegetation appeared to be fairly intact. Visibility was very good and crews were confident of finding 90 percent or more of all 0.01-acre infestations of the targeted species. Disturbances included recent burns and ongoing road construction. Most of the weedy species inventoried were found relatively close to the road shoulder. The area was given an ecological status rating of two.

Pump House (Area Number 5; Inset Map B)

The Pump House unit lies west of Bryce Canyon National Park along East Creek. *Bromus inermis* was the primary species found in this area. It was particularly thick south of the well along the Forest Service road. The crew also noted that *Bromus inermis* occurred almost continuously along the Forest Service road between the pump house and the Park boundary at the Mixing Circle group site (not mapped). Although not a target species, a small amount of *Tragopogon dubius* was mapped below the well site.

Crews were confident of finding at least 90 percent of all 0.01-acre infestations of the targeted species within the inventoried area. Little disturbance was noted except for the flow of water through East Creek. The area was assigned a level-two for ecological status.

Mixing Circle, Campgrounds, Visitor Center (Area Numbers 6, 7; Inset Map B)
The areas around the Visitor Center, North Campground, Sunset Campground, and Mixing Circle group sites, as well as portions of the Bryce Canyon Lodge, were inventoried due to their high visitor use and constant disturbance. The primary species found in the two campgrounds was *Bromus inermis*. Only two small infestations of *Bromus inermis* were founding the Sunset Campground, but several infestations were found west of the North Campground (primarily along the road shoulder). *Bromus inermis* was also found at the sewage disposal ponds. A single patch of *Convolvulus arvensis* and a single patch of *Tragopogon dubius* were also discovered west of the North Campground, again along the road shoulder. A single patch of *Carduus nutans* was observed growing amid the sagebrush behind the Visitor Center. The infestation consisted of only 2 rosettes, which were pulled upon discovery.

Relatively few target species were noted in the Mixing Circle group site. Two patches of *Bromus tectorum* were found north of the campsites along edges of the nearby meadow. A patch of *Bromus inermis* also was found in that meadow. A patch of *Salsola kali* was mapped south of the maintenance area.

Bromus inermis and *Bromus tectorum* were found around the Bryce Canyon Lodge and Ranger Station. *Dactylis glomeratus* was noted along the road shoulder between the Lodge and the camp store. A patch of *Marrubium vulgare* was discovered on the road shoulder across the street from the historic gas station. Sites around the Lodge and associated buildings were not inventoried as intensively as other areas, and it is likely that other weedy species occur there. The USU mapping crew will revisit these sites in 2005.

All of these areas receive a high amount of human disturbance. Road construction also contributes a large amount of disturbance. Visibility was generally good in all inventoried areas and the crew was confident of finding 90 percent or more of all 0.01-acre infestations of the targeted weedy species. Although highly disturbed, the area was assigned a level-two ecological status overall due to a relatively low abundance of weedy species.

Rim Trial, Navajo Loop Trail, Queen's Garden Trail (Area Numbers 8, 14; Inset Map B)
The Rim Trail and Navajo Loop Trail were chosen for inventory due to their heavy human use and consequentially high likelihood of invasive plant introductions. Surprisingly, no target species were found along the Navajo Loop trail or the Queen's Garden Trail. There were several native thistles along the Navajo Loop Trail and Queen's Garden Trail that could be confused for weedy thistles. The Rim Trail was inventoried from Sunrise Point to Bryce Point. A single patch of *Bromus inermis* was found on the Rim Trail just north of Sunset Point. The patch was pulled upon discovery. No other target species were found along the trail. Although not mapped, there were several small patches of *Agropyron cristatum* along the trail.

Visibility was excellent along the trails and crews were confident of finding 90 percent or more all 0.01-acre or larger infestations of the targeted species. The trails are used heavily by people and some pack animals. All three trails were assigned a level-one ecological status.

Tropic Canyon and Associated Drainages (Area Numbers 9, 10; Inset Map A)

Tropic Canyon is a large drainage system with several side canyons. Highway 12 passes through much of the drainage. Included in this inventory area are Little Henderson Canyon, Tropic Canyon, Water Canyon, Glory Cover, and Jolly Hollow. This was the weediest of all areas inventoried in 2004. The primary species found was *Bromus inermis* which occurred almost continuously consistently along the highway shoulder from Park boundary to Park boundary. It also was found along the west Park fenceline north of the highway, and along the fenceline near Shinglemill Swale and the irrigation ditch that feeds into Water Canyon. *Bromus tectorum* was the second most common species, found primarily along Highway 12. Most infestations were found directly on the road shoulder. Patches of *Bromus tectorum* also occurred in the northwest corner of the Park above Highway 12.

Tamarix ramosissima was found scattered along the wash in the main drainage paralleling Highway 12. All infestations except one were found in Water Canyon, or in Tropic Canyon below its junction with Water Canyon. Most infestations consisted of single mature trees.

Three separate infestations of *Cirsium vulgare* were mapped. Two infestations were found occurring at Glory Cove along the irrigation canal. A third infestation was found in Water Canyon, just inside the Park boundary. These infestations typically consisted of 1-2 plants each, and all were pulled upon their discovery.

Two separate infestations of *Elaeagnus angustifolia* were found below Glory Cove along the irrigation canal. Each infestation consisted of a single tree -- one mature and one a sapling. Each infestation had previously been treated, but had resprouted at the time of the inventory.

Several non-target species were mapped in this inventory area. *Melilotus officinalis* was prevalent along the main wash in Tropic Canyon from the eastern Park boundary up into Little Henderson Canyon. Due to its near continuous occurrence along the wash, it was mapped as a linear feature. It also was found continuously along the irrigation canal from the eastern Park boundary to the junction of the main wash and Water Canyon. Isolated infestations were found in the heads of Water Canyon and Tropic Canyon, as well as along upper portions of Highway 12.

Salsola kali was found frequently along the road shoulder of Highway 12. Infestations of *Salsola kali* were often directly on the road shoulder or within 10 yards of it. Most infestations were small, ranging in size from 0.001 to 0.1 acres in size. *Convolvulus arvensis* and *Dactylon glomeratus* were found along the road shoulder of Highway 12 as well. *Tragopogon dubius* was noted along Highway 12 and in Water Canyon. A single patch of *Halogeton glomeratus* was observed on the highway road shoulder above the head of Tropic Canyon. A single patch of *Marrubium vulgare* was found in the main wash at a spring below the junction of Jolley Hollow and Tropic Canyon's main wash. Species noted but not mapped include *Lactuca serriola, Polygonum aviculare,* and *Chenopodium album*.

Although the Tropic Canyon drainage system is one of the weediest in all of the 2004 NCPN inventories, it is important to note that the majority of weeds were found along Highway 12. Away from the highway the drainages had good stands of native vegetation including willow, cottonwood, wild rose, sagebrush, juniper, and rabbitbrush. Visibility was generally good in all places except along the irrigation canal near Glory Cove. The willows along this portion of the Canyon were very thick and difficult to inventory completely. It is likely that the crew missed some target species associated with the canal; however, crews were confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species in the overall inventory area. Disturbances include vehicle traffic and flooding along the washes within the drainage system. An overall ecological status of three was assigned; although excluding Highway 12, the remaining area probably has an ecological status closer to two.

Southern Park boundary (Area Number 13; Inset Map F)

The inventory area at the southwest corner of the Park contains a variety of habitats. The head of Podunk Creek is a small marshy meadow bounded by large steep hills covered by ponderosa pine and Douglas fir on the west and east. The meadow contained several weedy species. Two infestations of *Cirsium vulgare* were found in the bottom of the meadow at seeps near the Park boundary. Both were pulled upon discovery. *Cirsium vulgare* was also discovered in a side drainage below the road leading to Rainbow Point. The drainage in which these two infestations were found had recently been burned.

Bromus inermis was found scattered throughout the meadow, primarily along the road that runs along the meadow's east edge. Five infestations of *Phleum pratense,* ranging in size from 0.001 to 0.1 acres, were discovered along the road shoulder.

A few non-targeted species were found and mapped in this area. *Verbascum thapsus* was observed on the hills between Podunk Creek and the road to Rainbow Point. Each infestation occurred in an area that had recently burned. *Tragopogon dubius* was found scattered throughout the marshy meadow as well as in a side drainage feeding into Podunk Creek. *Dactylis glomeratus* was scattered lightly in a drainage above Podunk Creek. Two small infestations of *Melilotus officinalis* were found along the road running through the inventory area. Species noted but not mapped include *Lactuca serriola* and *Chenopodium album*. No weedy species were found on the hills to the west of Podunk Creek.

