# Hovenweep National Monument



## 2003 Invasive Non-Native Plant Inventory

Northern Colorado Plateau Inventory and Monitoring Network

Final Report

April 2005

Prepared by

**Steven Dewey and Kimberly Andersen**

**Utah State University**

*Cover photo*:

*Carduus nutans* (Musk thistle) found in the Goodman Point Unit, Photo by K. A. Andersen.

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**FINAL REPORT**

**Inventory of Invasive Non-native Plants**
**Conducted during 2003 in portions of Hovenweep National Monument,**
**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 Hovenweep National Monument. Results from other Parks are documented in separate Park-specific project reports. Also, please note that this report updates and replaces the 2003 Hovenweep National Monument Inventory Annual Progress Report (Dewey et al. 2003).

## BACKGROUND and JUSTIFICATION

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

In a 1992 a 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. Hovenweep National Monument is a member of the Southeast Utah Group of Parks, which are part of the Northern Colorado Plateau Inventory and Monitoring Network, as well as a member of a Prototype Park Cluster. The drafting of a plan for network vital signs monitoring is currently underway. A knowledge of current weed distribution, especially in or near 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 Hovenweep National Monument. It was anticipated that information from this inventory will be useful in the Monument’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 Monument.

3) Within the scope of this project, USU was to work with regional, network and Monument 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 2-person crew to inventory targeted species in designated areas of Hovenweep National Monument in 2003. Crew qualifications are documented in Appendix A.

### SELECTION OF TARGET SPECIES AND INVENTORY AREAS

Eleven species were identified as high-priority targets in the HOVE inventory (Table 1), and searched for systematically by all inventory crew members. Any other non-native species recognized as relatively new to HOVE 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.

**Table 1. List of invasive plant species targeted in Hovenweep National Monument in the 2003 Non-native Plant Inventory.**

| Invasive species | Common Name |
|---|---|
| *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 |
| *Elaeagnus angustifolia* | Russian olive |
| *Marrubium vulgare* | Horehound |
| *Onopordum acanthium* | Scotch thistle |
| *Tamarix ramosissima* | Saltcedar |
| *Ulmus pumila* | Siberian elm |

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 Monument 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" also were given priority. Areas actually inventoried in Hovenweep National Monument in 2003 included everything in the original Implementation Plan plus additional areas added after consultation with Ian Torrence, Vegetation Manager for the NPS Southeast Utah Group. Lands inventoried in Hovenweep National Monument primarily consisted of riparian areas, canyon bottoms, spring sites, roads, hiking trails, and other developed visitor use sites.

The focus of this inventory project was NPS lands. However, in some cases a limited number of additional lands immediately adjacent to the Hovenweep National Monument border were inventoried. This occurred if crew members found an infestation of a high-priority weed species straddling the Monument 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 Monument boundary. Non-NPS lands inventoried included portions of roads connecting each unit.

Monument natural resource staff and the NCPN Vegetation Ecologist worked closely with the USU crew to provide pre-existing weed distribution information. They also provided information about weed control efforts currently underway, and the best access routes to targeted areas. All of this information was used in planning the 2003 field inventory, and in gathering and analyzing data. NCPN and HOVE 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 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.

**Table 2. Description of data fields used in 2003 Inventory of Invasive Non-Native Plants in Hovenweep National Monument.**

| 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 | HOVE | 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<br>- 0.1 acre<br>- 0.25 acre<br>- 1 acre<br>- 2.5 acres<br>- 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%)<br>low (1 to 5%)<br>moderate (6 to 25%)<br>high (26 to 50%)<br>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<br>- bud<br>- flower<br>- immature fruit<br>- mature fruit<br>- seed dispersing<br>- 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<br>- sapling<br>- mature<br>- old-growth | Optional | GPS |
| Lifeform | Lifeform of species. | -tree<br>-shrub<br>-graminoid<br>-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.<br>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.<br>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.<br>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)<br>- riparian (along rivers or stream channels)<br>- perennial: stream flows continuously in time.<br>- intermittent: stream flows only at certain times of the year (typically on seasonal basis) when it receives water from springs or from melting snow.<br>- ephemeral: stream flows only in direct response to precipitation. Ephemeral streams generally lack obligate riparian vegetation.<br>- wetland (saturated soil for majority of growing season)<br>- playa lakebed (poorly drained depressions) | Required | GPS |
| Disturbance | Evaluate disturbance at population site | 1 - no disturbance apparent<br>2 - light to moderate disturbance<br>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<br>-Construction/Development<br>-Fire<br>-Fire Suppression<br>-Flooding<br>-Wind<br>-Geothermal<br>-Animal Disturbance (e.g. gopher mound, buffalo wallow<br>-Irrigation/Ditches<br>-Mining and Quarries<br>-Oil and Gas Exploration/Production<br>-Habitat Improvement Project<br>-Recreation/Visitor Use<br>-Right-of-Way -Construction/Maintenance<br>-Utility -Construction/Maintenance<br>-Trail/Outfitter/ORV use | Required | Field notes |

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

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

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

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

The 2003 inventory of invasive non-native plants in Hovenweep National Monument was conducted by a two-person USU crew between July 15 and August 6, 2003 (Table 3). Sites inventoried include the Square Tower Group, the Holly Group, the Hackberry and Horseshoe Group, the Cutthroat Castle Group, the Goodman Point Group, and the Cajon Group, primarily focusing on canyon bottoms and spring sites. Roads connecting the different units in Utah were also inventoried.

For purposes of planning and data analysis the inventoried lands were divided into seven 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 above the canyons were open and visibility was generally good, allowing relatively broad EDSW's (typically 50 to 100 yards). In areas such as canyon bottoms, or spring sites in which vegetation cover was heavy, 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. 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 Hovenweep National Monument 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 in 2003 in Hovenweep National Monument.**

| Area Number | Area Description | Dates Inventoried | Crew Members* | Acres Inventoried** | Corresponding Inset Map Names and Letter Codes*** |
|---|---|---|---|---|---|
| 1 | Square Tower Group | Jul 16-17, Aug 6, 2003 | KA,SD | 398.6 | Square Tower Group – C |
| 2 | Holly Group | Jul 15, 17, Aug 6, 2003 | KA,SD | 63.2 | Holly Group – I |
| 3 | Hackberry and Horseshoe Group | Jul 15, Aug 6, 2003 | KA,SD | 143.9 | Hackberry & Horseshoe Group - H |
| 4 | Cutthroat Group | Jul 15, 2003 | KA | 23.8 | Cutthroat Castle Group - N |
| 5 | Goodman Point Group | Jul 17, Aug 6, 2003 | KA,SD | 141.3 | Goodman Point Group - A |
| 6 | Cajon Group | Jul 16, Aug 6, 2003 | KA,SD | 39.2 | Cajon Group - B |
| 7 | Roads between units | Aug 6, 2003 | KA,SD | 156.4 | Road Section 1 – D<br>Road Section 2 – E<br>Cajon Lake – F<br>Little Cajon Lake – G<br>Hackberry & Horseshoe Group - H<br>Road Section 3 - J<br>Cajon Mesa – K<br>Road Section 4 – L<br>Road Section 5 – M<br>Cutthroat Castle Group - N |
| | **TOTAL** | | | 966 | |

* Crew abbreviations: KA = Kim Andersen, SD = Steve Dewey
** An Average of 150.9 acres inventoried per person per 10-hr day
*** 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 Hovenweep National Monument.

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, Monument 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 Monument. 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 Hovenweep National Monument. A Voucher specimen of *Linaria dalmatica* was collected on the west side of the Goodman Point Unit. Duplicate voucher specimens were processed for deposit in herbaria at USU and Hovenweep National Monument. The specimen 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 automatically 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 2003 are compiled into one shapefile labeled as 03pt-weed.shp. Between-feature points from 2003 are labeled 03psnpnt.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 Monument 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 2003 project and the location of smaller-scale (1:9,000) 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 was compiled for the final 2003 dataset by Utah State University using ArcGIS ArcCatalog software. The metadata was 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 and voucher specimens 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 in-service training for the USU crew in the form of weed I.D. quizzes or demonstrations, reviewing the key identifying characteristics of 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. At the end of the season the PI and CS conducted random field inspections of areas previously 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 Hovenweep National Monument in its entirety and some additional surrounding areas outside of the Monument during the summer of 2003, totaling 966 acres. The general location and relative size of areas inventoried in 2003 are represented in Figure 1. An average of 150.9 acres was inventoried per person per 10-hr day.

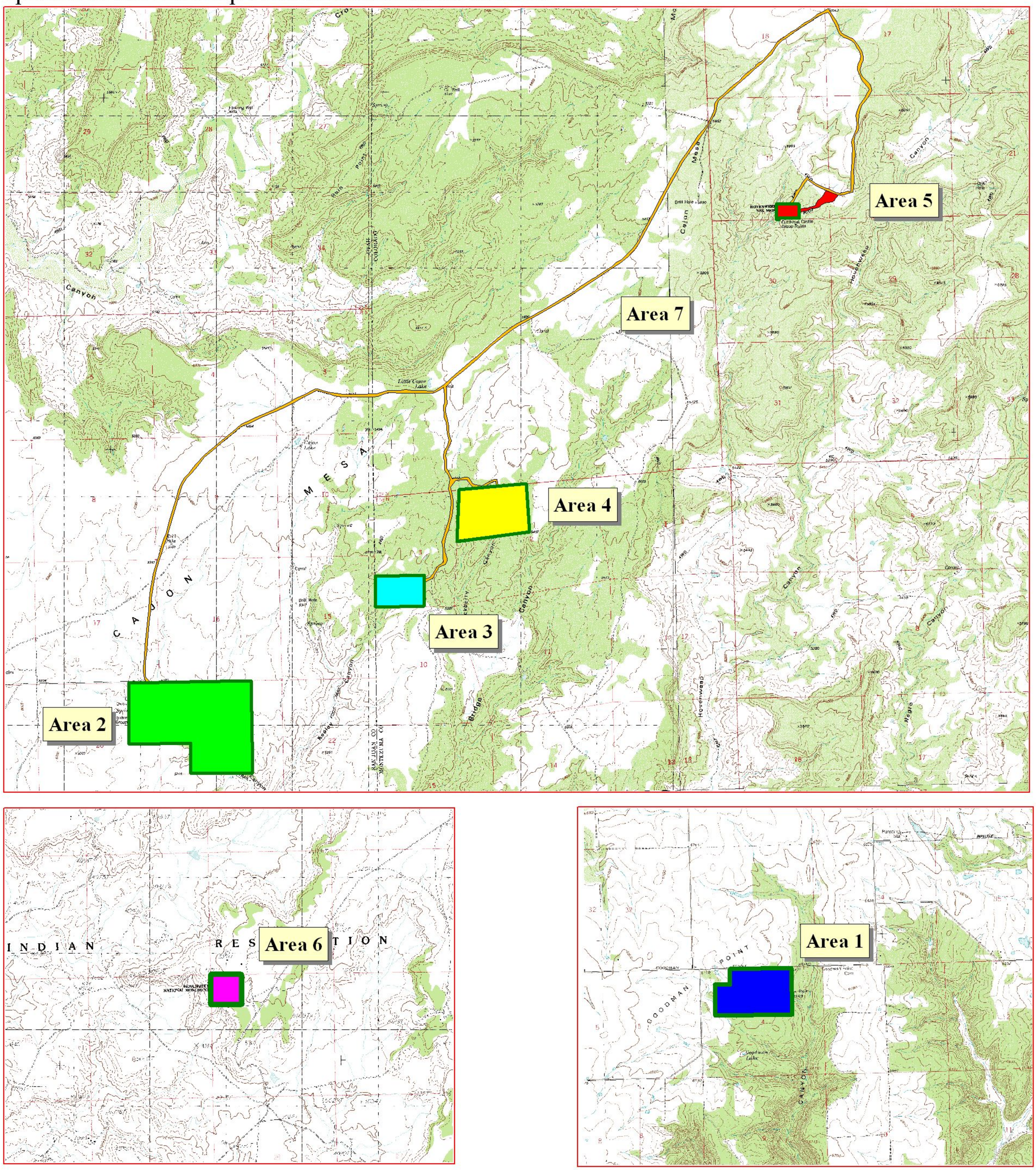
Figure 1 shows the seven inventory areas used in planning and field operations. The identification number, drainage description, and acreage of each inventory area are listed in the legend. Each inventory area is also color-coded for ease in identification. Figure 2 serves as orientation maps for the smaller 1:9,000 scale weed-distribution "Inset" maps found in Appendices H and I. Inset maps are distinguished by letters A - N, plus the name of a distinct geographic feature found within its boundaries. The corresponding inventory area numbers from Figure 1 are included in the Figure 2 legend in parentheses behind each inset map name. Fourteen inset maps are required to cover the seven inventory areas, and large inventory areas may span over two or more inset maps. For example, different sections of the road inventoried (Inventory Area 7) appear on ten different inset maps (C-H, J-N).

Invasive plants infested a total of 16.87 acres within the mapped areas (Table 4), an amount equal to 1.7 percent of the land inventoried. Of the 11 targeted species, only *Centaurea repens, Carduus nutans, Cirsium arvense,* and *Tamarix ramosissima* were found inside the Monument. No infestations of *Centaurea diffusa, Centaurea maculosa, Centaurea squarrosa, Elaeagnus angustifolia, Onopordum acanthium* and *Ulmus pumila* were discovered. Non-target species found and mapped were *Linaria dalmatica, Convolvulus arvensis, Arctium minus, Verbascum thapsus,* and *Solanum triflorum.*

**Table 4: Acres infested by invasive plant species within inventoried areas of Hovenweep National Monument and adjacent lands in 2003.**

| Species | Acres (Inside Monument) | Acres (Outside Monument) | Total Acres Infested |
|---|---|---|---|
| *Arctium minus* | 0.73 | --- | 0.73 |
| *Carduus nutans* | 3.48 | --- | 3.48 |
| *Centaurea repens* | 0 | 0.34 | 0.34 |
| *Cirsium arvense* | 6.7 | --- | 6.7 |
| *Convolvulus arvensis* | 0.23 | --- | 0.23 |
| *Lepidium latifolium* | 0 | 0.02 | 0.02 |
| *Linaria dalmatica* | 0.12 | --- | 0.12 |
| *Marrubium vulgare* | 0.77 | 2.06 | 2.83 |
| *Solanum triflorum* | 1.02 | --- | 1.02 |
| *Tamarix ramosissima* | 0.86 | 0.01 | 0.87 |
| *Verbascum thapsus* | 0.53 | --- | 0.53 |
| **Totals** | 14.44 | 2.43 | 16.87 |

Figure 1. Identification number and acreage of individual areas inventoried for non-native plant species in Hovenweep National Monument in 2003.




Area 1 - Goodman Point Group (141 acres)

Area 2 - Square Tower Group (399 acres)

Area 3 - Holly Group (63 acres)

Area 4 - Hackberry & Horseshoe Group (144 acres)

Area 5 - Cutthroat Castle Group (24 acres)

Area 6 - Cajon Group (39 acres)

Area 7 - Roads connecting units (156 acres)

Monument boundary

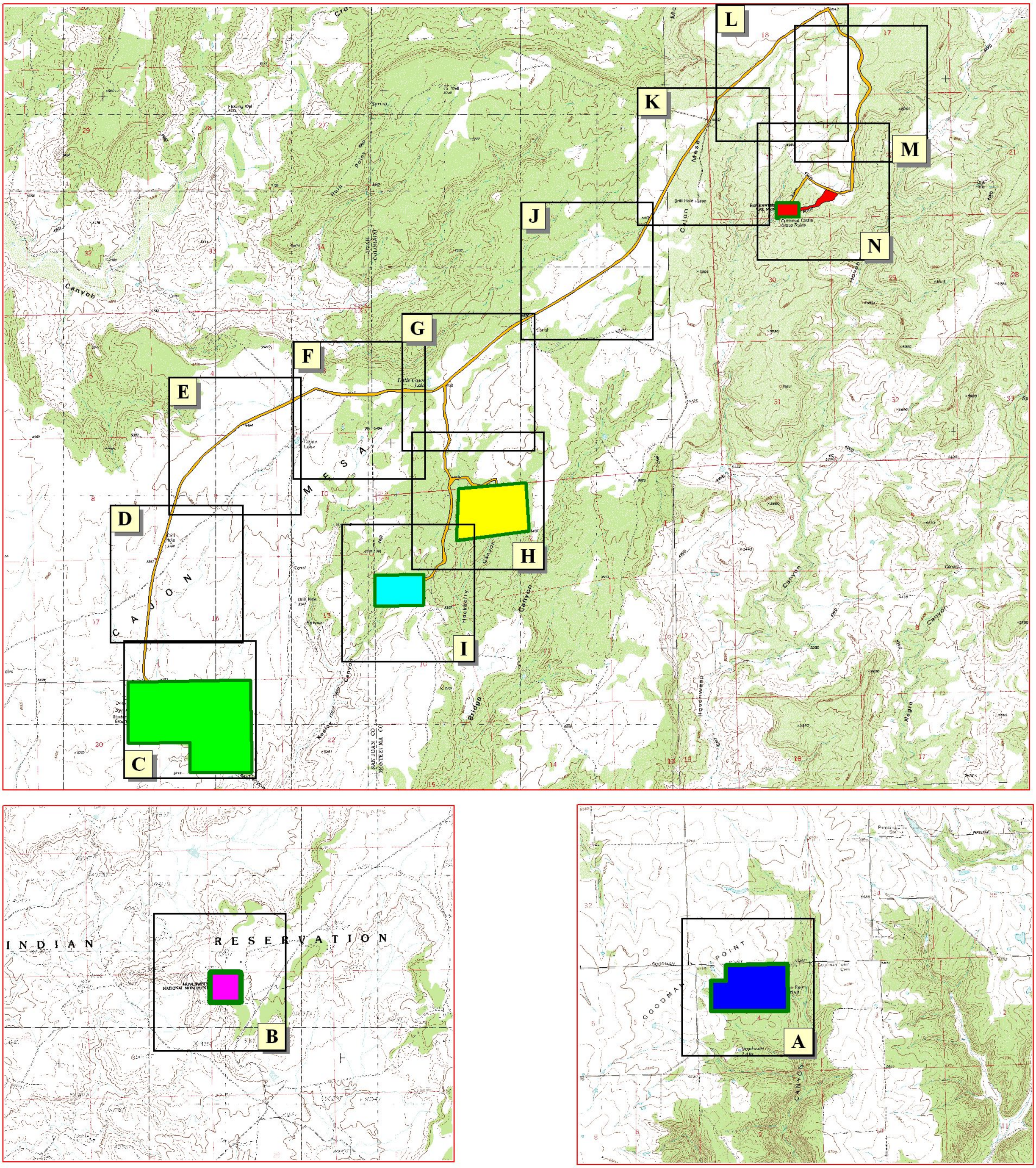
1:70,000 Scale

N



Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

Figure 2. Insets indicating the location, letter code, and name of the fourteen 1:9,000 scale maps used in Appendix tables to show weed distribution within inventoried areas of Hovenweep Natural Bridges National Monument in 2003.