Visibility tended to be good in all areas and crews were confident of finding at least 90 percent of all 0.01-acre infestations of the targeted species. The majority of infestations recorded were 0.001 acres in size and the native plant community appeared to be intact throughout much of the inventoried area. The meadow was full of various native grasses and sedges, and the surrounding hillsides were comprised of only native shrubs and trees. A recent fire was the only obvious disturbance in the area. The inventoried area was assigned an ecological status of two.

Mutton Hollow and Corral Hollow (Area Number 11, Inset Map F)

This inventory area included the drainages from Yovimpa Pass to the Park boundary including Mutton Hollow and Corral Hollow. Several plants of *Verbascum thapsus* were found at Riggs Springs as well as a single patch of *Bromus tectorum*. No targeted species were observed

between Yovimpa Pass and Riggs Springs. No target species were found in Mutton Hollow, but one patch of *Bromus inermis* was found at the junction between Corral Hollow and Lower Podunk Creek near the Park boundary.

The drainages were relatively dry and visibility was generally good. Crews were confident in finding all 0.01-acre or larger infestations of the targeted species. No obvious disturbances were noted in these drainages. An ecological status level two was assigned to the area.

Horse Hollow (Area Number 12; Inset Map F)

The majority of Horse Hollow lies outside the Park boundary but it was inventoried because it crosses into the Park at its southern tip and serves as a pack trail route. No weedy species were noted in Horse Hollow inside the Park boundary. However, the lower half of Horse Hollow outside the Park was lined with *Bromus tectorum*. Infestations of *Bromus tectorum* ranged in size from 0.1 to 1 acre in size, but the majority were in the 0.5-acre category. Infestations stretched from the junction with Lower Podunk Creek to within a quarter-mile of the Park's boundary. Although it did not appear to be actively spreading out of the wash, it has great potential to spread into the Park. Although it was not mapped, *Chenopodium album* also was found in the wash.

Visibility was generally good, and the crew was confident of having found all 0.01-acre infestations of the targeted species. No obvious disturbances were noted along the wash. The overall area was assigned an ecological status of three due to the abundance of *B. tectorum*.

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 Bryce Canyon 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 Bryce Canyon 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, sites of *Elaeagnus angustifolia* as well as several sites of *Tamarix ramosissima* had been previously treated, and infestations had simply resprouted.

If it does not already exist, the Park is urged to develop a comprehensive written management plan for invasive plant species in BRCA, 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 Bryce Canyon 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. USU plans to continue its inventorying efforts in Bryce Canyon National Park in 2005. 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, Bryce Canyon 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, Bryce Canyon 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 Bryce Canyon National Park would mean that species such as *Carduus nutans*, *Cirsium vulgare*, *Convolvulus arvensis*, *Marrubium vulgare*, *Phleum pratense*, and *Verbascum thapsus* should be given the highest control priority of the species mapped, and should be targeted for prompt Park-wide eradication. The small infestations of *Tamarix ramosissima* and *Elaeagnus angustifolia* in Tropic Canyon and the infestations of *Tamarix ramosissima* in Yellow Creek and Sheep Creek should continue to be the objects of eradication efforts. *Salsola kali* probably fits best into the second priority category of "contain and reduce" in some portions of the Park, but also could be a candidate for eradication in other areas. For example, *Salsola kali* was prevalent along Highway 12 in Tropic Canyon and probably beyond feasibility of eradication there, at least in the near term. But it was relatively rare along the main road in the East Creek meadows, and could be eliminated from that area. Plants that we would place in the third management category (lowest priority) include *Bromus tectorum* and *Bromus inermis*, both of which were widespread throughout the Park.

The Park will likely need additional inventory information before deciding in which management category to place *Tragopogon dubius*, *Chenopodium album*, *Dactylon glomeratus*, *Halogeton glomeratus*, *Lactuca serriola*, *Melilotus officinalis*, and *Polygonum aviculare*. 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 Bryce Canyon 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 989,950 per year visit Bryce Canyon 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 weed species inventoried in Bryce Canyon National Park were found along roadways. 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 at the heads of otherwise non-infested drainages could prevent rapid spread associated with flowing streams or flash flood events. For example, the control of *Tamarix ramosissima* at the head of Water Canyon could prevent new infestations from appearing throughout the remainder of that otherwise uninfested canyon. Traditional annual migration routes of deer, elk, or other large animals should be considered a high-probability area for weed seed transport and introduction.

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 Bryce Canyon National Park, 88.7 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 BRCA 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 23 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 Bryce Canyon 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).

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Appendix Tables and Figures

Appendix A. Crew Qualifications and Project Quality Assurance for the 2004 Invasive Non-native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-Native Plant Inventory in Bryce Canyon 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 2004 Invasive Non-native Plant Inventory, Bryce Canyon 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 2004 Invasive Non-native Plant Inventory, Bryce Canyon 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 Bryce Canyon National Park During the 2004 Invasive Non-native Plant Inventory.

Weeds Detected



Figure 1. *Bromus tectorum* found on the road shoulder near the campground store, BRCA PR-32.



Figure 2. *Bromus tectorum* on road shoulder, BRCA PR-32.



Figure 3. *Bromus tectorum* along road shoulder, BRCA PR-32.



Figure 4. *Bromus inermis* in the East Creek meadows, BRCA PR-17.

Weeds Detected



Figure 5. *Bromus inermis* along road construction in the East Creek meadows, BRCA PR-19.



Figure 6. *Bromus inermis* in the East Creek meadows BRCA PR-18.



Figure 7. *Bromus inermis* along the East Creek meadows, BRCA PR-17.



Figure 8. *Bromus inermis* along meadows in East Creek area.

Weeds Detected



Figure 9. *Marrubium vulgare* on road shoulder near the camp store, BRCA PR-33.



Figure 10. *Marrubium vulgare* on road shoulder near the camp store, BRCA PR-33.



Figure 11. Landscape view of *Marrubium vulgare* on road shoulder, BRCA PR-33.



Figure 12. *Carduus nutans* found in burn near Bryce Point, BRCA PR-31.

Weeds Detected



Figure 13. *Carduus nutans* found in burn near Bryce Point, near BRCA PR-31.



Figure 14. *Carduus nutans* in recent burn, BRCA PR- 31.



Figure 15. *Cirsium vulgare* found in Tropic Canyon, BRCA PR-4.



Figure 16. *Cirsium vulgare* found along canal banks in Tropic Canyon, BRCA PR-4.

Weeds Detected



Figure 17. *Verbascum thapsus* found in recent burn near Yovimpa Point, BRCA PR-25.



Figure 18. *Verbascum thapsus* in recent burn near Yovimpa Point, BRCA PR-25.



Figure 19. *Salsola kali* below road cut in Tropic Canyon, BRCA PR-9.



Figure 20. *Salsola kali* on road shoulder in Tropic Canyon, BRCA PR-9.

Weeds Detected



Figure 21. *Phleum pratense* found in Podunk Creek, BRCA PR-34.

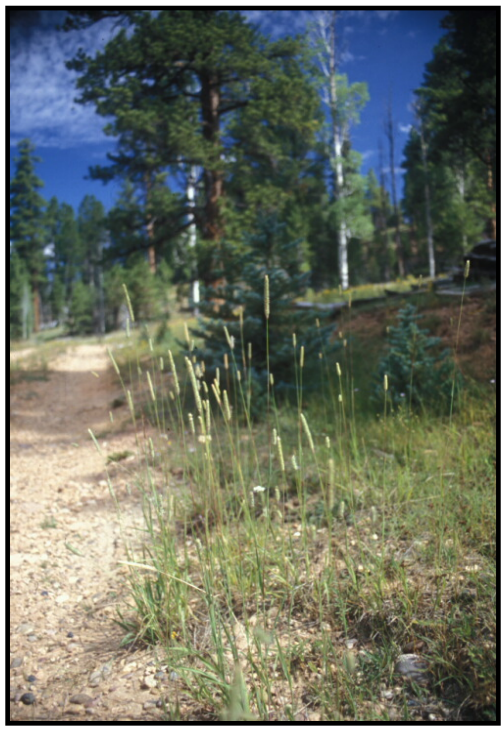


Figure 22. *Phleum pratense* along road in Podunk Creek, BRCA PR-34.