Inset A - Goodman Point Group (Area 1)
Inset B - Cajon Group (Area 6)
Inset C - Square Tower Group (Areas 2, 7)
Inset D - Road Section 1 (Area 7)
Inset E - Road Section 2 (Area 7)
Inset F - Cajon Lake (Area 7)
Inset G - Little Cajon Lake (Area 7)
Inset H - Hackberry & Horseshoe Group (Areas 4, 7)
Inset I - Holly Group (Area 3)
Inset J - Road Section 3 (Area 7)
Inset K - Cajon Mesa (Area 7)
Inset L - Road Section 4 (Area 7)
Inset M - Road Section 5 (Area 7)
Inset N - Cutthroat Castle Group (Areas 5,7)

1:70,000 Scale

N

Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

The most abundant target species found in the Monument was *Cirsium arvense*. The crew recorded 6.7 acres of this species during the project. *Cirsium arvense* comprised 39.7 percent of the total infested acreage inventoried. *Carduus nutans* and *Marrubium vulgare* together made up an additional 37 percent of the total infested acreage inventoried. However, 73 percent of the *Marrubium vulgare* infestations recorded were found on the inventoried roads outside the Monument.

Not all non-native species that were found were mapped. For example, species such as *Chenopodium album*, *Amaranthus albus*, *Amaranthus retroflexus*, *Lactuca serriola*, *Melilotus officinalis*, *Bromus tectorum*, *Portulaca oleracea*, and *Salsola kali* were present in inventoried areas but were ignored due to their previously recognized presence and/or abundance in the Monument. 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 *Linaria dalmatica*, *Arctium minus*, *Convolvulus arvensis*, and *Verbascum thapsus*.

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 Hovenweep National Monument. Following is a summary of the weed situation within the individual Monument units.

<u>Goodman Point Group (Area Number 1; Inset Map A)</u>
The entire Goodman Point Group unit was inventoried. The Goodman Point Group was the weediest of the six units, probably because the surrounding lands are used for agricultural purposes. The primary weedy species found in the unit was *Cirsium arvense*, with individual infestations ranging in size from 0.01 acres to 2.5 acres. Cirsium arvense could be found mostly in the central portion of the unit in open meadows that drained into the streambed the exited the east side of the unit.

*Carduus nutans* was the second most abundant species, growing extensively throughout the Goodman Point Group. It was found in a variety of vegetation types including under juniper, mixed with sagebrush, sedge communities, and alongside the spring-fed stream. Most infestations were recorded as small patches of less than 0.01 acre, but patch sizes ranged up to 0.25 acre occasionally.

A single *Tamarix ramosissima* sapling was found in the middle of the unit growing in a mixture of grasses and *Cirsium arvense*. A single patch of *Centaurea repens* also was recorded, although it was not actually on Monument land. It was found on the north border across the paved road on private land, but was mapped due to its proximity and potential to spread into the Monument.

*Linaria dalmatica* was a non-target species, but was mapped due to its known aggressive nature in other regions of the West. Three small infestations of *Linaria dalmatica* were found on the southern portion of the unit. Two infestations were moderately dense and one infestation was very dense.

Other non-target species that were mapped include *Convolvulus arvensis*, *Arctium minus*, *Verbascum thapsus*, and *Solanum triflorum*. Infestations of *Arctium minus* were concentrated on the eastern end along a streambed below a spring. *Verbascum thapsus* was found on slickrock above the spring. *Convolvulus arvensis* and *Solanum triflorum* were found in the southwest corner of the unit along a small ditch.

Weedy species observed but not mapped include *Chenopodium album*, *Amaranthus albus*, *Amaranthus retroflexus*, *Lactuca serriola*, *Melilotus officinalis*, *Bromus tectorum*, *Portulaca oleracea*, and *Salsola kali*. These non-targeted species were generally found as small patches or single plants, except for *Salsola kali* and *Bromus tectorum* which were considerably more abundant. *Salsola kali* was especially abundant along the northeast corner of the unit where windblown plants had collected next to the fence and formed dense mats of dead material up to 2-3 feet deep. *Bromus tectorum* was dispersed throughout the unit and appeared to be especially dense under juniper.

Native vegetation including juniper, sagebrush, cliffrose, rabbitbrush, and native grasses, was abundant in most of the Goodman Point Group unit. Visibility was generally good, except for portions of the streambed below the spring at the eastern section of the unit. Wild roses made it impossible to cover the entire streambed but it was searched as thoroughly as was possible. The crew was confident of finding at least 90 percent of all targeted species infestations 0.01 acre or greater in size on the unit. No obvious disturbance was noted in the Goodman Point Group. An ecological status of three was assigned due to the abundance of non-native plant infestations found.

Square Tower Group (Area Number 2; Inset Map C)

The Square Tower Group unit is the most visited of the six units in Hovenweep National Monument and consists of several developed sites including the visitor center, employee housing, and campground. The entire unit was inventoried during this project. The unit consisted both of upland areas covered with juniper and sagebrush, and canyons comprised of cottonwood, willow, and rabbitbrush.

*Tamarix ramosissima* was the more abundant of the two targeted species found in the Square Tower Group unit. The majority of the seventeen recorded *Tamarix ramosissima* infestations were found in Little Ruin Canyon at the southern boundary of the unit. Three small infestations were noted in the canyon to the east of the campground. Thirteen of the infestations showed signs of previous mechanical control. (It is assumed that those stumps had been treated with herbicide at the time of cutting because regrowth was minimal, although there was no way for the inventory crew to be sure). Most infestations were small with the majority of shoots in the sapling category. Some were new plants, but most were relatively recent regrowth from previously treated trees.

The only other targeted species recorded in the Square Tower Group unit was *Marrubium vulgare.* Eleven of the sixteen infestations of this species were found in disturbed sites such as the Visitor Center parking lot, along the road shoulder entering the unit, and at the location of the old Ranger Station. The remaining five infestations were found in the bottoms of the two canyons in the unit.

Species noted but not mapped in the Square Tower Group unit include *Bromus tectorum*, *Chenopodium album*, *Salsola kali*, *Sisymbrium altissimum*, and *Verbena bracteata*.

Visibility was generally good throughout the unit. Willows were very thick in the head of Little Ruin Canyon, below the spring, and it is possible that some small infestations of one or more target species might have been missed. However, the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species in the overall unit. Several disturbances from visitor use and Monument employees are to be expected in the developed sites such as the campground, hiking trails, maintenance areas, and housing areas. Due to the abundance of the several non-target species and the presence of the two target species, the Square Tower Group was assigned an ecological status level of two.

Holly Group (Area Number 3, Inset Map I)

The Holly Group is a small unit consisting mostly of juniper and sagebrush. The entire unit was inventoried and no targeted or non-targeted weed species were found. However, a large infestation of *Tamarix ramosissima* was noted just outside the Monument's southern boundary. No significant disturbance was noted within the unit's boundaries. Visibility was generally good and the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of targeted species. The unit was assigned an ecological status of one.

Hackberry and Horseshoe Group (Area Number 4; Inset Map H)

The Hackberry and Horseshoe Group unit was one of the larger inventoried, and the entire unit was searched thoroughly during this project. The unit consisted of canyon bottoms containing willow and cottonwood species, and uplands consisting of juniper and low-growing shrub communities. This was the second weediest unit inventoried during this project, with most weeds occurring in association with spring sites. The greatest number of non-native species were concentrated in Hackberry Canyon.

The most abundant target species in the unit overall was *Tamarix ramosissima*. It was found in both of the main canyons that run north to south across the unit, although it was most abundant in the west canyon. All eleven infestations found in the west canyon had been cut and treated previously, but had resprouted. Three of the infestations in the east canyon (Hackberry) had been previously treated also. Five of the seven infestations mapped in the east canyon were either saplings or established trees that had been cut and resprouted.

*Carduus nutans* was the second most abundant species recorded in this unit and all three infestations were found below the spring in Hackberry Canyon. The infestations ranged in size from 0.01 acre to 0.1 acre, with moderate to heavy canopy cover.

A single infestation of *Cirsium arvense* was found approximately 50-60 yards below the spring in Hackberry Canyon. This 0.01-acre infestation was growing directly in the streambed and had a very dense canopy cover. *Verbascum thapsus* was a non-target species found in both canyons in trace amounts, and the four infestations recorded consisted of 2-3 plants each. These plants were also very closely associated with spring sites in each canyon. Two infestations of *Marrubium vulgare* were also located directly below the spring in Hackberry Canyon. Each infestation of *Marrubium vulgare* consisted of only a handful of plants.

Little or no recent human-caused disturbance was visible in the unit away from trails, parking areas, or other structures. Visibility was generally very good and the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of targeted species in the unit. Due to the presence of targeted species and the size of the infestations recorded, in the unit was assigned an ecological status of two.

Cutthroat Castle Group (Area Number 5; Inset Map N)
The small unit consisted of juniper and sagebrush habitat as well as some cottonwood and willow habitat. The entire unit was inventoried and only a few *Tamarix ramosissima* saplings were found along the streambed running east to west across the unit, and on the west border. Several small pockets of *Tamarix ramosissima* were noticed outside the Monument's boundaries in the drainages around the Cutthroat Castle Group unit, but were not mapped. No other targeted species were found in the unit and very little disturbance was noted beyond the parking area. Visibility was good and the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species. Due to the relatively small size of the infestations, the unit was assigned an ecological status level of two.

Cajon Group (Area Number 6; Inset Map B)
The Cajon Group is a medium sized unit that has little vegetative cover. The entire unit was inventoried for this project. The majority of the unit consists of dry sagebrush and juniper habitat. One small spring site is located near the southwest corner of the unit and one small drainage exits the northwest corner. Two infestations of *Tamarix ramosissima* were found below the spring. One infestation consisted of a single sapling and the other was just a few saplings. One plant of *Marrubium vulgare* was found roughly 5-10 yards below the spring. Little disturbance was seen in the Cajon Group unit and the crew was confident of finding at least 90 percent of all 0.01-acre or larger infestations of the targeted species. Due to the relatively small size of the infestations, the unit was assigned an ecological level of two.

Roads between units (Area Number 7, Inset Maps C, D, E, F, G, H, J, K, L, M, N)
The roads between the Square Tower Group, Hackberry and Horseshoe Unit, Holly Unit, and Cutthroat Castle Group were searched and mapped for weeds even though they were outside the Monument's boundaries. The crew felt that *Marrubium vulgare*, *Centaurea repens*, and *Lepidium latifolium* observed growing along the road could easily be spread into the Monument by visitor and NPS vehicles, and therefore should be mapped. M*arrubium vulgare* was most prevalent near the Square Tower Group's north boundary. It is suspected that *Marrubium vulgare* infestations already inside this unit were most likely parented by infestations along the main road.

Five dense patches of *Centaurea repens* were also found along the road shoulder between the Square Tower Group and the Hackberry and Horseshoe unit. Two small plants of *Centaurea repens* were found within 300 yards of the entrance to the Hackberry and Horseshoe unit. Two fairly dense infestations of *Lepidium latifolium* were discovered along the road between the Square Tower Group and the Hackberry Horseshoe unit. It is very likely that *Centaurea repens* and *Lepidium latifolium* will invade the Monument if these infestations are not controlled. The search for weeds along the roads outside of the Monument should not be considered a complete

inventory. Instead, it was a sample survey of relatively obvious infestations that were noticed while driving.

## 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 Hovenweep National Monument. It is anticipated that the information obtained from this inventory will be useful in the Monument'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 Hovenweep National Monument is already implementing many effective weed control strategies and practices, for which they are to be commended. The majority of inventoried sites of *Tamarix ramosissima* had been cut and treated previously in the Square Tower Group unit and the Hackberry and Horseshoe Unit, and the infestations had simply resprouted. Discussions with Ian Torrence indicated that NPS employees had also been involved in removing *Tamarix ramosissima* in several of the units over the past couple of years. This was evident by the absence of large mature *Tamarix* trees in the canyon bottoms and the absence of large infestations of *Tamarix* such as those found in infested areas directly outside the Monument.

If it does not already exist, the Monument is urged to develop a comprehensive written management plan for all invasive plant species in HOVE, similar to the plan currently being finalized by Utah State University for Dinosaur National Monument. If there currently is a written plan, the Monument is encouraged to review and improve it on a regular basis. An excellent reference that will aid the Monument 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 aimed at early detection. Inspections of all high-visitation areas should be performed at least annually, whereas inventories of the more remote sites or habitats least suitable for weed establishment or spread might need to be performed only once every 3 to 5 years. A rotating schedule should be developed by Hovenweep National Monument to inventory a portion of their land each year, so that within a reasonable number of years all of the Monument could be inspected. The key is to schedule inventories often enough to detect all new weed infestations before they exceed a size considered feasible for eradication. Early detection of invasive weeds through regular searches and mapping is just as essential to successful weed management as the early detection of wildfires is to effective fire management.

Tied to an ongoing inventory effort, Hovenweep National Monument also should consider establishing permanent monitoring sites 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, Hovenweep National Monument 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 species should be given highest priority, with the ultimate objective being 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, and 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 that strategy to Hovenweep National Monument would mean that the least abundant species should be identified in each unit and targeted for prompt unit or Monument-wide eradication. *Linaria dalmatica, Tamarix ramosissima, Arctium minus, Verbascum thapsus,* and *Convolvulus arvensis* should be the highest priority species in the Goodman Point Group. *Marrubium vulgare* and *Tamarix ramosissima* should be given the highest control priority in the Cajon Group unit and the Square Tower Group. *Cirsium arvense, Marrubium vulgare,* and *Verbascum thapsus* should receive the highest control priority in the Hackberry and Horseshoe unit. The *Tamarix ramosissima* found in the Cutthroat Castle Group unit would also fit into the

highest control priority category. Eradication of these weedy species is probably very feasible in the units listed. If effective prevention, early detection, and rapid response strategies are implemented now, managers should be able to keep all of these and other portions of the Monument free from the impacts of these species. Eventually, it should be possible to eradicate all other inventoried infestations in Hovenweep National Monument as the total infested acreage inside the entire Monument is approximately 15 acres.

The Monument will likely need additional inventory information before deciding in which management category to place *Amaranthus albus, Amaranthus retroflexus, Bromus tectorum, Chenopodium album, Lactuca serriola, Melilotus officinalis, Portulaca oleraceus, Salsola kali, Sisymbrium altissimum,* and *Verbena bracteata.* With the exception of *Bromus tectorum* and *Salsola kali* in the Goodman Point Group, these non-native species appeared to be only lightly to moderately distributed in the Monument, but this assessment is based on an incomplete sample survey rather than a full inventory. If further study reveals that these species truly are relatively rare in the Monument, we suggest that they be targeted for prompt eradication, even though they were not originally considered high-priority species.

Although several weedy species were found in Hovenweep National Monument, native vegetation is still abundant throughout most portions of the Monument. *Salix spp.* were found to be abundant at the springs in the Square Tower Group and *Populus* species were found at the heads of several springs in the other units. However, these species and other native vegetation will eventually be reduced significantly or even lost if control strategies are not expanded and continued.

The second objective of this project was to identify potential sources of weed introduction and significant vectors involved in weed spread in the Monument. Humans are the most likely vectors for new introductions of invasive plant species into Hovenweep National Monument 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 29,000 per year visit Hovenweep National Monument. 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. 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. Monument 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 Monument's Visitor Center, through displays or a video program, and evening fireside presentations to visitors made by NPS personnel.

Routine Monument 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 Monument 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 K). 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 as a significant source of introduction and spread. 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. 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 Hovenweep National Monument, 98.5 percent of the inventoried acres were free of all targeted species. Furthermore, 100 percent of all inventoried lands were completely free of 23 additional targeted 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 Hovenweep National Monument that are currently "clean" should be identified as WPAs, and management should take all appropriate measures to keep invasives from spreading into them. For example, the Holly Group unit could be designated as a Weed Prevention Area because no weed species were found during the inventory. Protecting and preserving lands in this weed-free condition is much more cost-effective than restoring extensive areas already badly infested by invasives, 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 Monument or Park could help to justify increased budgets for prevention practices. Increasing the number of weed-free acres 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 2003 Invasive Non-native Plant Inventory in Hovenweep National Monument.

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

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

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

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

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

## Appendix B. Standard GPS Data Dictionary used in the 2003 Invasive Non-native Plant Inventory in Hovenweep National Monument.

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

| | |
|---|---|
| **Time** | Time, Auto generate Create, 24 Hour Format<br>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<br>Minimum = 5, Maximum = 500, Default Value = 20<br>Required, Normal |
| **Notes** | Text, Maximum Length = 50<br>Normal, Normal |
| **Time** | Time, Auto generate Create, 24 Hour Format<br>Normal, Normal |
| **Date** | Date, Auto generate Create, Month-Day-Year Format<br>Normal, Normal |
| **Ar-weed** | Area Feature, Label 1 = Time<br>GPS-generated polygon |
| Species | Menu, Required, Normal |

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

| | |
|---|---|
| **Notes** | Text, Maximum Length = 50<br>Normal, Normal |
| **Time** | Time, Auto generate Create, 24 Hour Format<br>Normal, Normal |
| **Date** | Date, Auto generate Create, Month-Day-Year Format<br>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)<br>Minimum = 1, Maximum = 100, Default Value = 1<br>Required, Normal |
| **% Cover** (IA only)<br>Trace: < 1 %<br>Low: 1 to 5 %<br>Mod: 6 to 25 %<br>High: 26 to 50 %<br>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<br>Minimum = 1, Maximum = 100, Default Value = 1 |

| | |
|---|---|
| | Required, Normal |
| **Notes** | Text, Maximum Length = 50<br>Normal, Normal |
| **Date** | Date, Auto generate Create, Month-Day-Year Format<br>Normal, Normal |
| **Time** | Time, Auto generate Create, 24 Hour Format<br>Normal, Normal |
| **Point** | Point Feature, Label 1 = Notes |
| Notes | Text, Maximum Length = 50<br>Normal, Normal |
| **Line** | Line Feature, Label 1 = Notes |
| Notes | Text, Maximum Length = 50<br>Normal, Normal |
| **Area** | Area Feature, Label 1 = Notes<br>Text, Maximum Length = 50<br>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<br>Minimum = 0, Maximum = 360, Default Value = 0<br>Normal, Normal |
| **Notes** | Text, Maximum Length = 50<br>Normal, Normal |
| **Date** | Date, Auto generate Create, Month-Day-Year Format<br>Normal, Normal |
| **Time** | Time, Auto generate Create, 24 Hour Format<br>Normal, Normal |
| **Voucher** | Point Feature, Label 1 = Notes |
| Species | Menu, Required, Normal |

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

| | |
|---|---|
| **Notes** | Text, Maximum Length = 50<br>Normal, Normal |

## Appendix C. Relationship of NCPN Project Data Elements to IMR and NAWMA Weed Mapping Standards used in 2003 Invasive Non-native Plant Inventory in Hovenweep National Monument.

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)<br>a. Intraspecific Name<br>b. Authority for Name | Required<br>a. Optional<br>b. Optional (Recommend Kartez) | Required<br>a. Optional<br>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<br>a. State listed noxious weed<br>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<br>a. Park Unit (4-letter code)<br>b. Park Subunit<br>c. Network Name<br>d. Region<br>e. Weed Management Area<br>f. Other | a. Required<br>b. Optional<br>c. Required<br>d. Required<br>e. Optional<br>f. Optional | N/A | a. YES<br>b. NO<br>c. YES<br>d. NO<br>e. NO<br>f. NO | Office<br><br>Office | |
| CHANGES IN SPECIES POPULATION OVER TIME | 1. Infested Area<br>a. Unit of Measure (Acre or Hectare) | Required<br>a. Required | Required<br>a. Required | YES | Field | |
| | 2. Gross Area<br>a. Unit of Measure (Acre or Hectare) | Optional<br>a. Optional | Optional<br>a. Optional | YES | Field | |
| | 3. Canopy Cover (% Aerial)<br>A. Type of Measurement (actual/estimated/mid-pt of cover class) | Required<br>a. Required | Required<br>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)<br>a. Date of Action<br>b. % of Population treated (1-25)(/26-50)(51-75)(76-100) | Optional<br><br><br><br>a. Optional<br>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)<br>- 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<br>- Actual or estimated | Optional (highly recommended) | N/A | NO | | Can be derived in GIS |
| | | 4. Slope Position (top 1/3, mid 1/3, low, 1/3, toe) | Optional (highly recommended) | N/A | NO | | Not a helpful data field – too variable, also can be derived in GIS |
| | | 5. Soil Type | Optional (highly recommended) | N/A | NO | | Field crews not knowledgeable about soils. Can be derived from soil maps. |
| | | 6. Landform | Optional (highly recommended) | N/A | NO | | We tried this last year, too much variation & difficult to interpret. Data quality not sufficient. |
| | | 7. Geologic Substrate | Optional (highly recommended) | N/A | NO | | Can be derived in GIS from geologic maps. |
| | | 8. Climate (Develop Link to Separate Table with Avg. Temp & Precip.) | Optional (highly recommended) | N/A | NO | | Tabular and spatial climate data are available for GIS analysis. |
| | BIOTIC DATA | 1. Life Form (Grass/Forb/Shrub/Tree) | Required | N/A | YES | Office | |
| | | 2. Ecological Status | Required | N/A | YES | Field and Office | |
| | | 3. Values At Risk | Required | N/A | NO | | Relationship of weed occurrences to resource values can be derived through GIS analysis as needed. |
| | | 4. Vegetation Classification | Optional (highly recommended) | N/A | NO | | Vegetation classifications not available yet for NCPN parks |
| | | 5. Dominant Associated Species | Optional (highly recommended) | N/A | YES | Field | |
| | | 6. Cover Type | Optional (highly recommended) | N/A | NO | | Standard cover type classifications not yet being applied in NCPN parks. |
| | | 7. Habitat Type | Optional (highly recommended) | N/A | NO | | Not applicable to NCPN parks. |
| | | 8. Seral Stage | Optional (highly recommended) | N/A | NO | | These relationships not described for NCPN parks. |
| | | 9. Disturbances *(See Below) | Optional (highly recommended) | N/A | (yes) | Field and office | Describe for broader survey areas, but only generally at polygon or point level |

**Appendix D. GPS Settings using in 2003 Invasive Non-native Plant Inventory in Hovenweep Monument.**

**System / Setup**

**Configurations**

**Data**

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

**GPS**

(Advanced mode window)

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

**Real Time**

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

**Coordinates**

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

**Units**

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

**Formats**

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

**Appendix D . GPS Settings using in 2003 Invasive Non-native Plant Inventory in Hovenweep National Monument. (cont)**

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

**Data Dictionaries**

(Select NCPN-04)

**Feature Settings**

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

**About**

(Nothing to set here)

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

**Appendix E. Photograph and list of equipment used in 2003 Invasive Non-native Plant Inventory in Hovenweep National Monument.**

# Equipment



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

**Appendix F. Dominant Vegetation Types Key used in 2003 Invasive Non-native Plant Inventory, Hovenweep National Monument.**

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

**Appendix F. Dominant Vegetation Types Key used in 2003 Invasive Non-native Plant Inventory, Hovenweep National Monument.**

| 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 Hovenweep National Monument During the 2003 Invasive Non-native Plant Inventory.

# Weeds Detected



**Figure 1.** *Marrubium vulgare* flowers and leaves. (HOVE PR-3)



**Figure 2.** *Marrubium vulgare* found growing along the road shoulder. (HOVE PR-3)

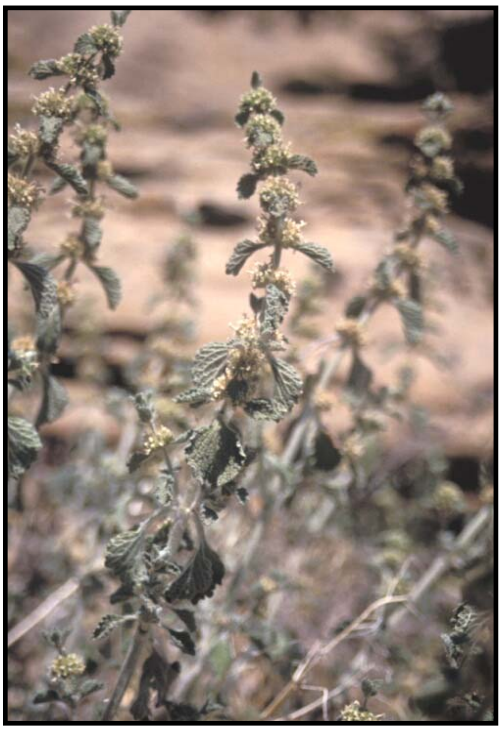


**Figure 3.** *Marrubium vulgare* flowers and leaves. (HOVE PR-32)



**Figure 4.** *Marrubium vulgare* growing in stream channel near a spring in Hackberry Canyon. (HOVE PR-32)

# Weeds Detected



**Figure 5.** *Marrubium vulgare* growing up underneath cattle guard. (HOVE PR-4)



**Figure 6.** *Marrubium vulgare* growing underneath cattle guard at entrance to the Square Tower Group and visitor center. (HOVE PR-4)



**Figure 7.** *Lepidium latifolium* in full flower. (HOVE PR-2)



**Figure 8.** *Lepidium latifolium* growing along road shoulder. (HOVE PR-2)

# Weeds Detected



**Figure 9.** *Centaurea repens* flowers. (HOVE PR-34)



**Figure 10.** *Centaurea repens* found growing along road shoulder. (HOVE PR-1)



**Figure 11.** *Centaurea repens* plants along road shoulder (HOVE PR-34)



**Figure 12.** *Centaurea repens* plants along road shoulder near the Hackberry Unit. (HOVE PR-34).

# Weeds Detected

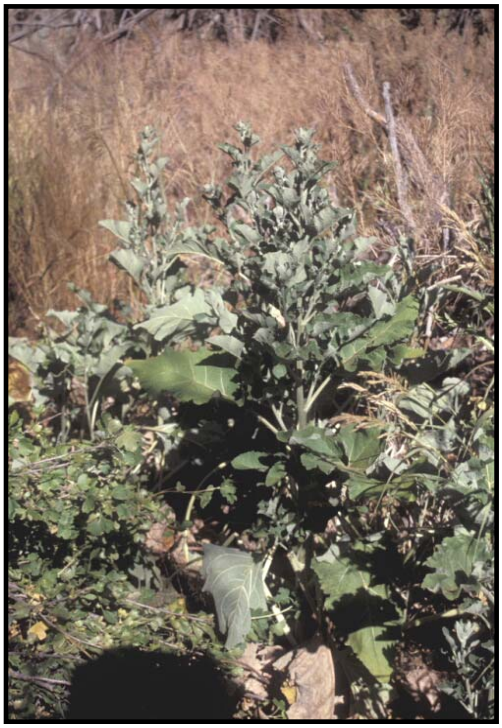


**Figure 13.** *Arctium minus* in the Goodman Point Unit. (HOVE PR-18)



**Figure 14.** *Arctium minus* growing along the creek bottom at the east end of the Goodman Point Unit. (HOVE PR-18)



**Figure 15.** Senesced *Verbascum thapsus* plants in the Goodman Point Unit. (HOVE PR-21)



**Figure 16.** *Verbascum thapsus* found growing in the Goodman Point Unit near HOVE PR- 21.

# Weeds Detected



**Figure 17.** *Linaria dalmatica* flowers. (HOVE PR-22)



**Figure 18.** *Linaria dalmatica* plants in sagebrush. (HOVE PR-22).



**Figure 19.** *Linaria dalmatica* growing in the Goodman Point Unit. (HOVE PR-22).



**Figure 20.** *Linaria dalmatica* growing underneath sagebrush. (HOVE PR-22)

# Weeds Detected



**Figure 21.** *Carduus nutans* flowers in the Goodman Point Unit (HOVE PR- 35)



**Figure 22.** *Carduus nutans* rosettes in the east end of the Goodman Point Unit. (HOVE PR-14)



**Figure 23.** *Carduus nutans* plants growing along the wash in Hackberry Canyon. (HOVE PR-36)



**Figure 24.** *Carduus nutans* rosette (right) and native thistle rosette (left). (HOVE PR-6)

# Weeds Detected



**Figure 25.** *Carduus nutans* in Goodman Point Unit (HOVE PR-35)



**Figure 26.** *Carduus nutans* along creek bottom in Goodman Point Unit (HOVE PR-17)



**Figure 27.** *Cirsium arvense* flowers in the Hackberry Unit. (HOVE PR-37)



**Figure 28.** Rosettes of *Cirsium arvense* in the Goodman Point Unit. (HOVE PR-7)

# Weeds Detected



**Figure 29.** *Cirsium arvense* in creek bottom below spring in the Goodman Point Unit. (HOVE PR-38)



**Figure 30.** *Cirsium arvense* mixed in smooth brome in large open field in the Goodman Point Unit. (HOVE PR-8)



**Figure 31.** *Cirsium arvense* in SW corner of the Goodman Point Unit along small creek. (HOVE PR-12)



**Figure 32.** *Cirsium arvense* in creek bottom below spring in Hackberry Canyon. (HOVE PR-37)

# Weeds Detected



**Figure 33.** *Tamarix ramosissima* sapling in the Cutthroat Castle Group. (HOVE PR-30)



**Figure 33.** *Tamarix ramosissima* sapling in the creek bottom of the Cutthroat Castle Group. (HOVE PR-30)



**Figure 35.** Lone *Tamarix ramosissima* sapling mapped by Kim Andersen in the Goodman Point Unit. (HOVE PR-9)



**Figure 36.** Controlled *Tamarix ramosissima* in Little Ruin Canyon, at the park boundary of the Square Tower Group. (HOVE PR-26)

# Weeds Detected



**Figure 37.** *Solanum triflorum* found in the Goodman Point. (HOVE PR-13)



**Figure 38.** *Convolvulus arvensis* was found in the Goodman Point Unit.*

*Photograph not taken in Hovenweep National Monument, but representative of the plants found and mapped.