Figure 23. *Phleum pratense* in flower, Podunk Creek.



Figure 24. *Phleum pratense* along road in Podunk Creek, near BRCA PR-34.

Bryce Canyon Landscapes



Figure 25. Inventoried fields at Sheep Creek Flats, BRCA PR-1.



Figure 26. Inventoried hillsides in Sheep Creek Flats.



Figure 27. Inventoried hills and valley in Sheep Creek Flats, BRCA PR-2.



Figure 28. Sheep Creek Flats inventory area and Park boundary, BRCA PR-3.

Bryce Canyon Landscapes



Figure 29. Inventoried wash in Tropic Canyon, BRCA PR-5.



Figure 30. Looking southwest over the Tropic Canyon inventory area, BRCA PR-8.



Figure 31. Mouth of Water Canyon above Highway 12.



Figure 32. Looking into the mouth of Water Canyon, BRCA PR-10.

Bryce Canyon Landscapes



Figure 33. Looking up Tropic Canyon from the mouth of Water Canyon, BRCA PR-11.



Figure 34. Looking down Tropic Canyon from the mouth of Water Canyon, BRCA PR-11.



Figure 35. Inventoried area in Jolley Hollow, BRCA PR-13.



Figure 36. Looking down Jolley Hollow towards Tropic Canyon, BRCA PR-14.

Bryce Canyon Landscapes



Figure 37. Looking down Jolley Hollow, BRCA PR-15.



Figure 38. Inventoried road shoulder of Highway 12 near the mouth of Water Canyon.



Figure 39. Looking into the Amphitheater from the Rim Trail.



Figure 40. Inventoried fields in the East Creek meadows, near BRCA PR-17.

Bryce Canyon Landscapes



Figure 41. Inventoried fields in the East Creek meadows, BRCA PR-18.



Figure 42. East Creek meadows inventory area, BRCA PR-21.



Figure 43. Inventoried area at the head of Podunk Creek, BRCA PR-22.



Figure 44. Inventoried marsh in Podunk Creek, BRCA PR-23.

Bryce Canyon Landscapes



Figure 45. Looking south in Podunk Creek, BRCA PR24.



Figure 46. Yovimpa Point after summer storm, BRCA PR-26.



Figure 47. Lower Podunk Hollow, Corral Hollow, and Horse Hollow, BRCA PR-27.



Figure 48. Road leading to Yovimpa Pass near Podunk Creek.

Bryce Canyon Landscapes



Figure 49. Inventoried area in a recent burn along the Rim Trail, BRCA PR-29.



Figure 50. Rim Trail running along the edge of the canyon to Inspiration Point and Bryce Point.



Figure 51. Looking into Bryce Canyon from Bryce Point at trails to be inventoried in 2005, BRCA PR-30.



Figure 52. Inventory area along the Rim Trail, BRCA PR-28.

Crew

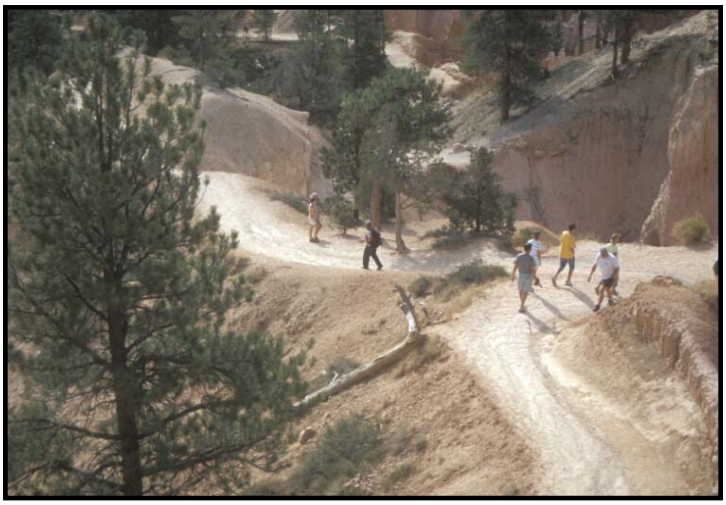


Figure 53. Ruth Richards inventorying the Queen's Garden Trail.



Figure 54. Ruth Richards, Hillary Hudson, Bridget Atkin, and Melanie Ballard during a morning planning meeting in the East Creek meadows.

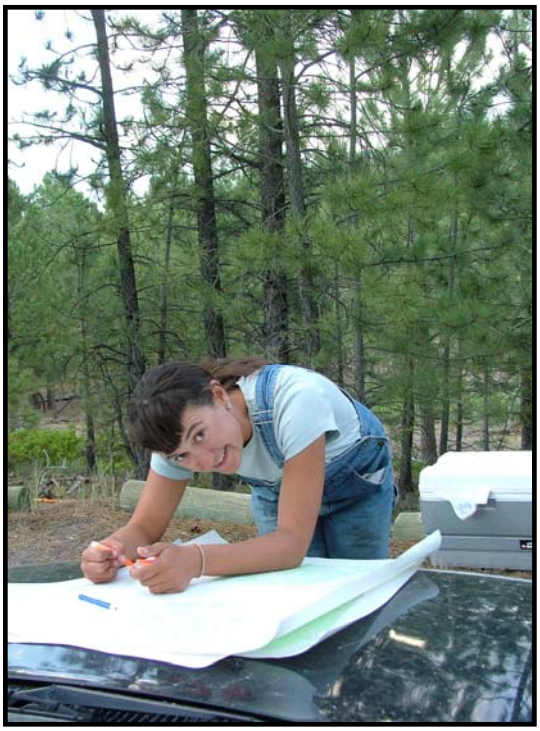


Figure 55. Hillary Hudson marking her inventoried area on the map at the end of the day.

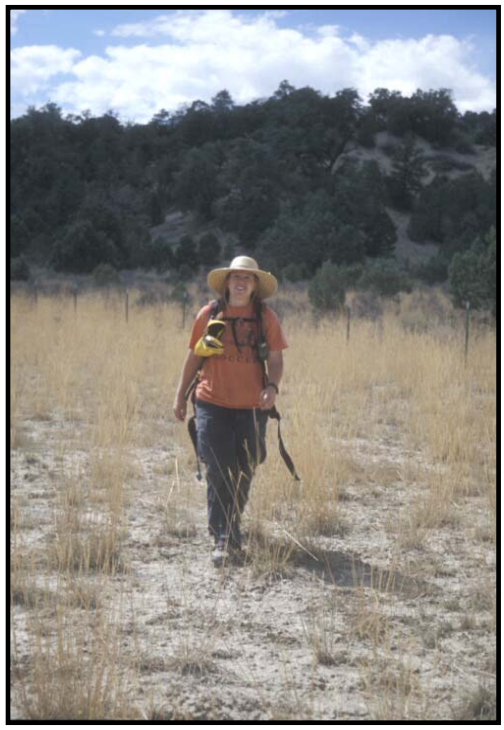


Figure 56. Ruth Richards inventorying the Sheep Creek Flats area.

Crew



Figure 57. Hillary Hudson looking at the maps for the upcoming day's work.



Figure 58. Melanie Ballard and Hillary Hudson hiking up Riggs Springs Trail.

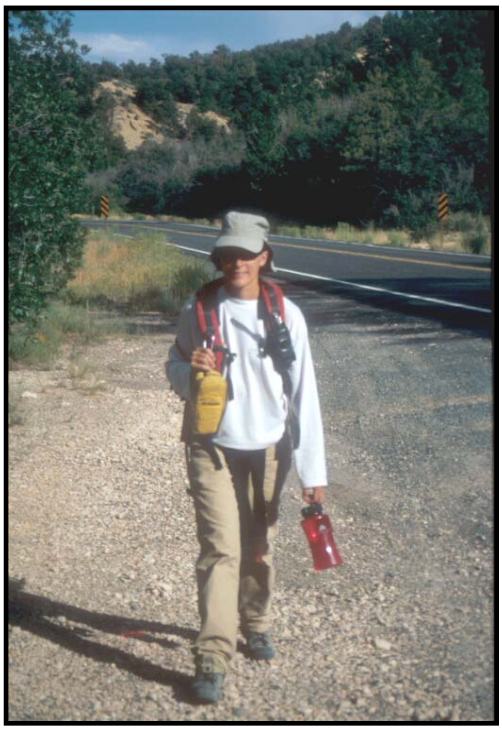


Figure 59. Melanie Ballard inventorying along Highway 12 in Tropic Canyon.



Figure 60. Bridget Atkin and Hillary Hudson at the Riggs Springs Trail.

Crew

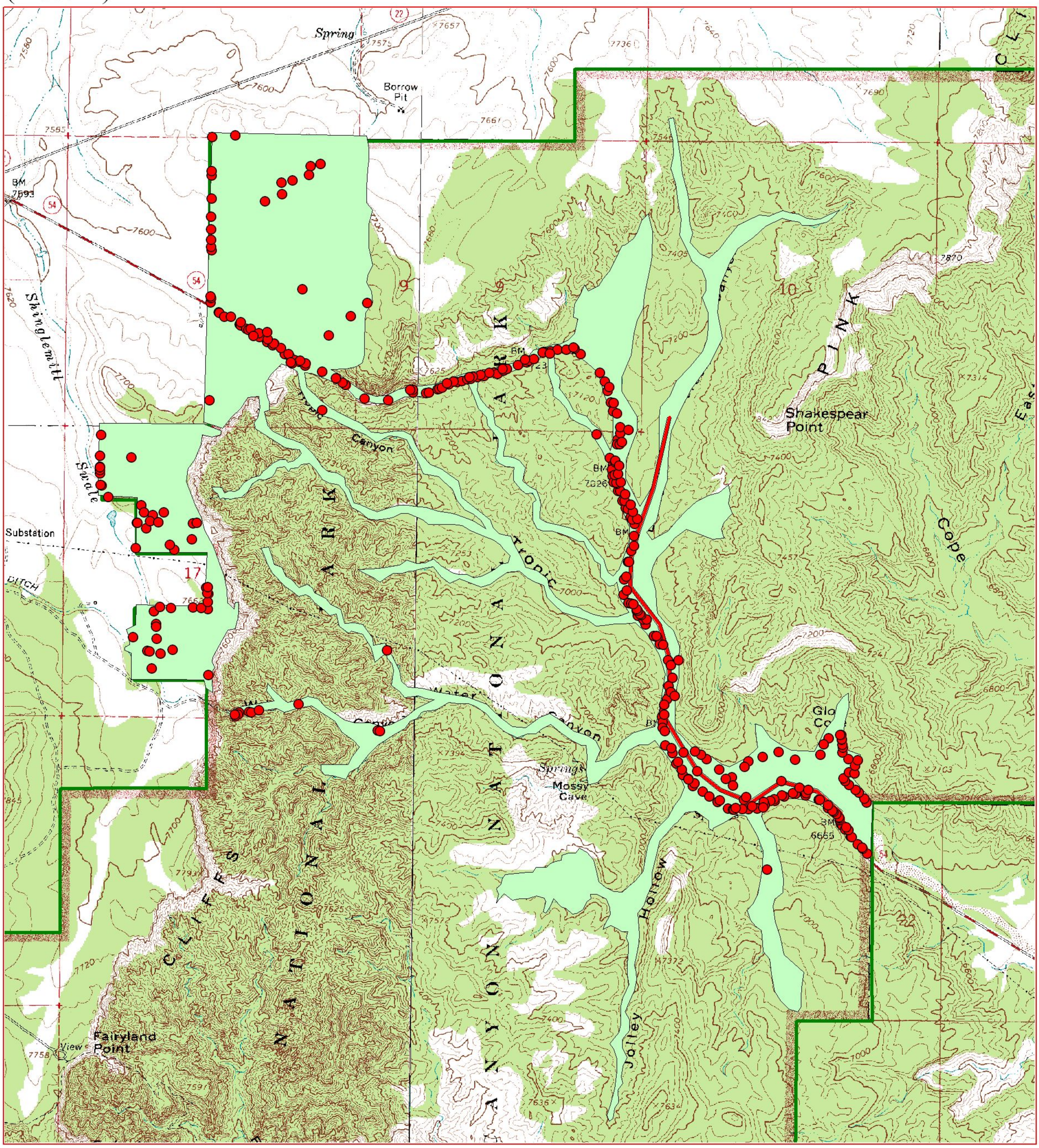


Figure 61. Ruth Richards mapping along the road in the East Creek meadows.



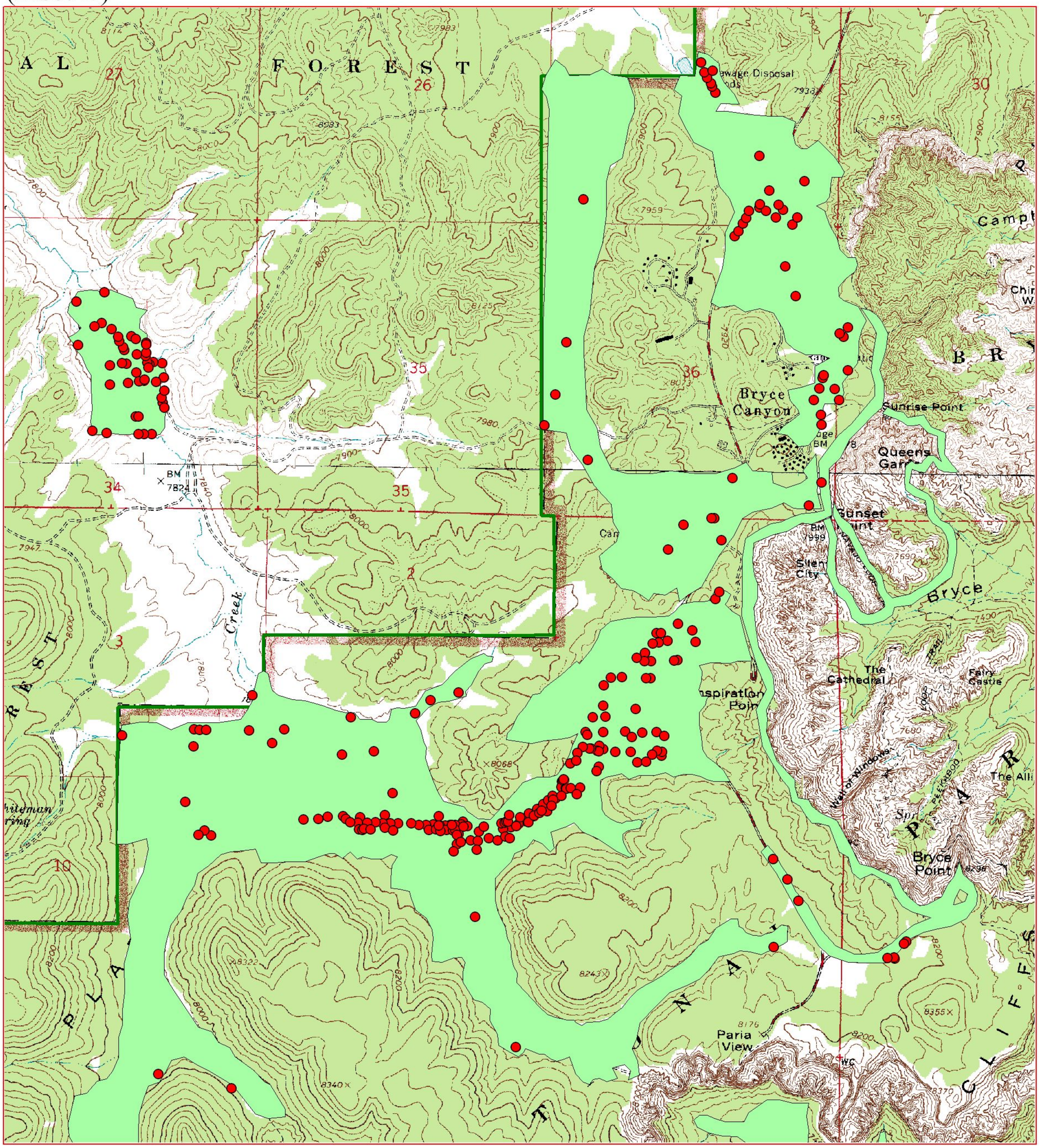
Figure 62. Ruth Richards carrying *Carduus nutans* found and pulled in the East Creek meadows.