# Hovenweep Landscapes




**Figure 39.** Entrance sign for Goodman Point Unit.



**Figure 40.** Looking southeast of creek in Goodman Point.



**Figure 41.** Above spring in Goodman Point, looking east. (HOVE PR-20)



**Figure 42.** Open fields in Goodman Point Unit. (HOVE PR-10)

# Hovenweep Landscapes




**Figure 43.** Cajon Unit sign.



**Figure 44.** View looking east of the Cajon Unit.



**Figure 45.** View looking north over the Cajon Unit.



**Figure 46.** View of small canyon containing ruins in the Cajon Unit.

# Hovenweep Landscapes




**Figure 47** Hackberry and Horseshoe Unit sign..



**Figure 48.** View looking south down Hackberry Canyon. (HOVE PR-31)



**Figure 49.** View looking up Hackberry Canyon. (HOVE PR-33)

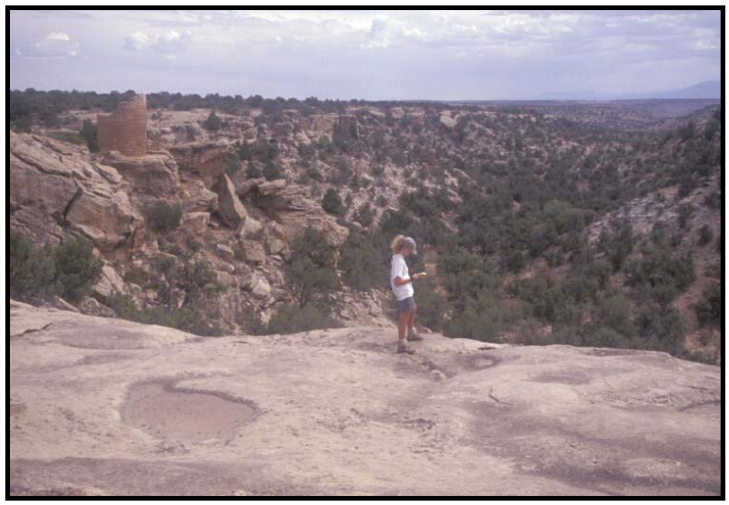


**Figure 50.** Kim Andersen standing above the canyon west of Hackberry Canyon in the Hackberry Unit (HOVE PR-39)

# Hovenweep Landscapes

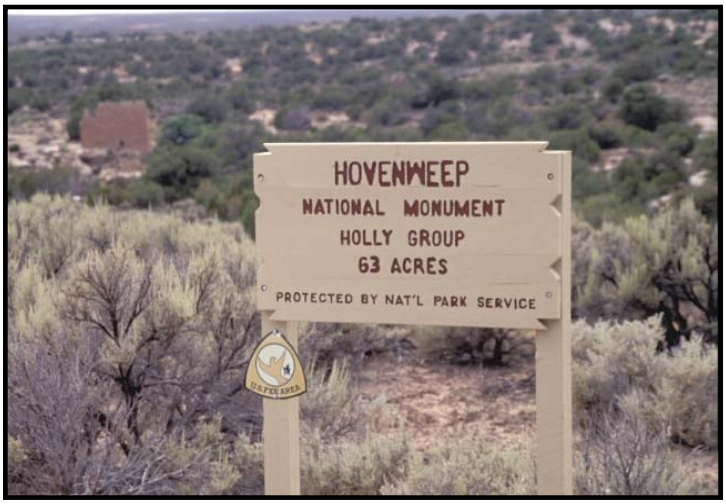



**Figure 51.** Sign at entrance to the Holly Group.



**Figure 52.** View of the canyon in the Holly Group.



**Figure 53**. View of the survey area in the Holly Group.

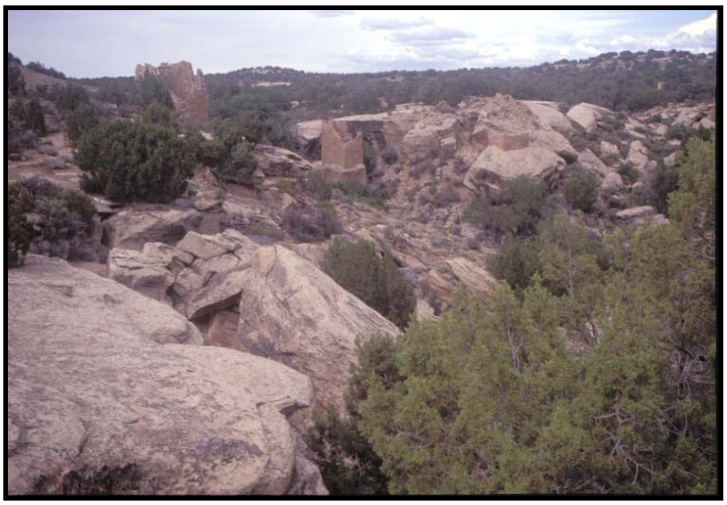


**Figure 54.** View of the canyons in the Holly Group.

# Hovenweep Landscapes



**Figure 55.** View looking down Little Ruin Canyon in the Square Tower Group.



**Figure 56.** View looking west up Little Ruin Canyon in the Square Tower Group. (HOVE PR-23)



**Figure 57.** View looking WNW up Little Ruin Canyon and uplands of the Square Tower Group. (HOVE PR-23)



**Figure 58.** Canyon east of Little Ruin Canyon in the Square Tower Group. (HOVE PR-25)

# Hovenweep Landscapes



**Figure 59.** View of the Square Tower Group Unit with the Sleeping Ute in the background. (HOVE PR-15)



**Figure 60.** View looking NNE at the sagebrush community of the Square Tower Group. (HOVE PR-16)



**Figure 61.** View looking west at the Cutthroat Castle Group Ruins. (HOVE PR-28)



**Figure 62.** Looking NNE at the Cutthroat Castle Group Ruins. (HOVE PR-29)

# Crew



**Figure 63.** Steve Dewey doing a quality control check of *Linaria dalmatica* found in the Goodman Point Unit.




**Figure 64.** Steve Dewey outside of the Holly Group Unit.

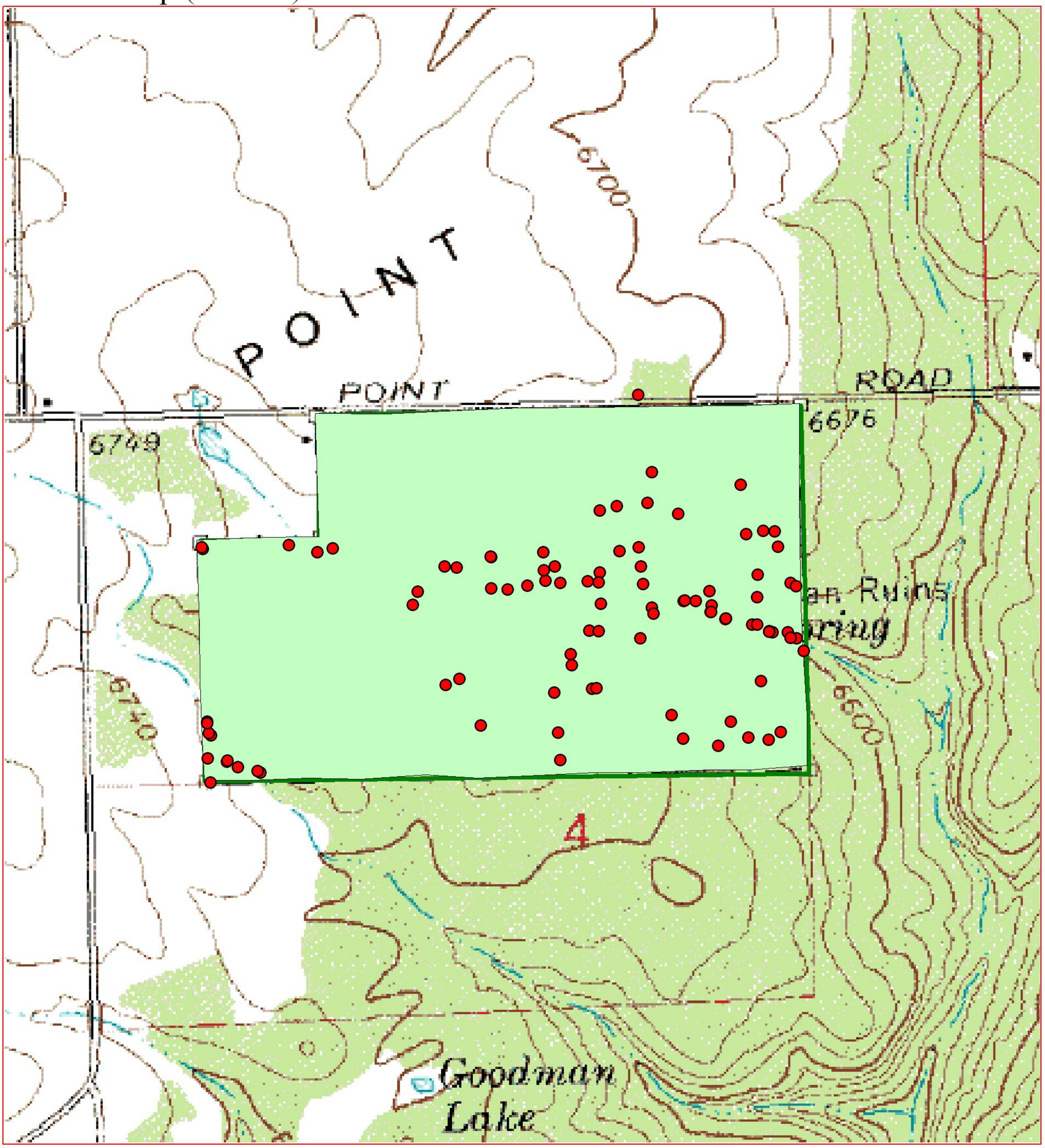


**Figure 65.** Kim Andersen mapping *Linaria dalmatica* in the Goodman Point Unit.



**Figure 66.** Kim Andersen taking a voucher photograph of *Carduus nutans* in the Goodman Point Unit.

# Appendix H. Overall Weed Distribution in Inventoried Areas - Goodman Point Group (Inset A)




Weed Points

Inventoried Area

Monument boundary

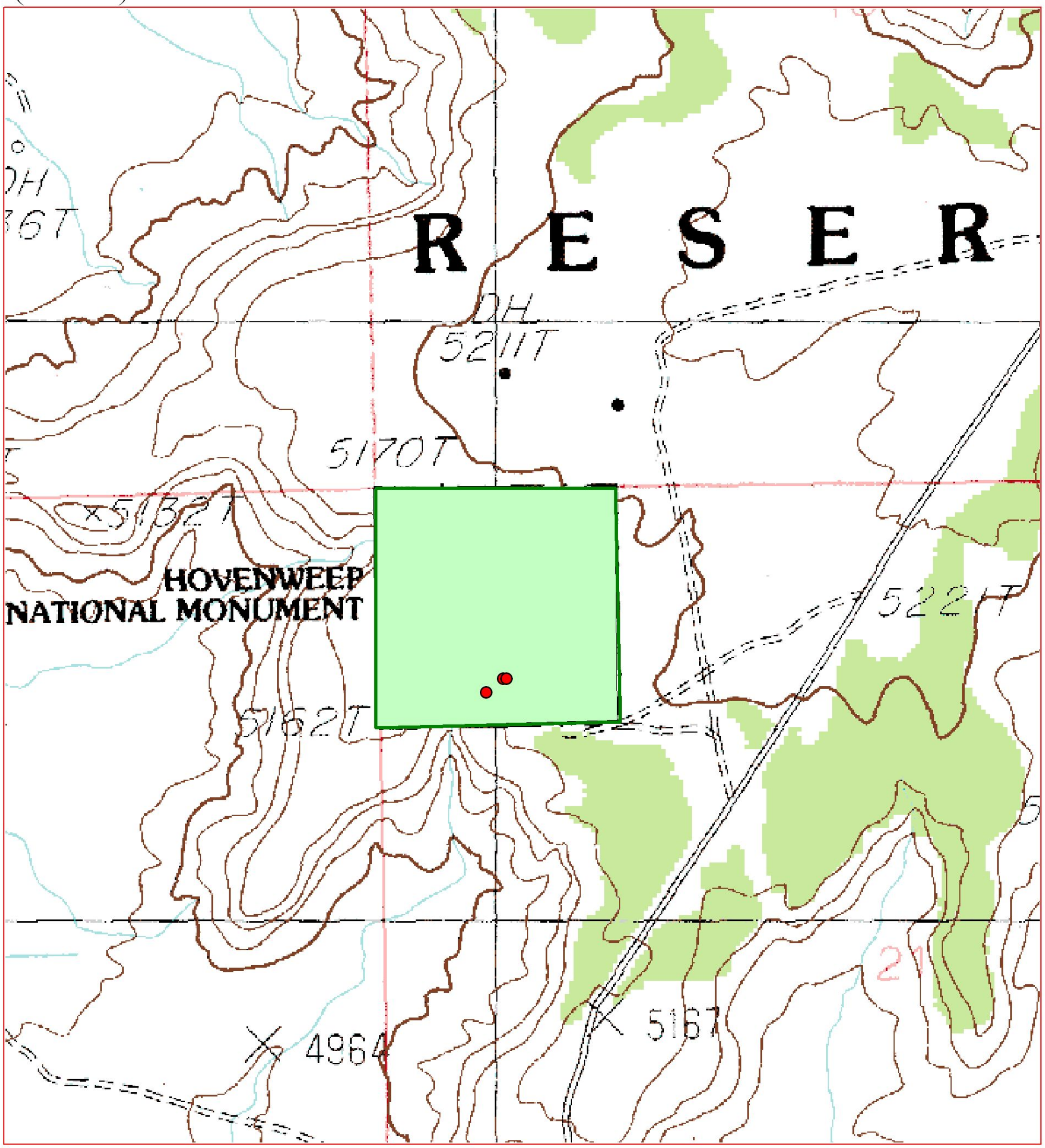
0 500 1000 1500 Feet

1:9,000 Scale

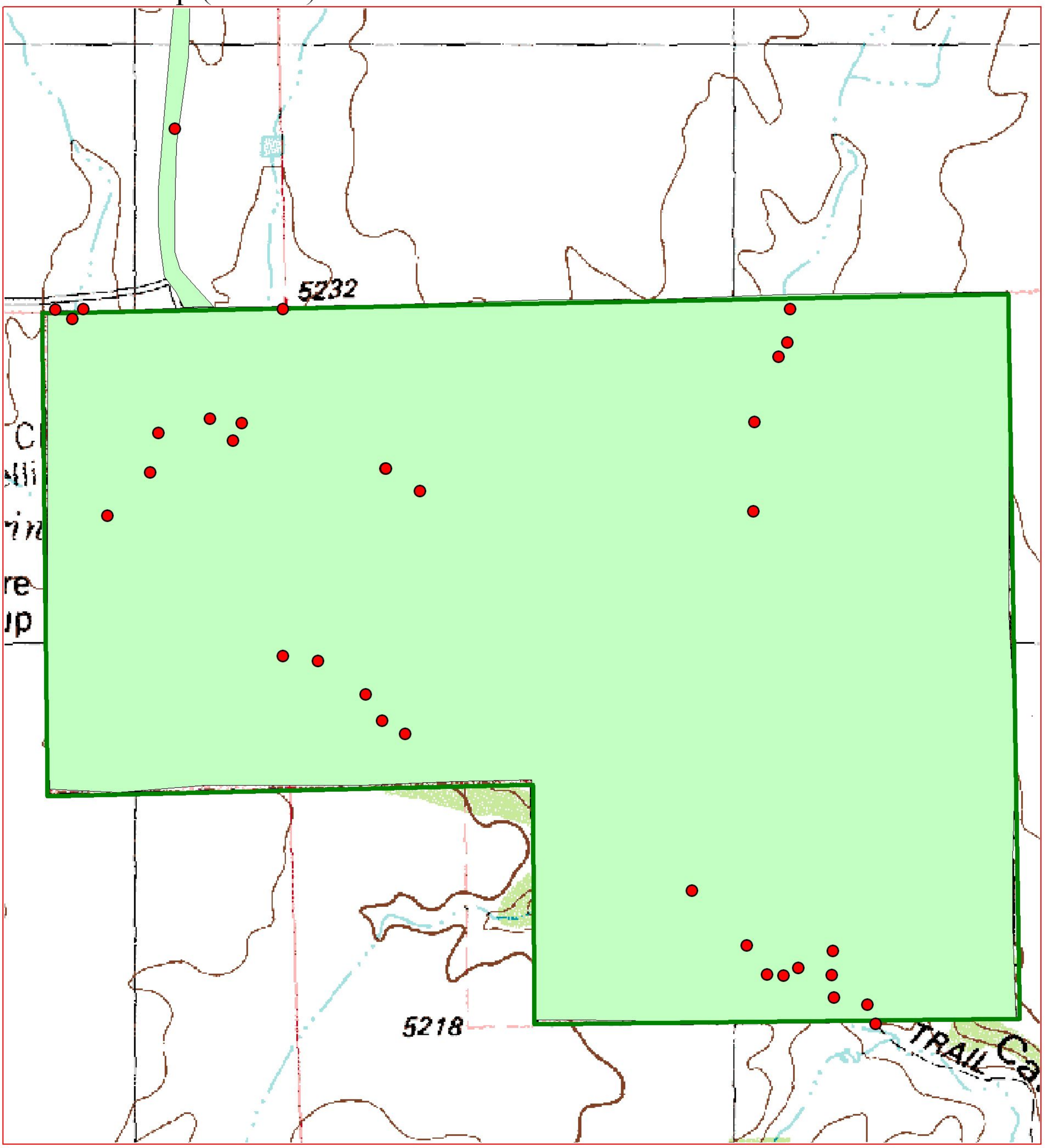
N

Inset A
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Cajon Group (Inset B)



# Appendix H. Overall Weed Distribution in Inventoried Areas - Square Tower Group (Inset C)




Weed Points

Inventoried Area

Monument boundary

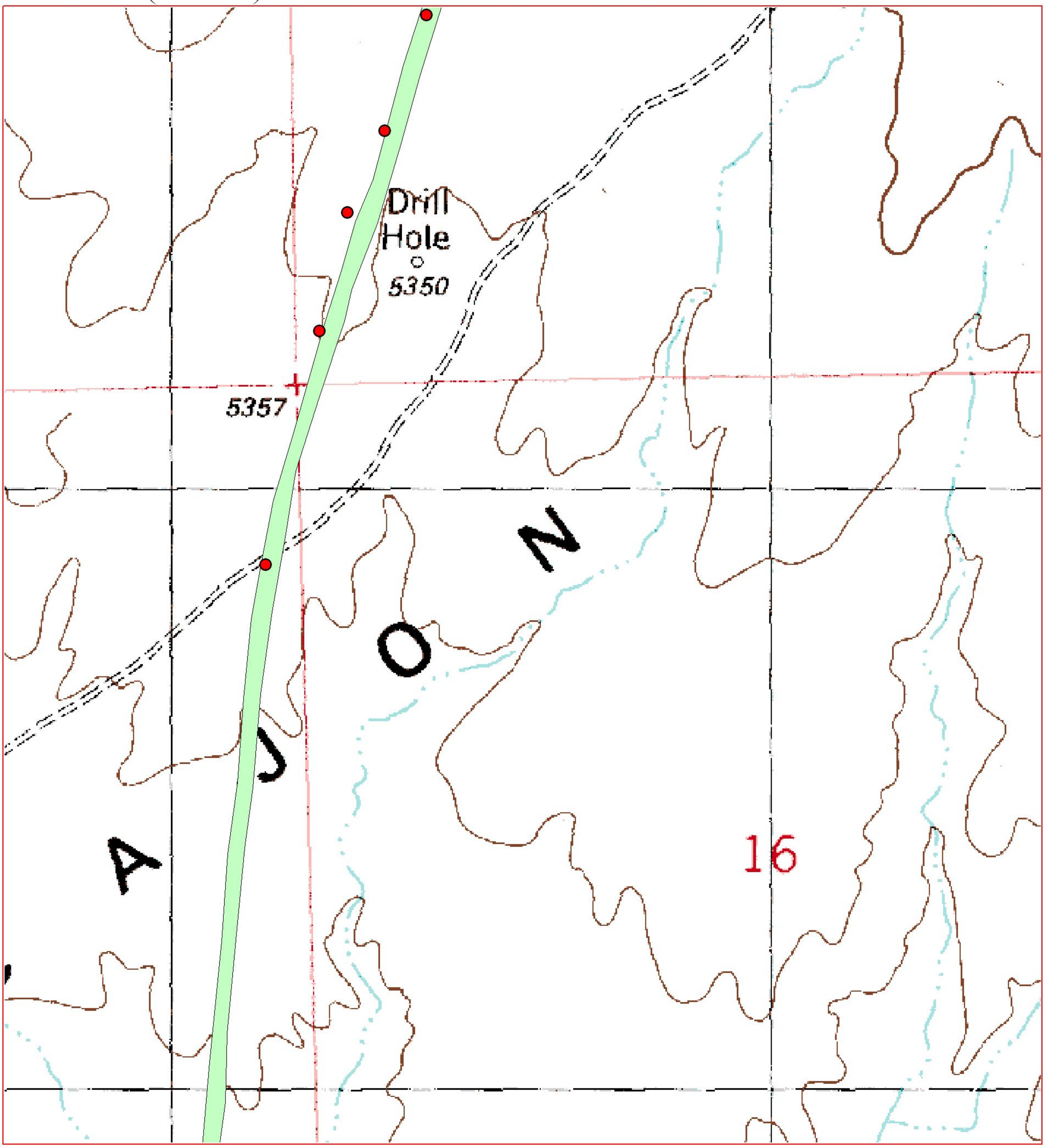
0 500 1000 1500 Feet

1:9,000 Scale

N

Inset C
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Road Section 1 (Inset D)




0 500 1000 1500 Feet

1:9,000 Scale

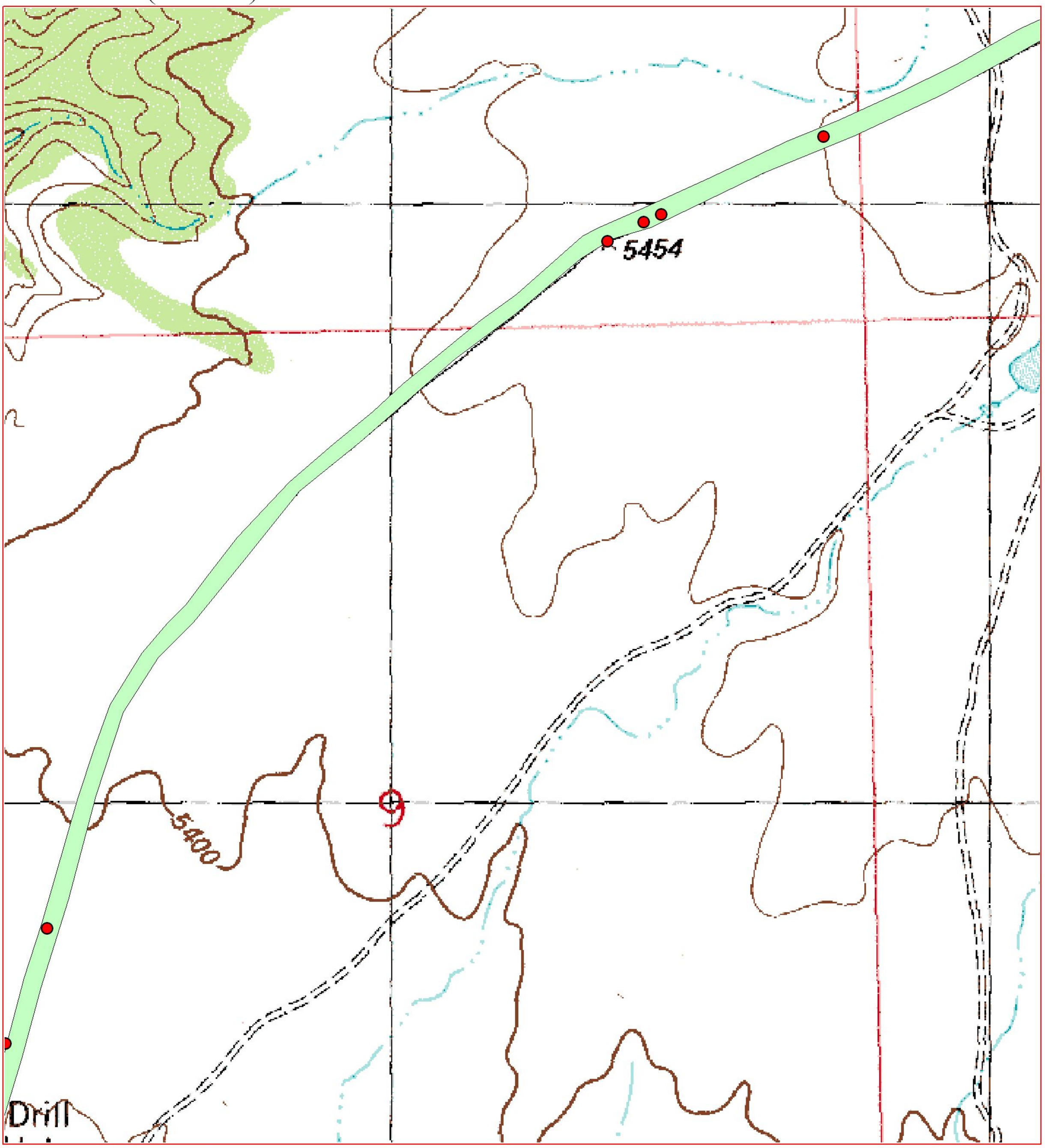
Weed Points

Inventoried Area

N

Inset D
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Road Section 2 (Inset E)




0 500 1000 1500 Feet

1:9,000 Scale

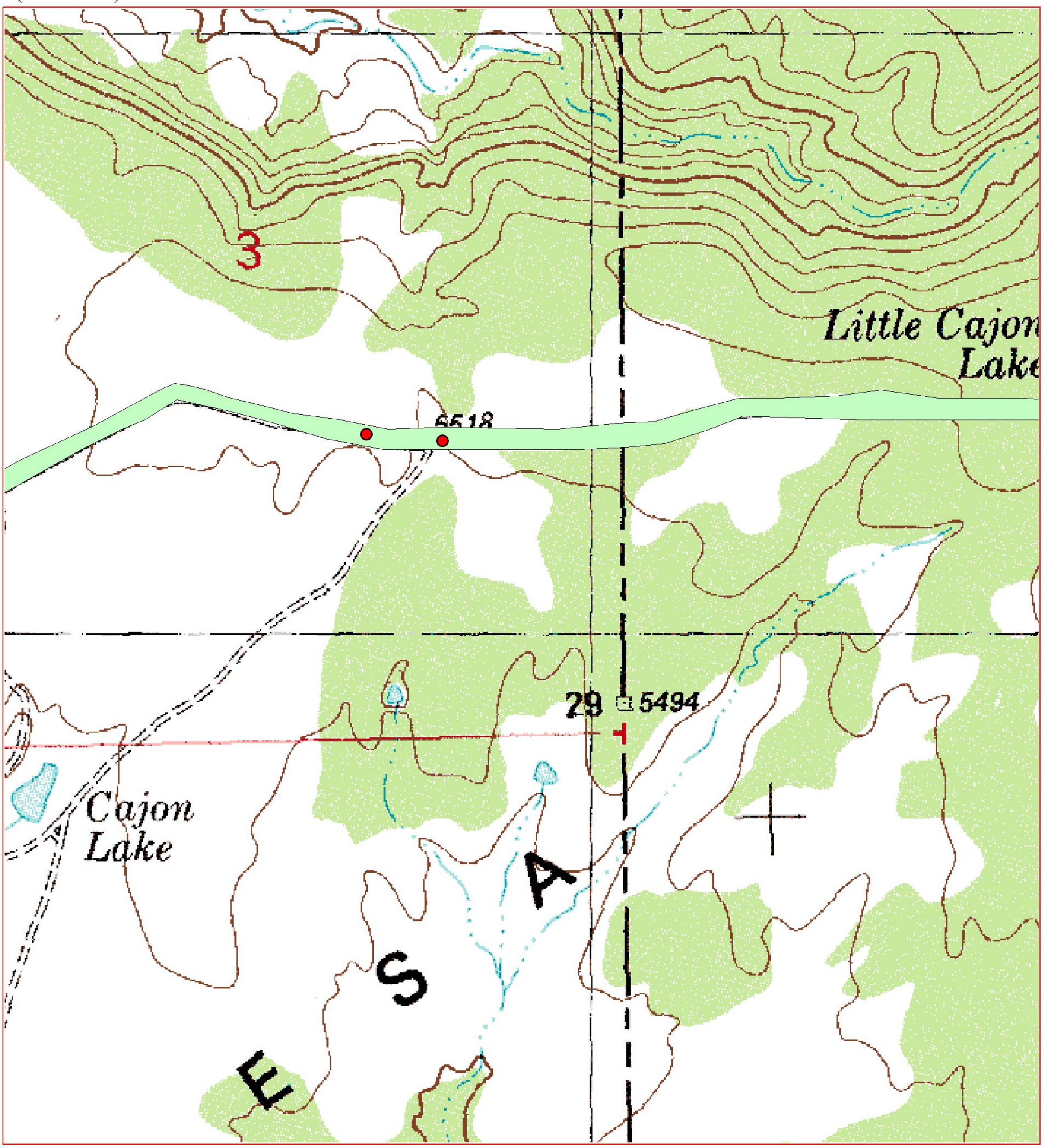
Weed Points

Inventoried Area

N

Inset E
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Cajon Lake (Inset F)




0 500 1000 1500 Feet

1:9,000 Scale

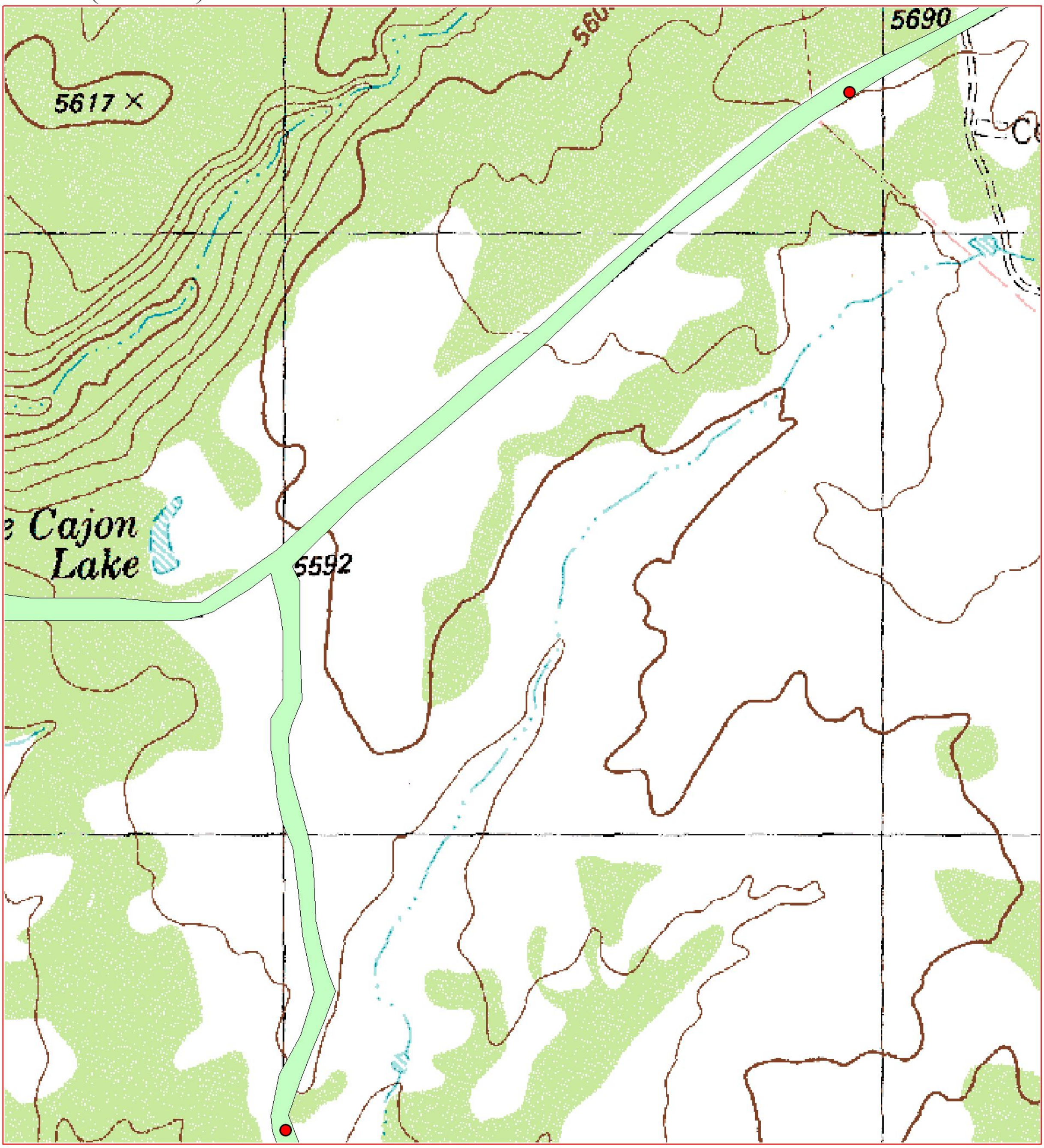
N

Weed Points

Inventoried Area

Inset F
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Little Cajon Lake (Inset G)




0 500 1000 1500 Feet

1:9,000 Scale

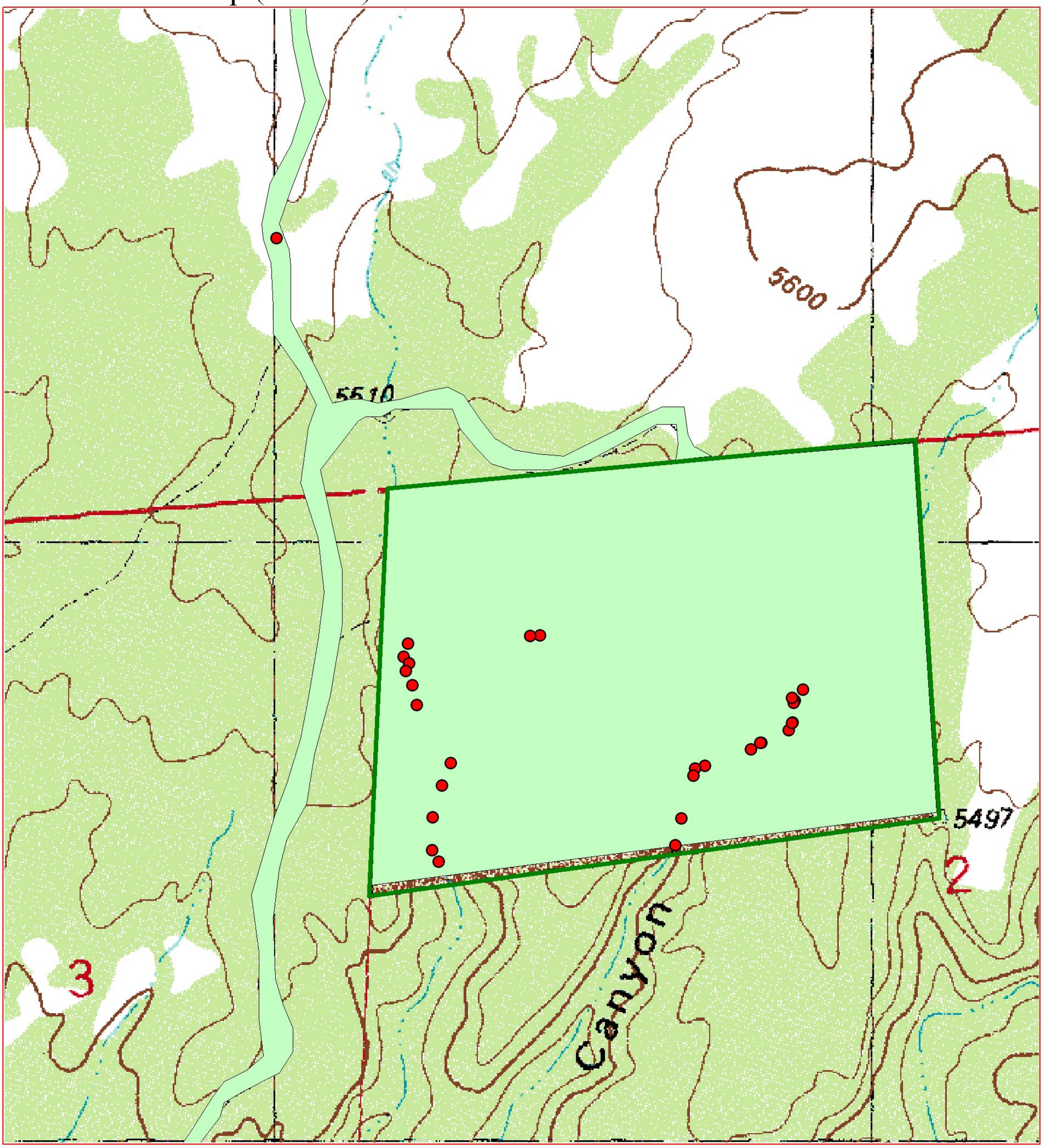
N

Weed Points

Inventoried Area

Inset G
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Hackberry and Horseshoe Group (Inset H)




0 500 1000 1500 Feet

1:9,000 Scale

N

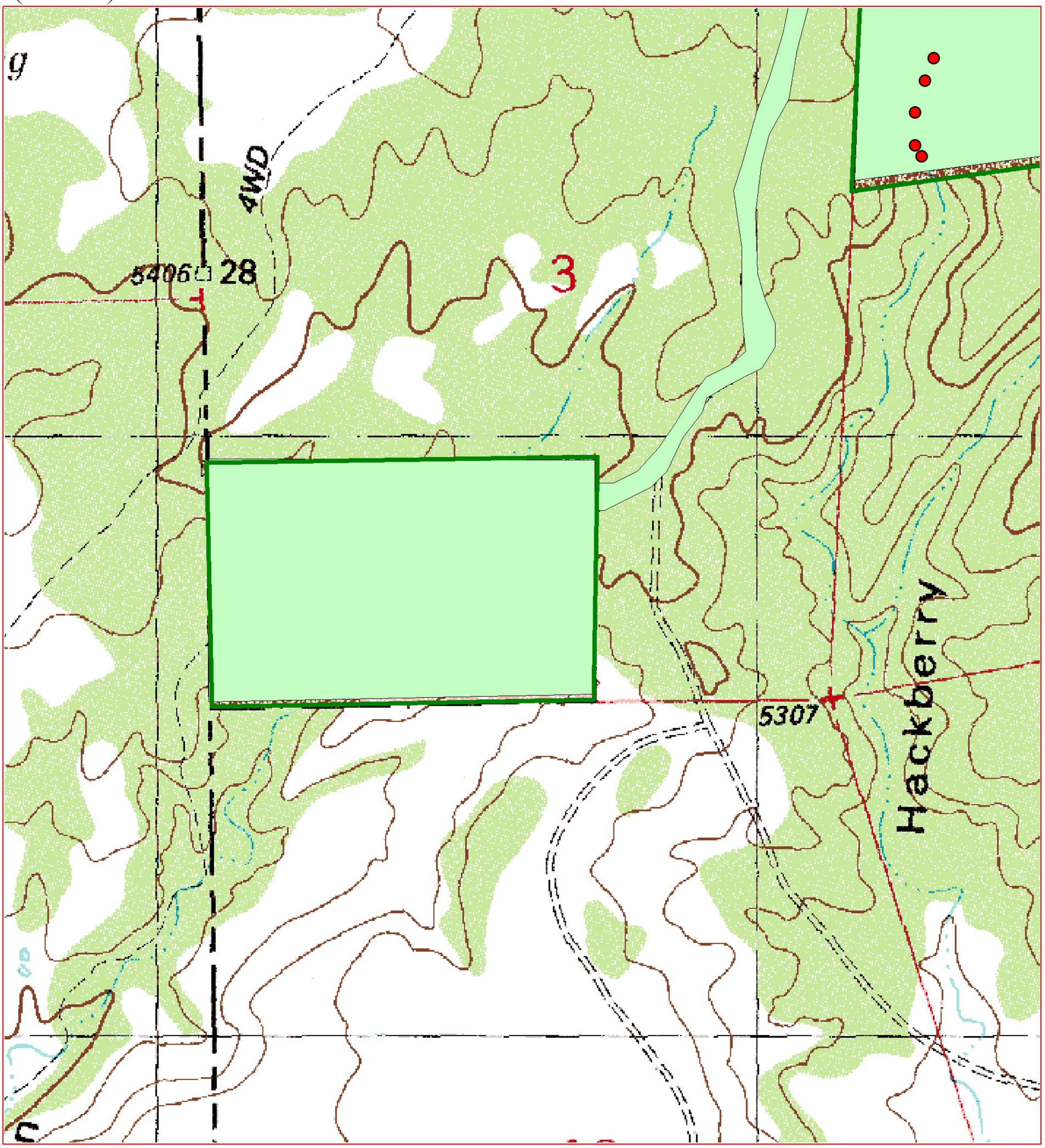
Weed Points

Inventoried Area

Monument boundary

Inset H
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Holly Unit (Inset I)