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

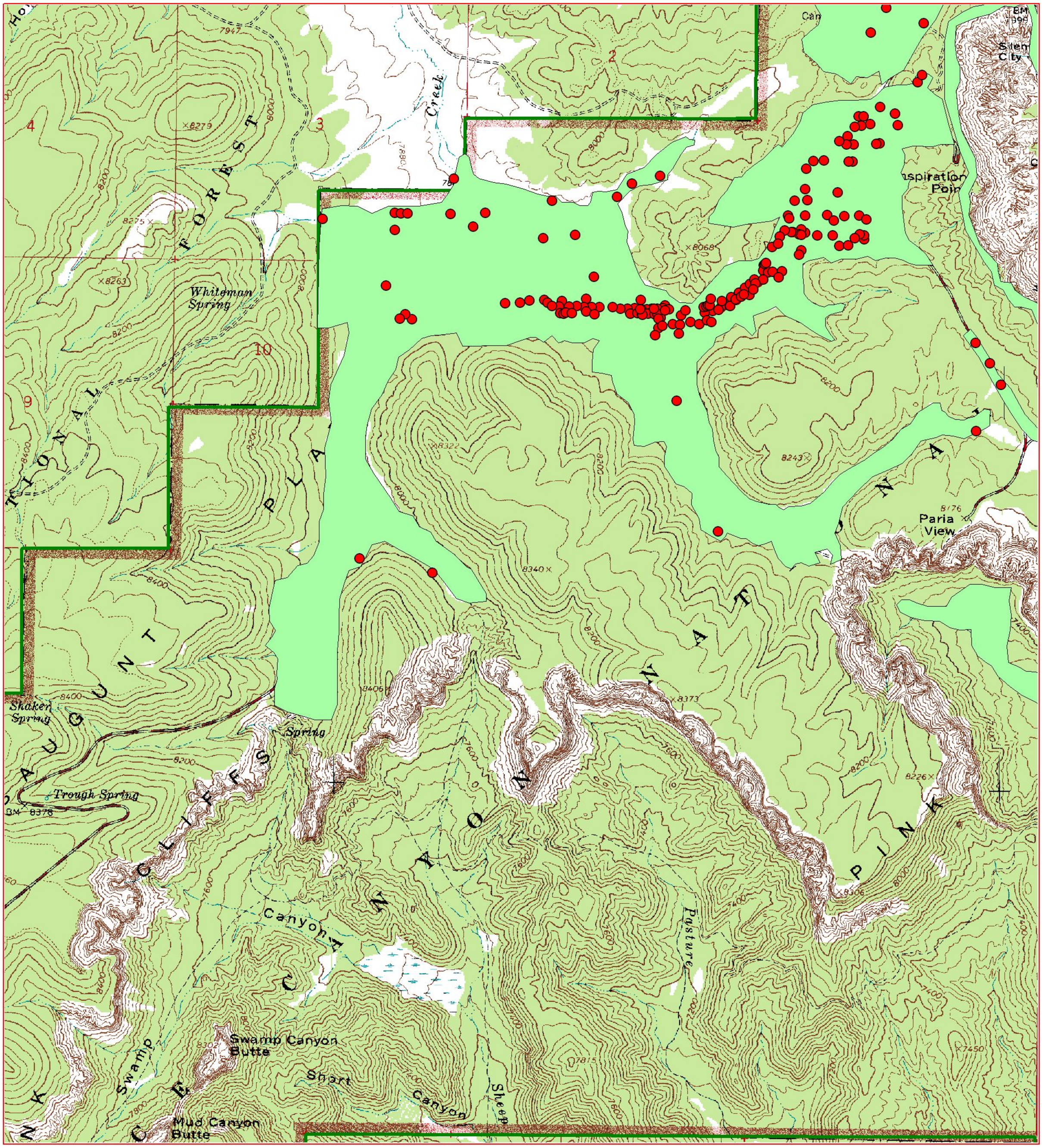


Inset A
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

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



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



0 0.5 1 Miles

Weed Points

Inventoried Area

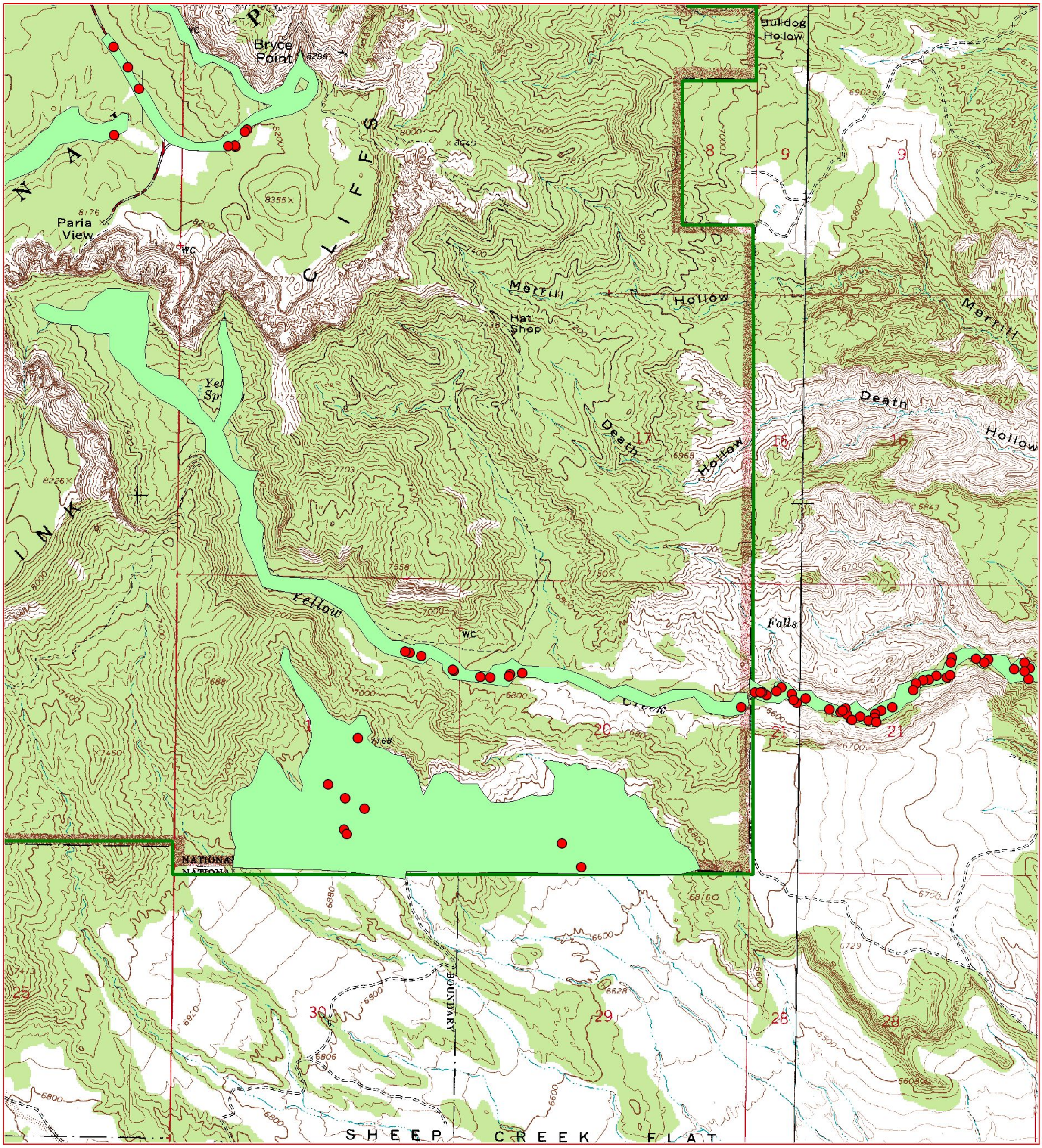
Park Boundary

N

1:30,000 Scale

Inset C
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Yellow Creek (Inset D)



Inset D
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - East Yellow Creek (Inset E)