0 500 1000 1500 Feet

1:9,000 Scale

N

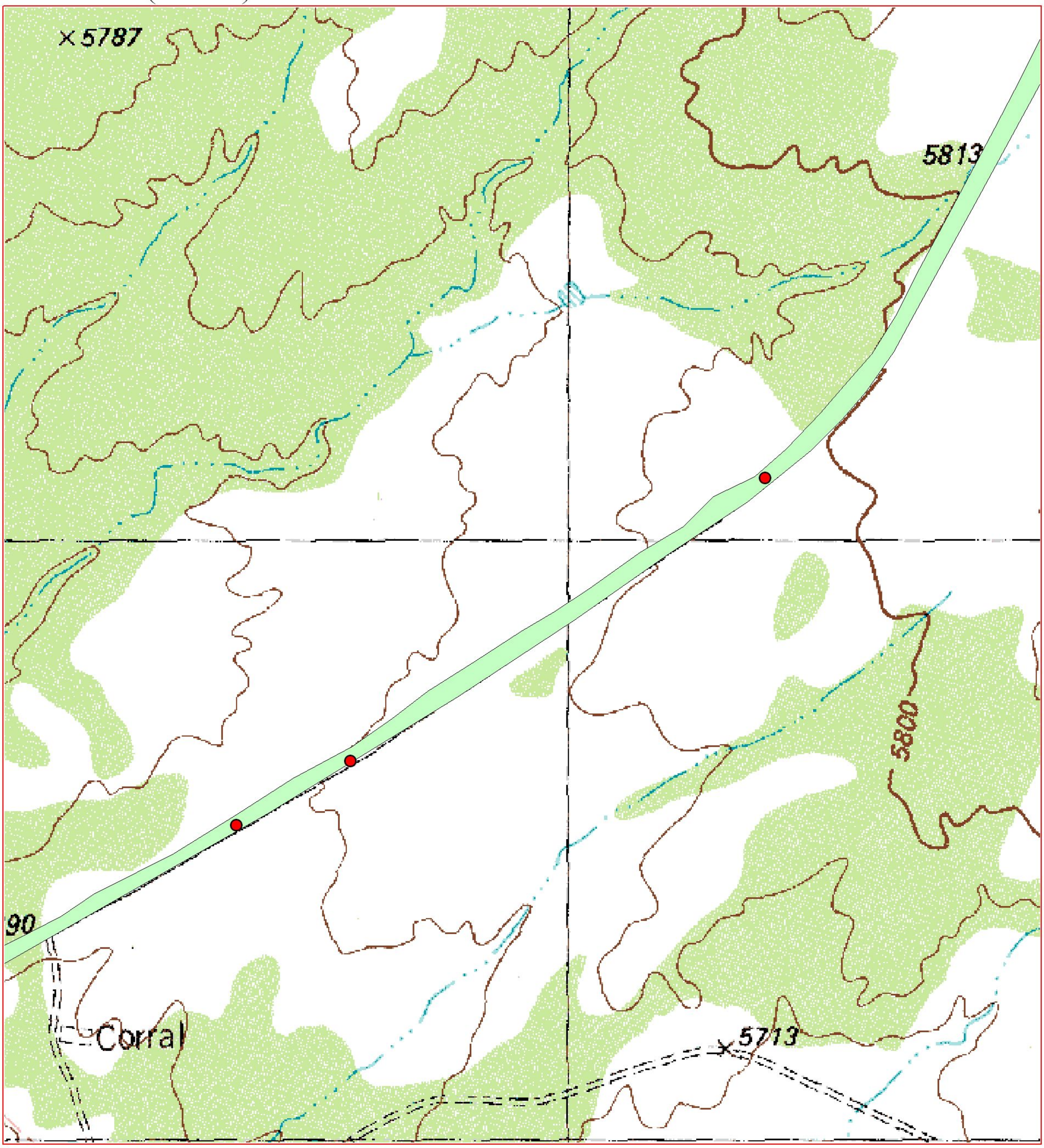
Weed Points

Inventoried Area

Monument boundary

Inset I
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Road Section 3 (Inset J)




0 500 1000 1500 Feet

1:9,000 Scale

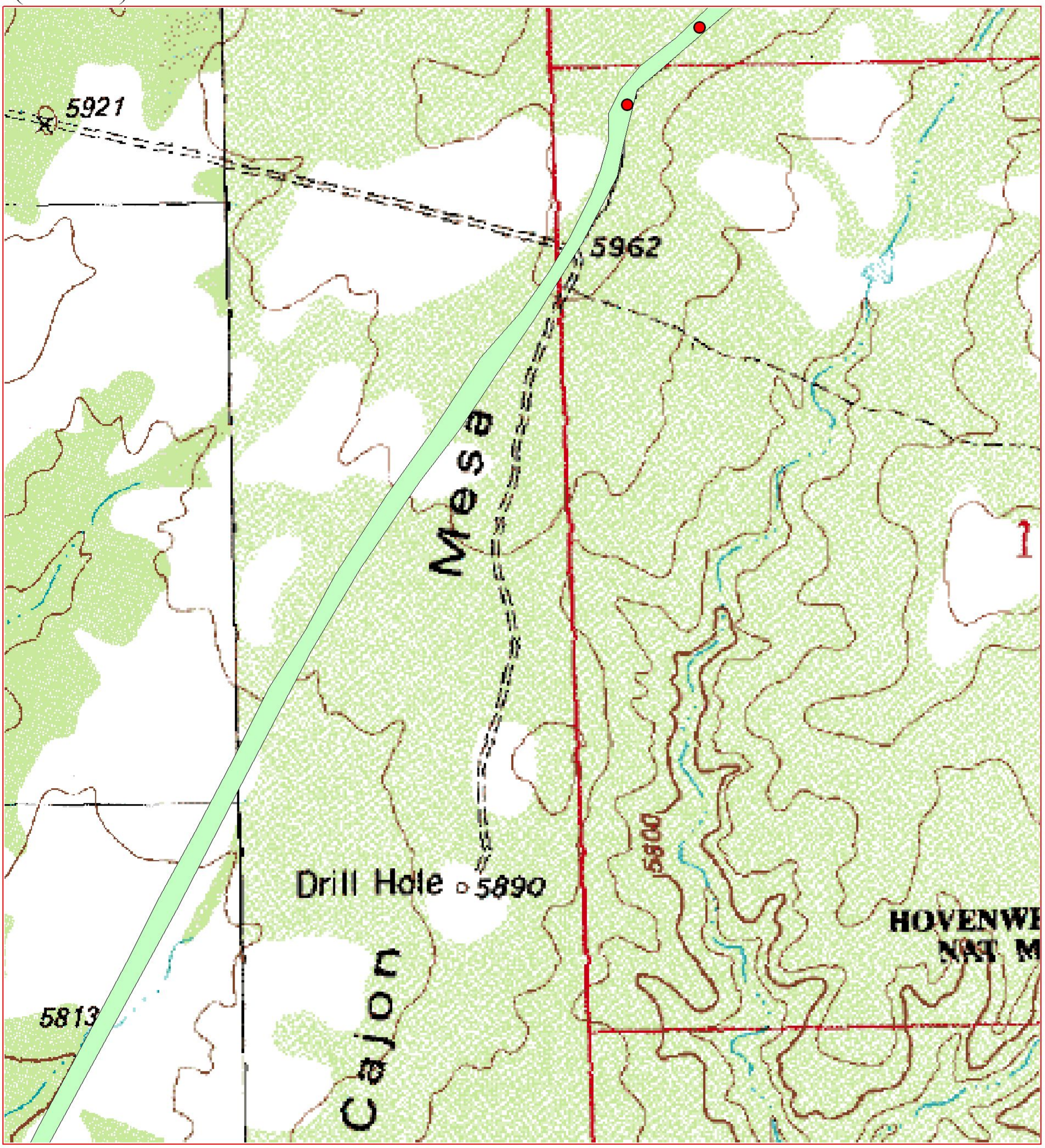
Weed Points

Inventoried Area

N

Inset J
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Cajon Mesa (Inset K)




0 500 1000 1500 Feet

1:9,000 Scale

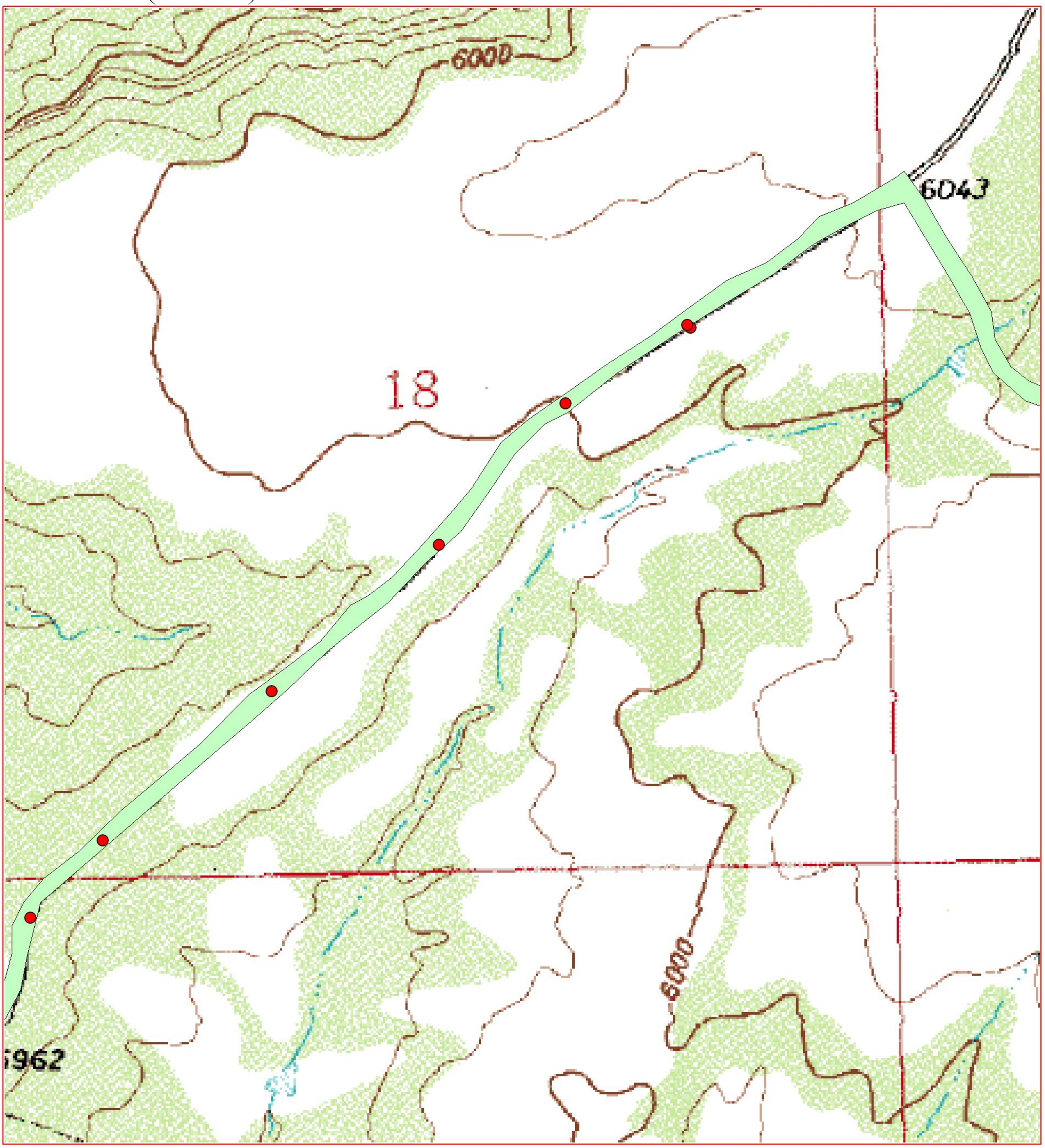
N

Weed Points

Inventoried Area

Inset K
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Road Section 4 (Inset L)




0 500 1000 1500 Feet

1:9,000 Scale

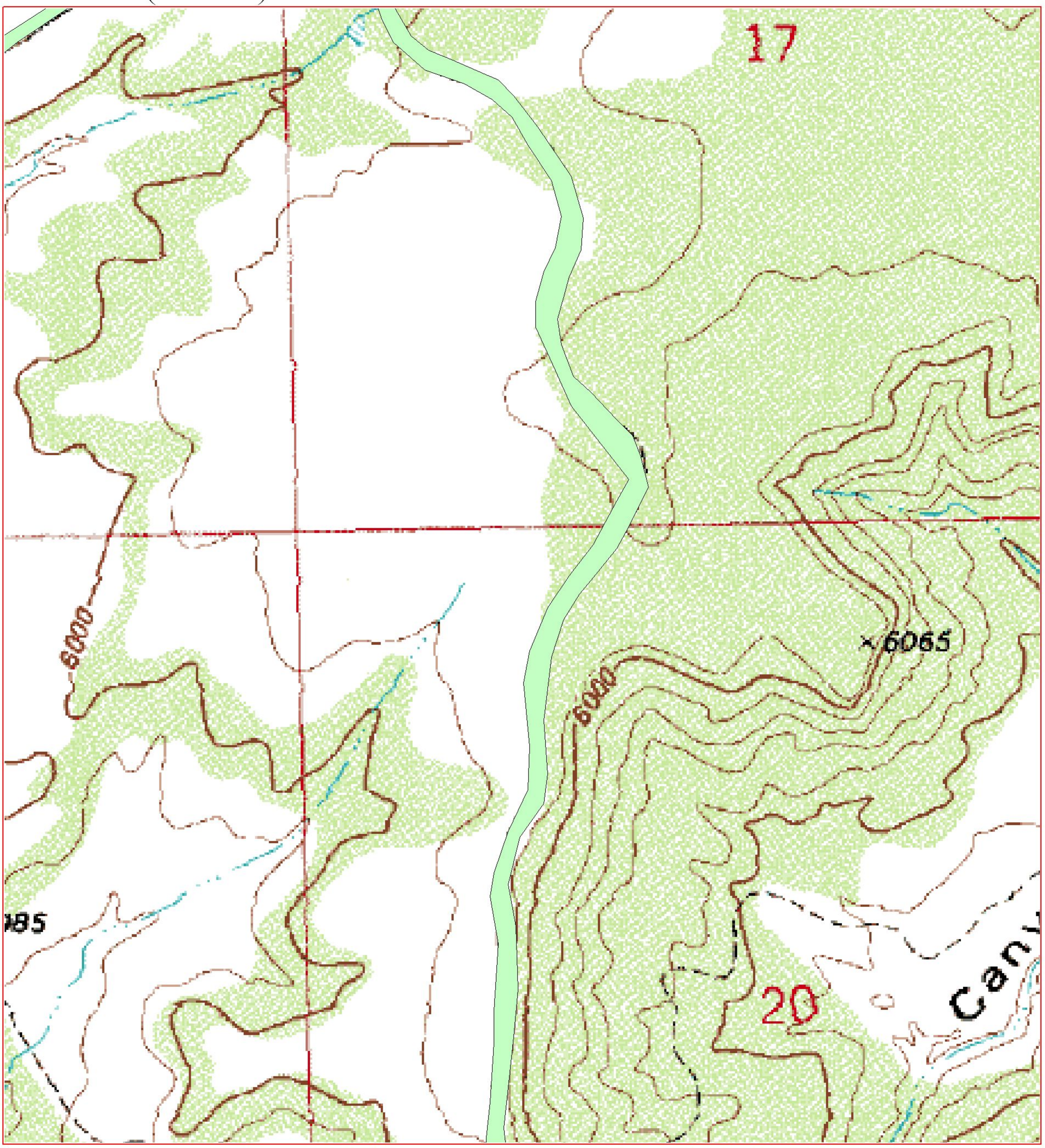
N

Weed Points

Inventoried Area

Inset L
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Road Section 5 (Inset M)