0 0.5 1 Miles

Weed Points

Inventoried Area

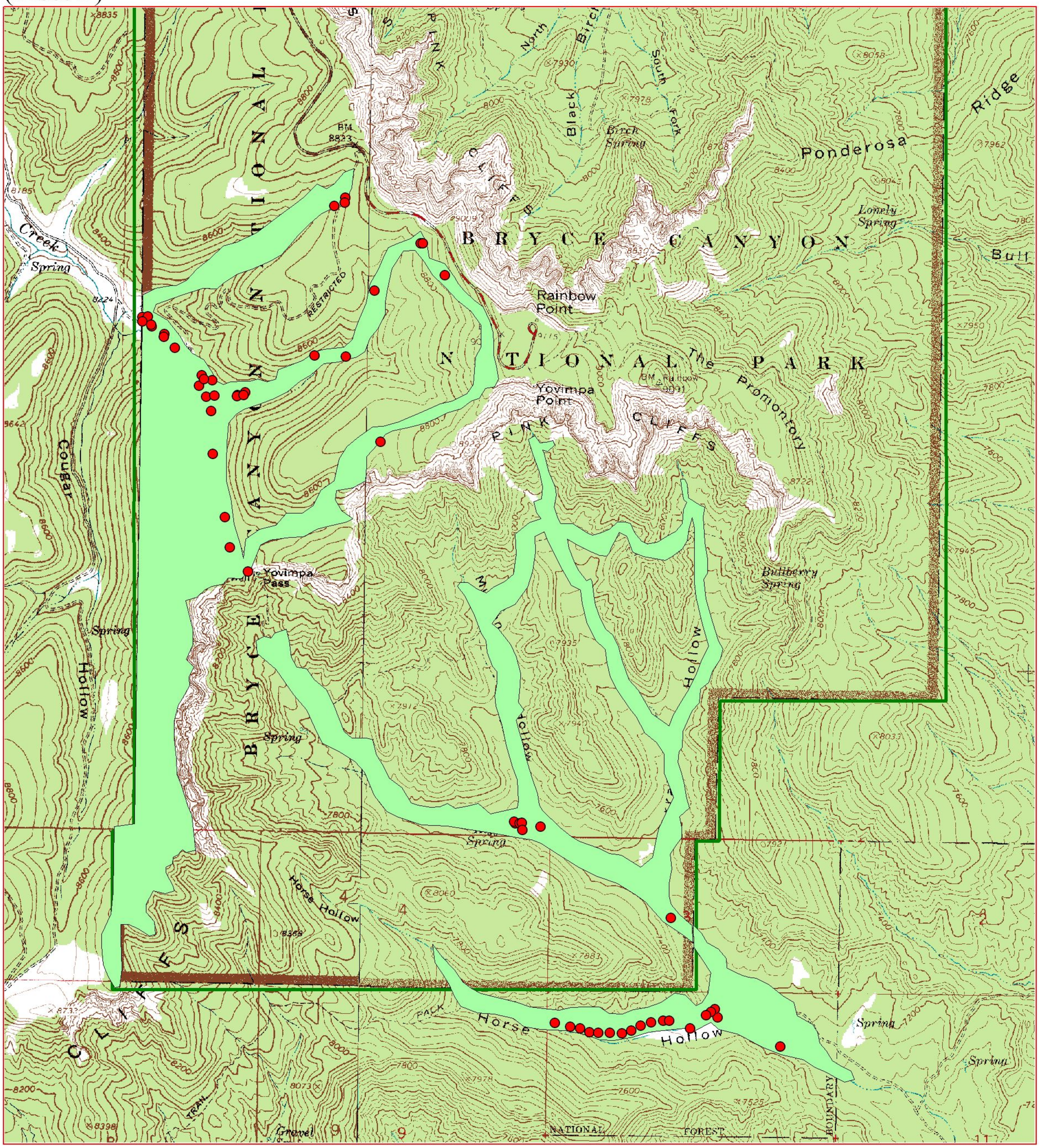
Park Boundary

N

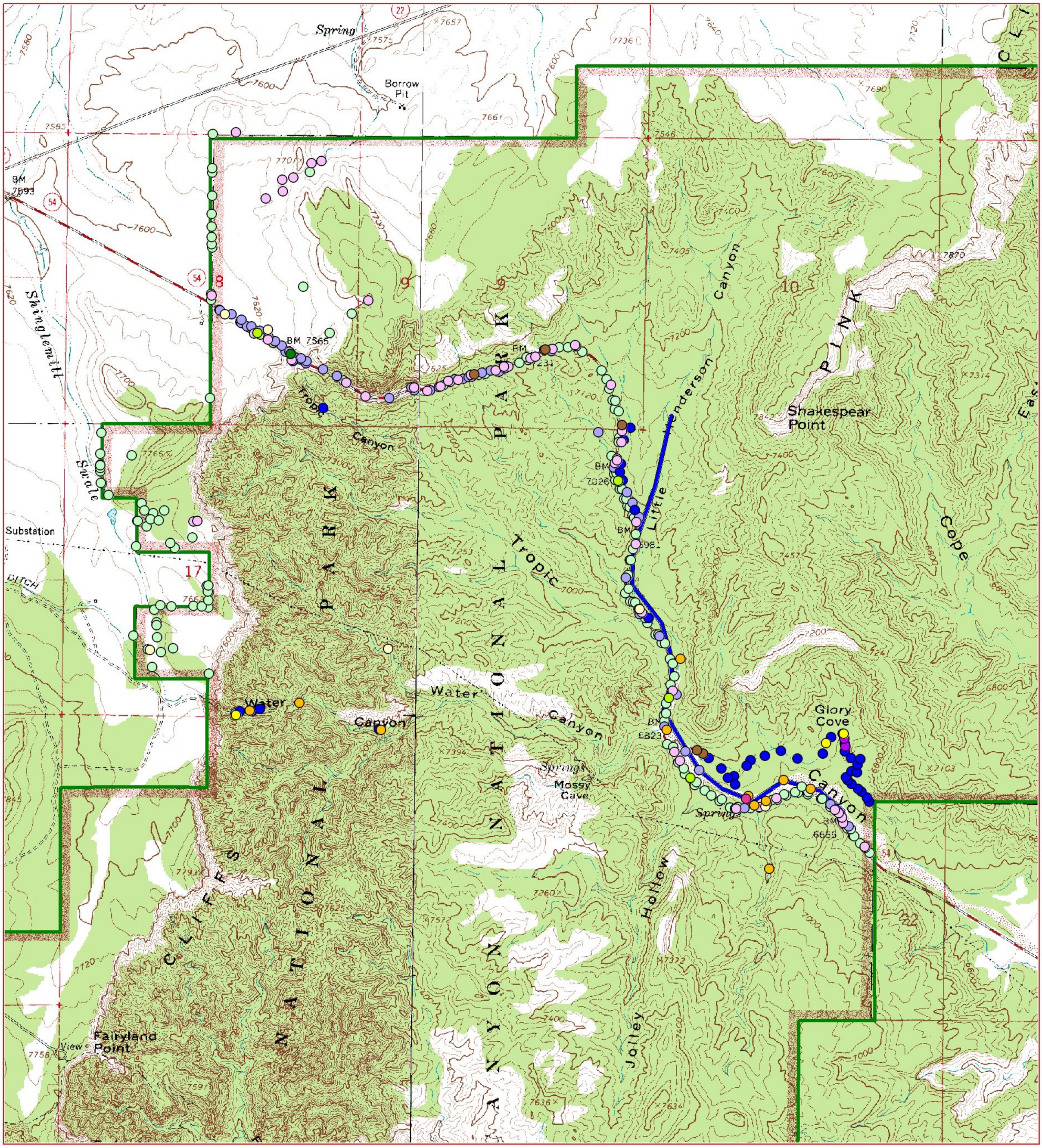
1:30,000 Scale

Inset E
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

Appendix H. Overall Weed Distribution in Inventoried Areas - Yovimpa Point (Inset F)



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



- *Bromus inermis*
- *Bromus tectorum*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Dactylis glomerata*
- *Elaeagnus angustifolia*
- *Halogeton glomeratus*
- *Marrubium vulgare*
- *Melilotus officinalis*
- *Melilotus officinalis*
- *Salsola kali*
- *Tamarix ramosissima*
- *Tragopodon dubius*
- Park Boundary