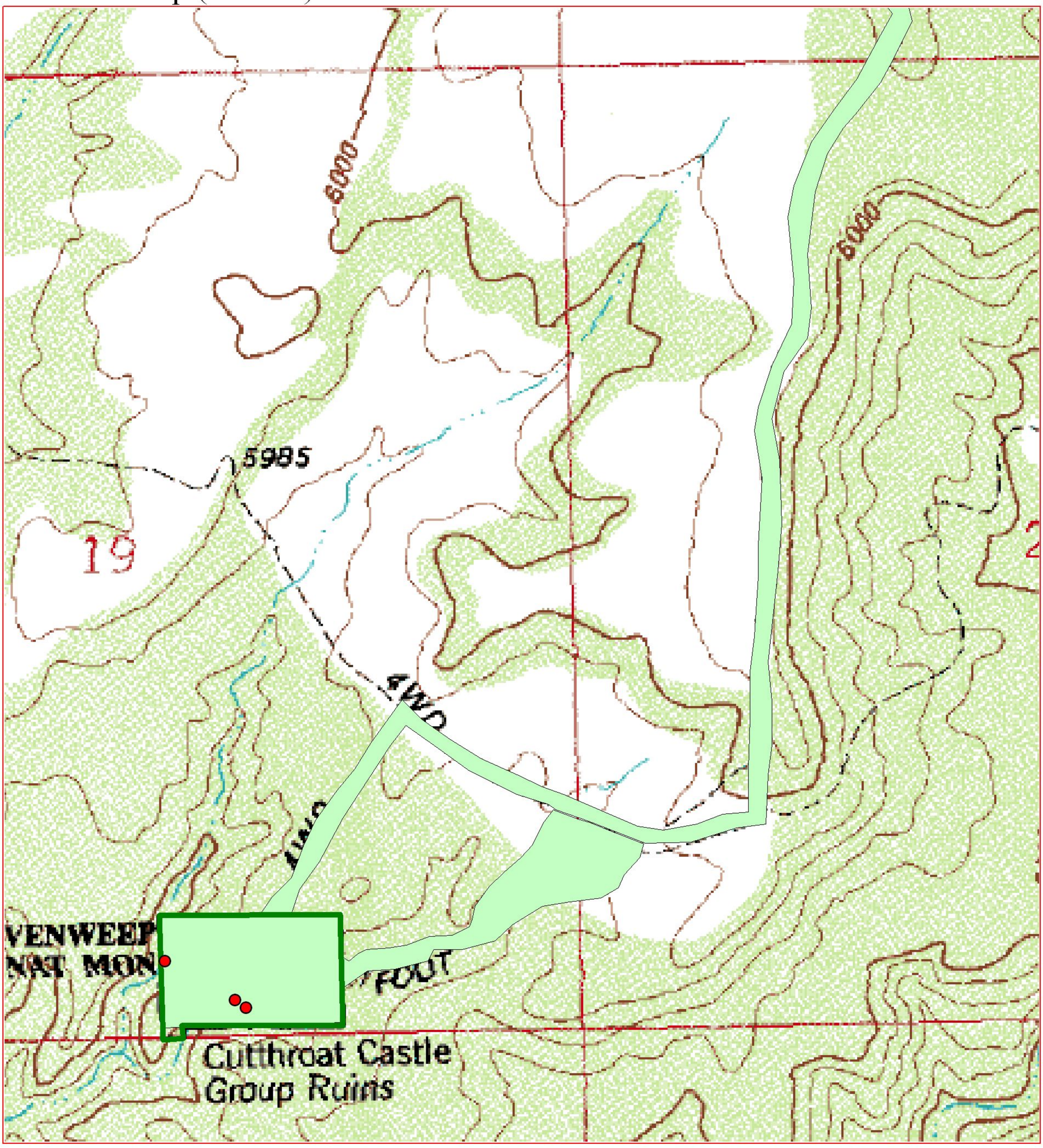

* No Targeted Species Detected

Inventoried Area

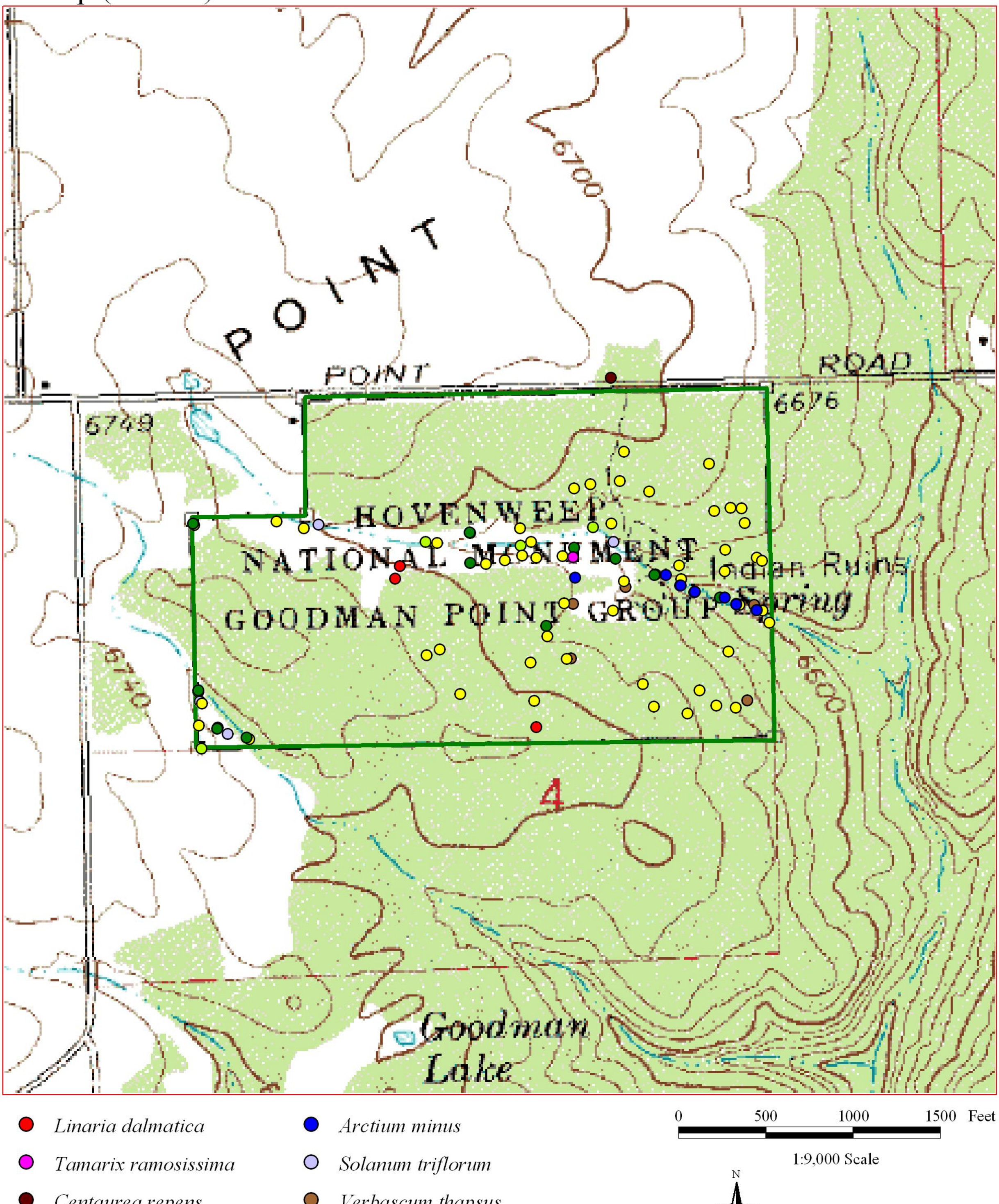


Inset M
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix H. Overall Weed Distribution in Inventoried Areas - Cutthroat Castle Group (Inset N)



# Appendix I. Weed Species Detected in Inventoried Areas - Goodman Point Group (Inset A)




- *Linaria dalmatica*
- *Tamarix ramosissima*
- *Centaurea repens*
- *Carduus nutans*
- *Cirsium arvense*
- *Arctium minus*
- *Solanum triflorum*
- *Verbascum thapsus*
- *Convolvulus arvensis*
- Monument boundary

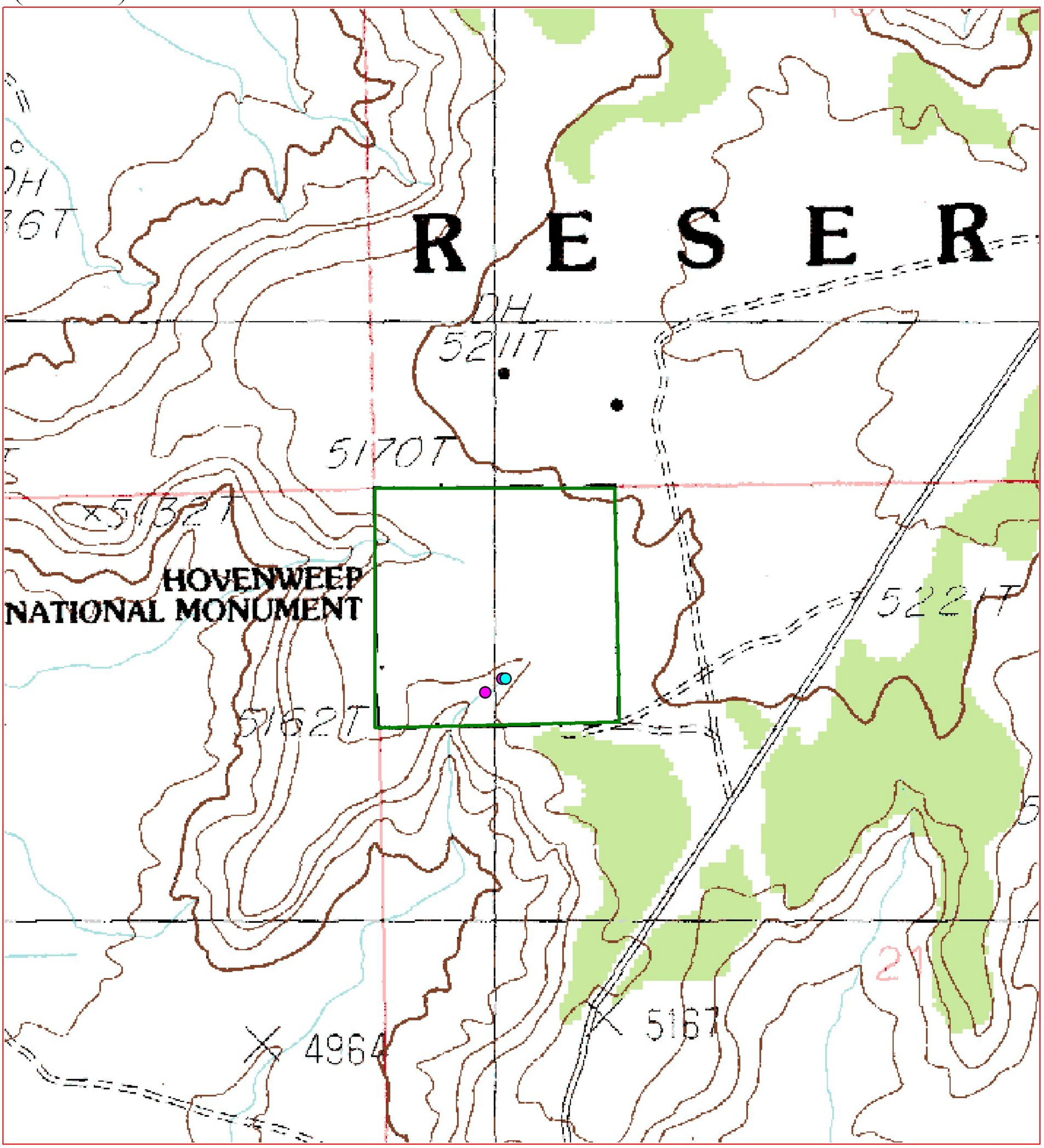
0 500 1000 1500 Feet

1:9,000 Scale

N

Inset A
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Cajon Group (Inset B)