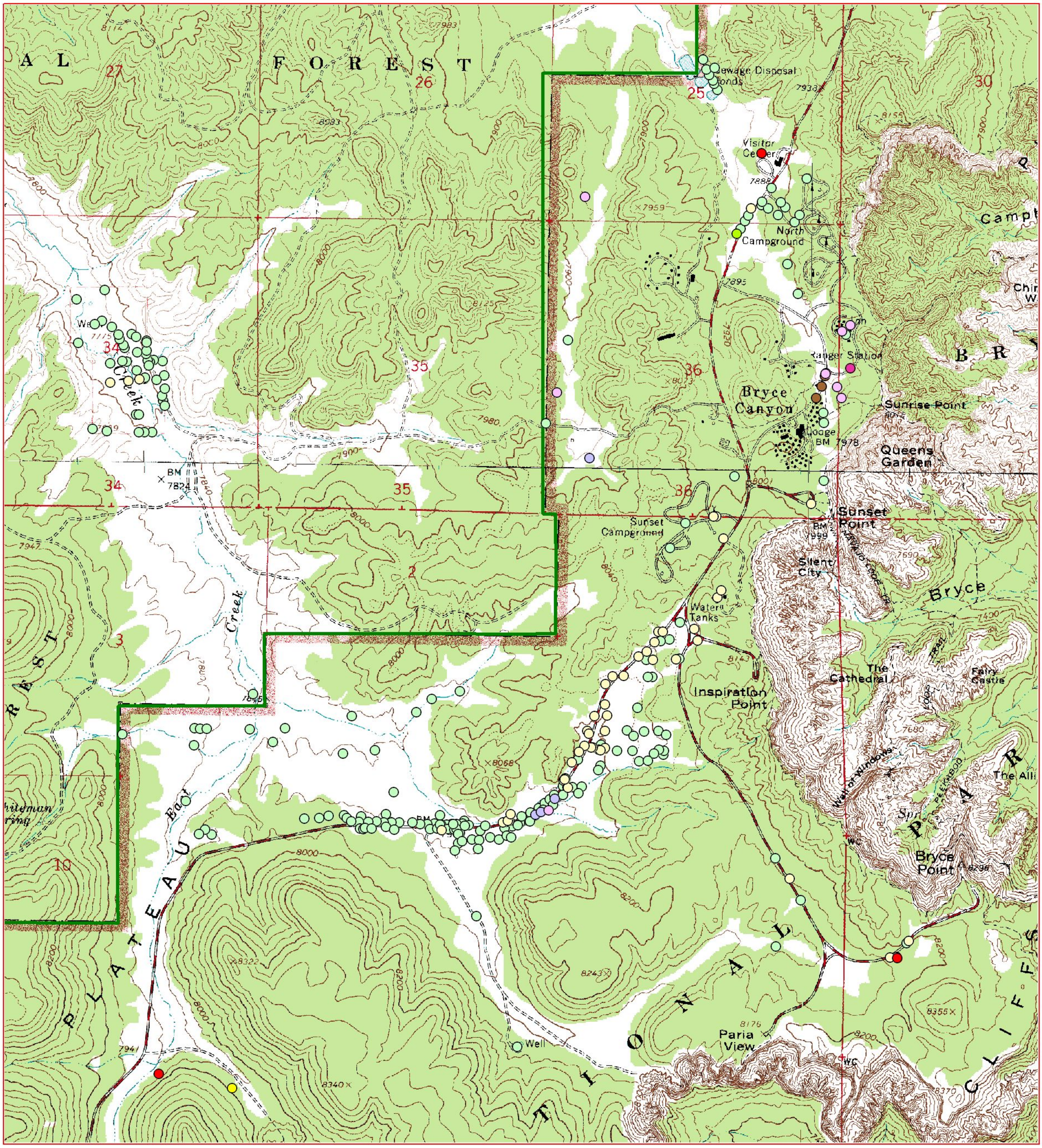
0 0.5 1 Miles

N

1:30,000 Scale

Inset A
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

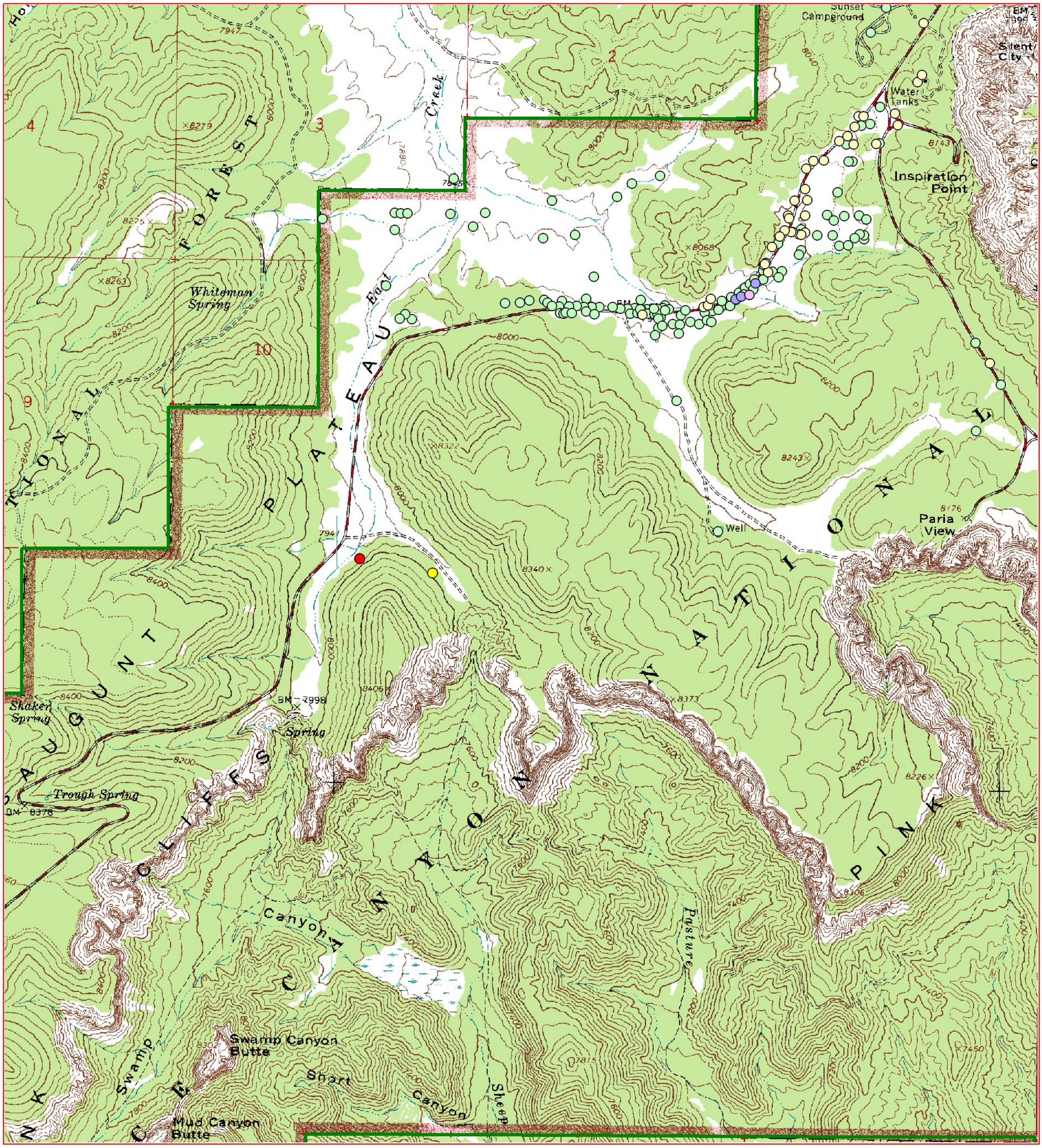
Appendix I. Weed Species Detected in Inventoried Areas - Inspiration Point (Inset B)



- *Bromus inermis*
- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium vulgare*
- *Convolvulus arvensis*
- *Dactylis glomerata*
- *Marrubium vulgare*
- *Salsola kali*
- *Tragopodon dubius*
- Park Boundary

Inset B
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

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



- *Bromus inermis*
- *Bromus tectorum*
- *Carduus nutans*
- *Cirsium vulgare*
- *Salsola kali*
- *Tragopodon dubius*
- Park Boundary

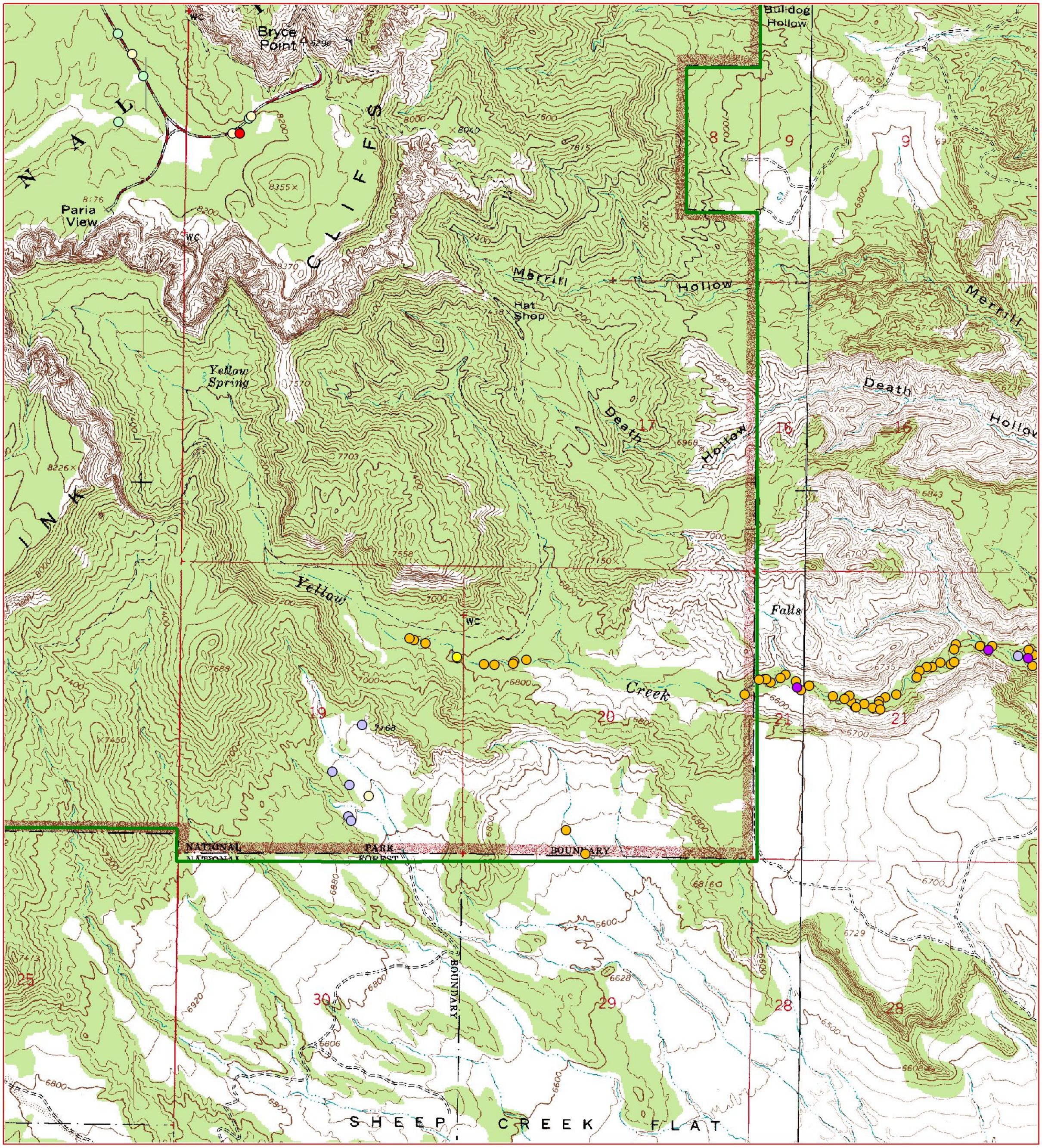
0 0.5 1 Miles

N

1:30,000 Scale

Inset C
Utah State University
Bryce Canyon National Park
2004 Invasive Non-Native Plant Inventory
Northern Colorado Plateau Network

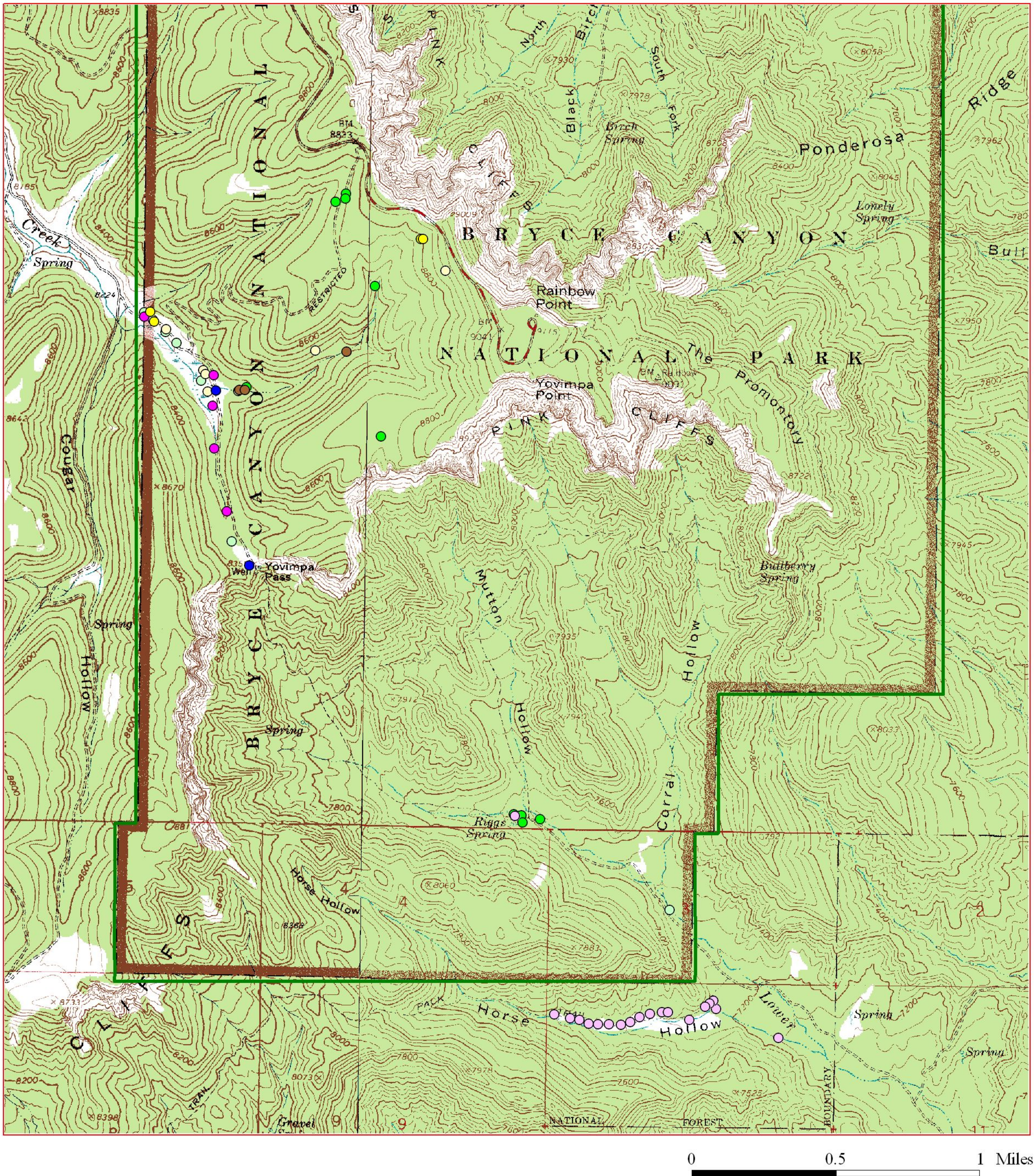
Appendix I. Weed Species Detected in Inventoried Areas - Yellow Creek (Inset D)



Appendix I. Weed Species Detected in Inventoried Areas - East Yellow Creek (Inset E)



Appendix I. Weed Species Detected in Inventoried Areas - Yovimpa Point (Inset F)



- *Bromus inermis*
- *Bromus tectorum*
- *Cirsium vulgare*
- *Dactylis glomerata*
- *Melilotus officinalis*
- *Phleum pratense*
- *Tragopodon dubius*
- *Verbascum thapsus*
- Park Boundary

Inset F
Utah State University
Bryce Canyon National Park
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 2004 inventory of invasive plants in Bryce Canyon 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 vulgaris*				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*					
Chenopodium album			X								
Cirsium arvense				X		**Other:**					
Cirsium vulgare	X					*Lactuca serriola*			X		
Conium maculatum				X		*Melilotus officinalis*		X			
Convolvulus arvensis	X					*Polygonum aviculare*			X		
Cynoglossum officinale				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