*Marrubium vulgare*

*Tamarix ramosissima*

Monument boundary

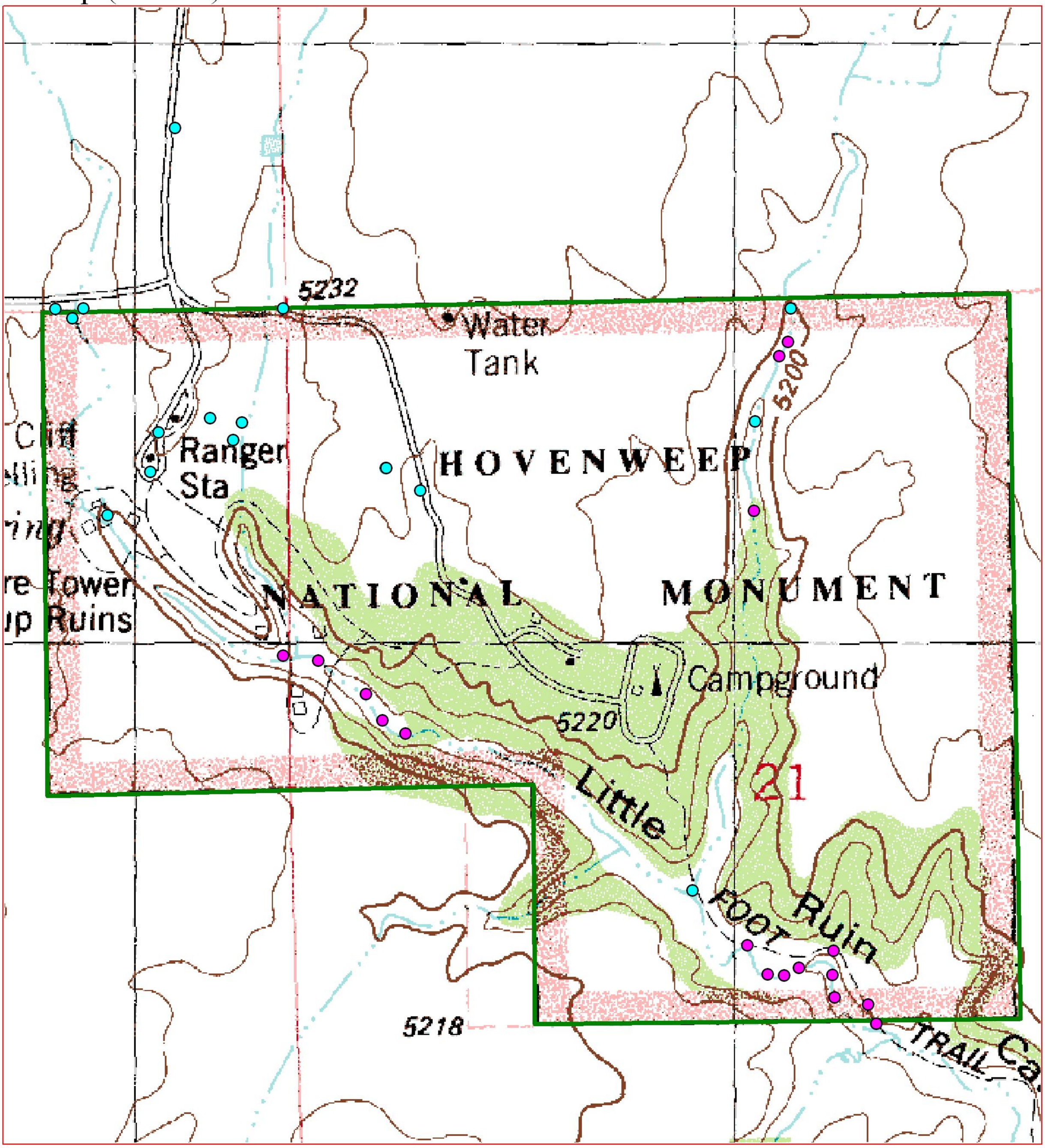
0 500 1000 1500 Feet

1:9,000 Scale

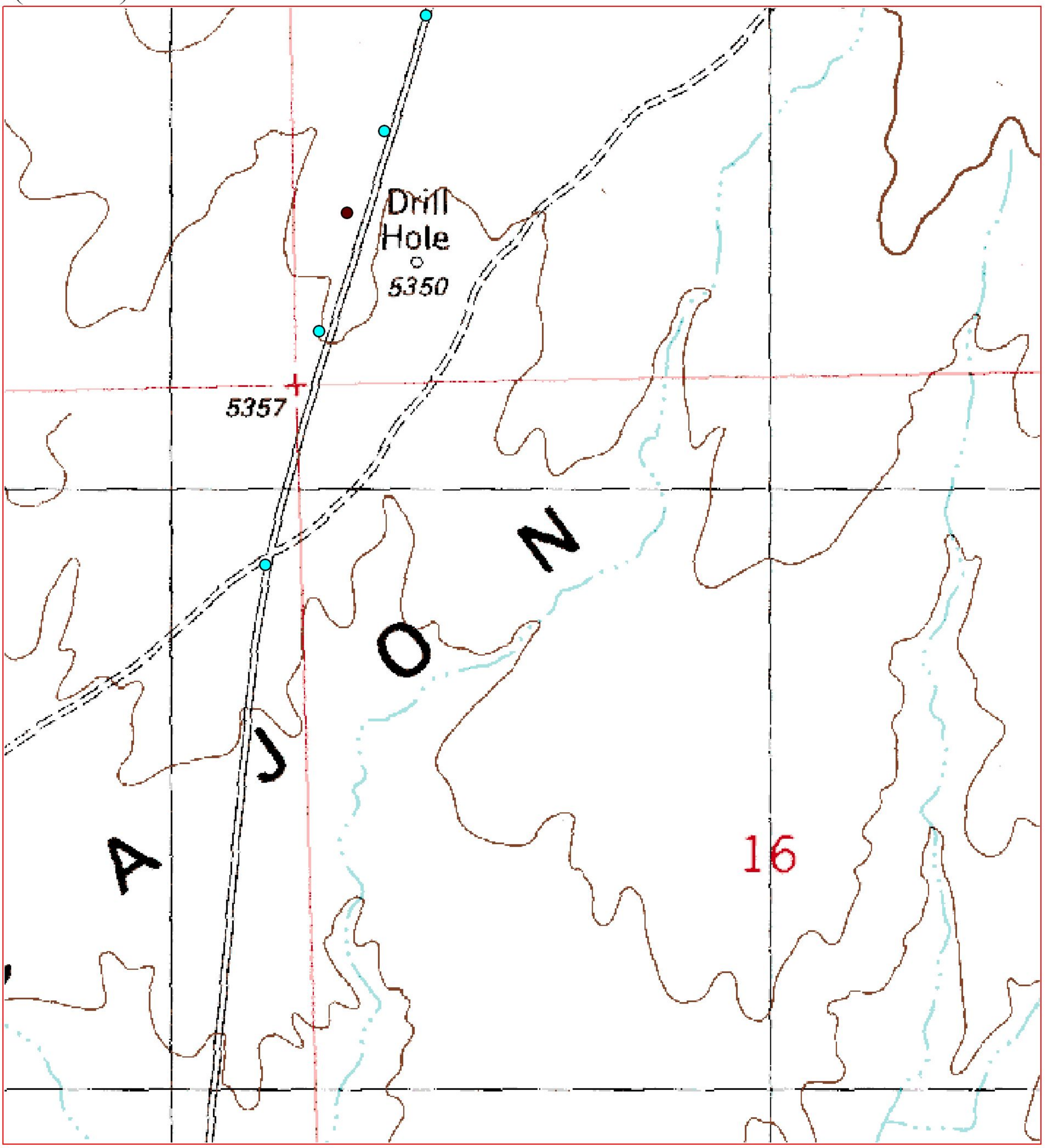
N

Inset B
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

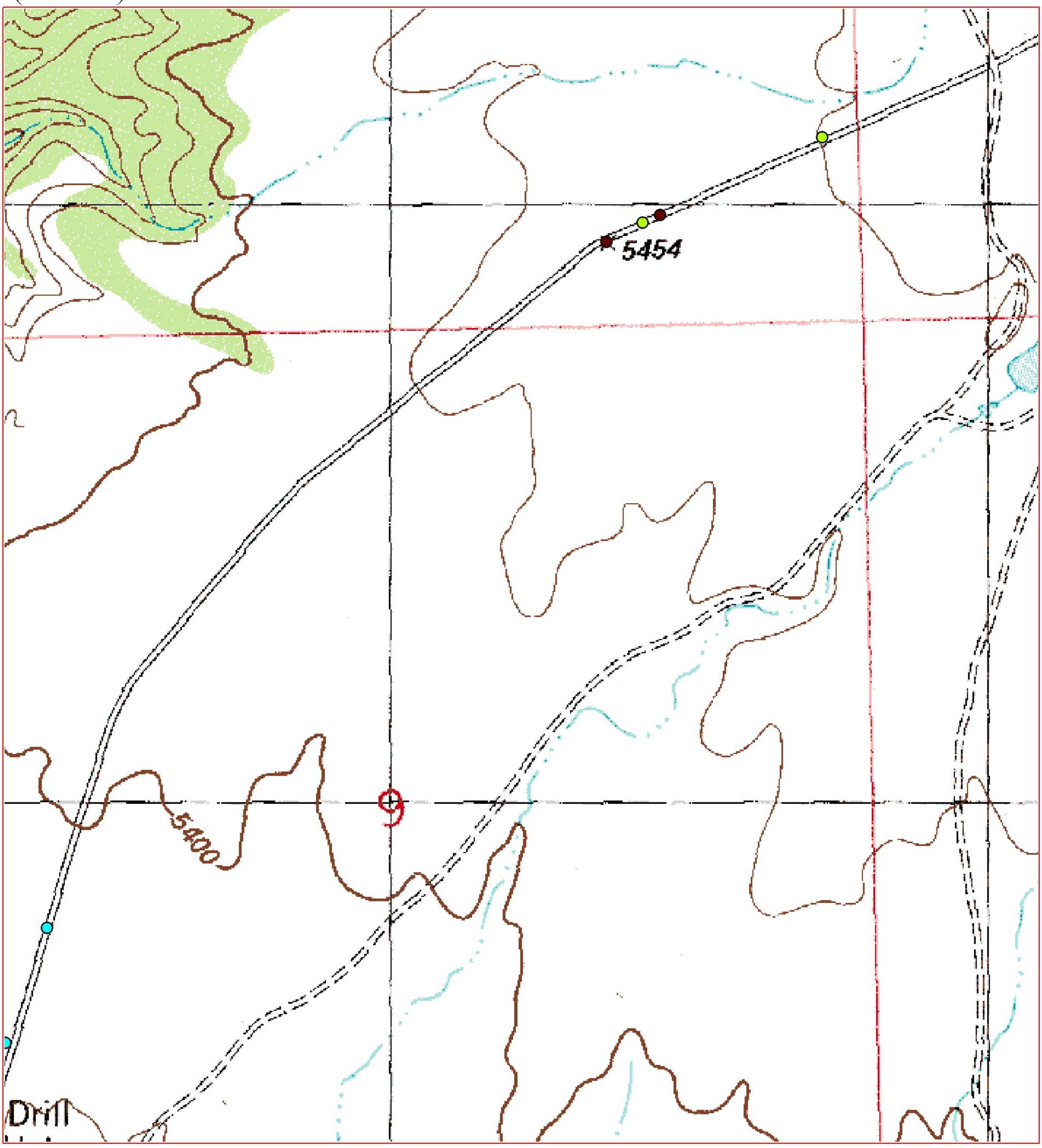
# Appendix I. Weed Species Detected in Inventoried Areas - Square Tower Group (Inset C)



# Appendix I. Weed Species Detected in Inventoried Areas - Road Section 1 (Inset D)



# Appendix I. Weed Species Detected in Inventoried Areas - Road Section 2 (Inset E)




0 500 1000 1500 Feet

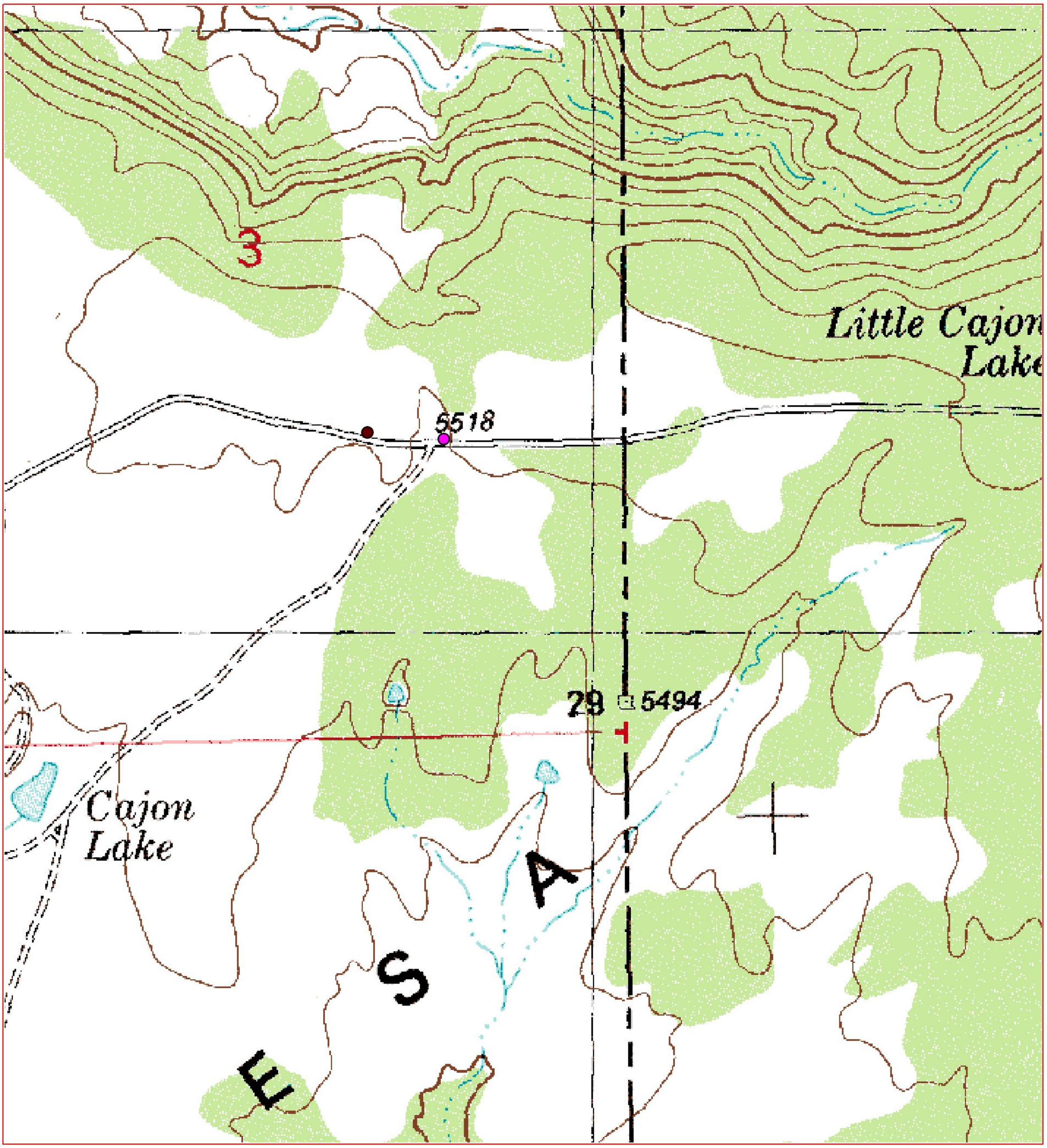
1:9,000 Scale

N

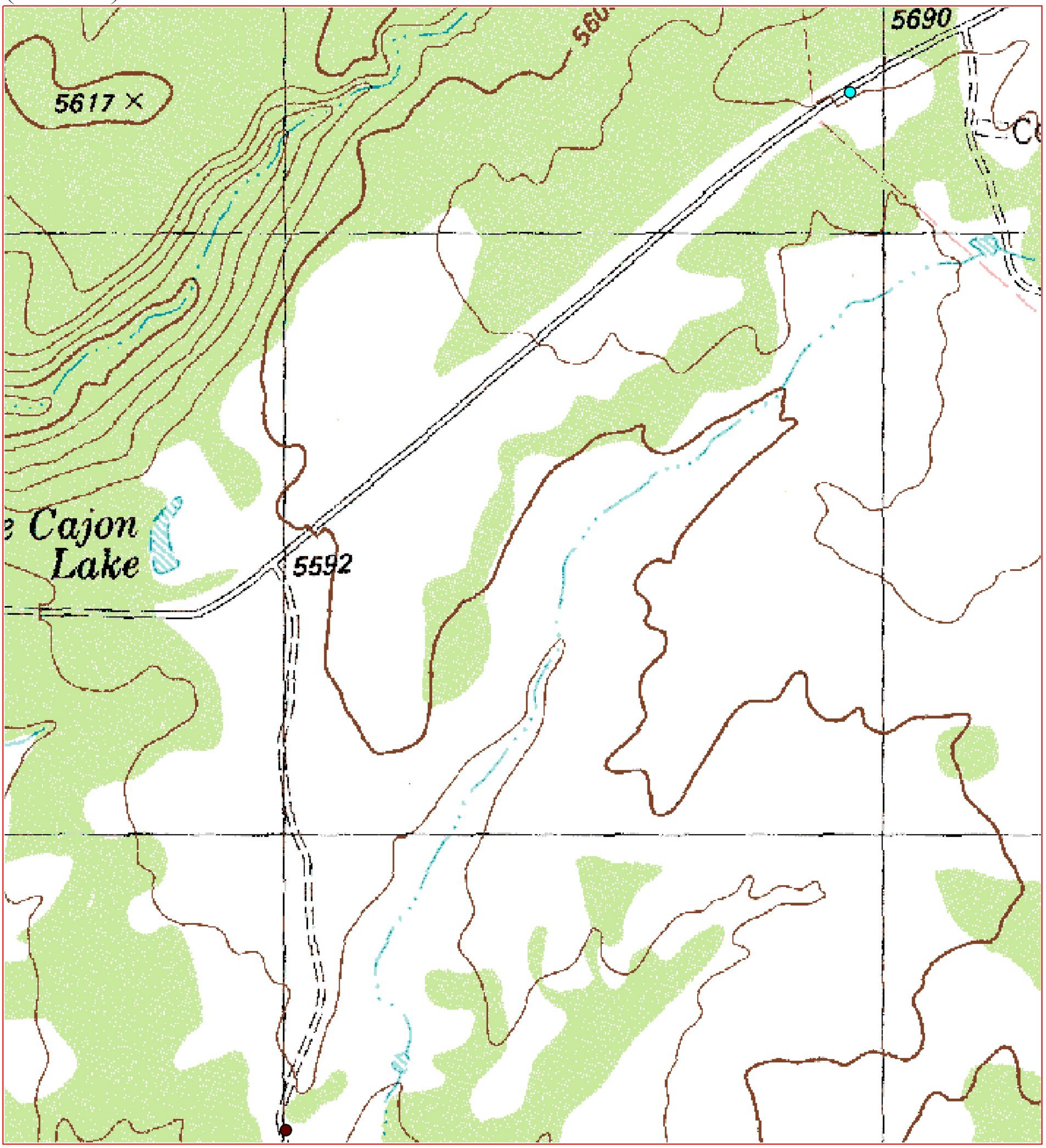
- *Centaurea repens*
- *Lepidium latifolium*
- *Marrubium vulgare*

Inset E
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Cajon Lake (Inset F)



# Appendix I. Weed Species Detected in Inventoried Areas - Little Cajon Lake (Inset G)




0 500 1000 1500 Feet

1:9,000 Scale

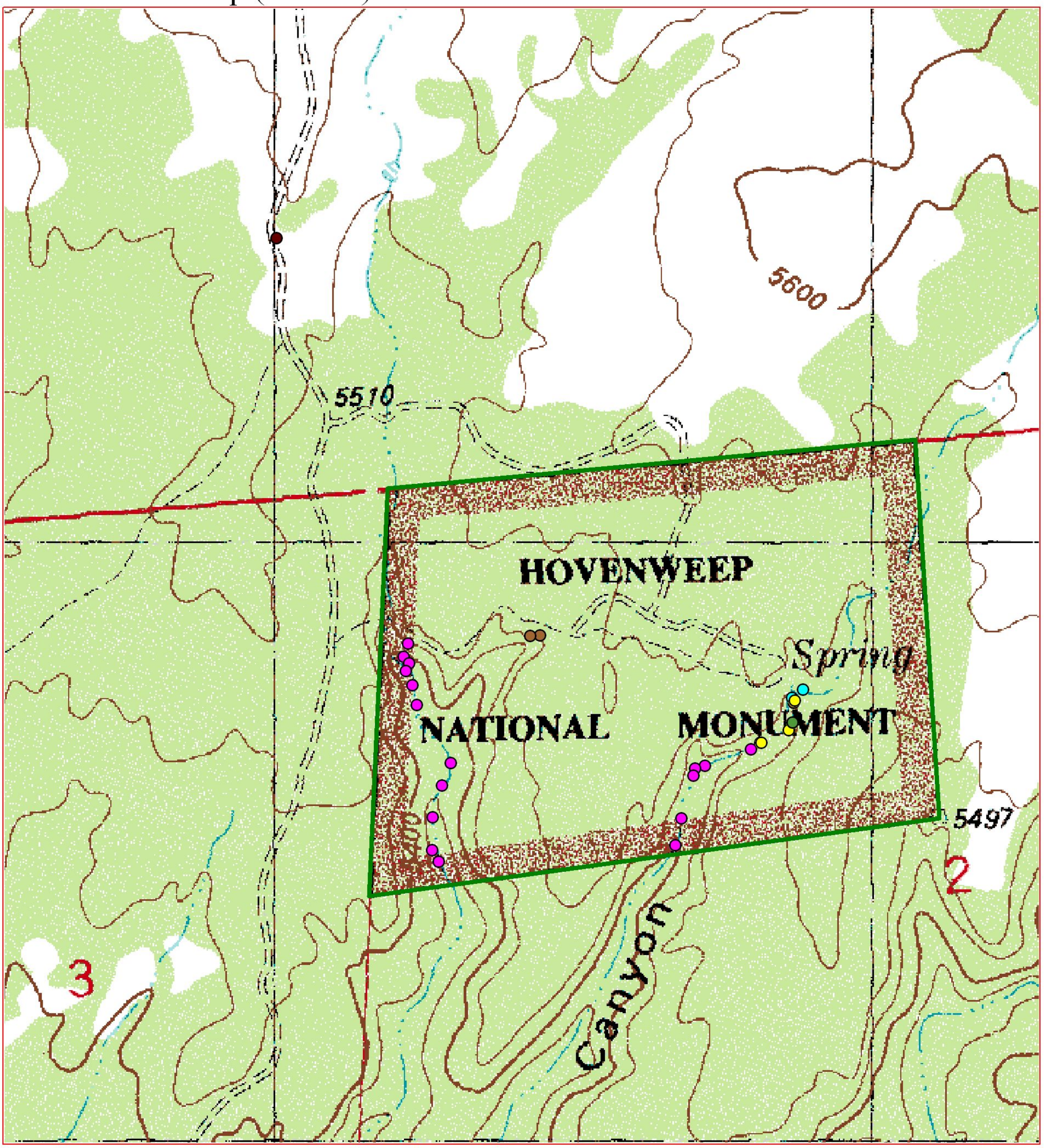
N

● *Centaurea repens*

● *Marrubium vulgare*

Inset G
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Hackberry and Horseshoe Group (Inset H)




- *Carduus nutans*
- *Centaurea repens*
- *Cirsium arvense*
- *Marrubium vulgare*
- *Tamarix ramosissima*
- *Verbascum thapsus*
- Monument boundary

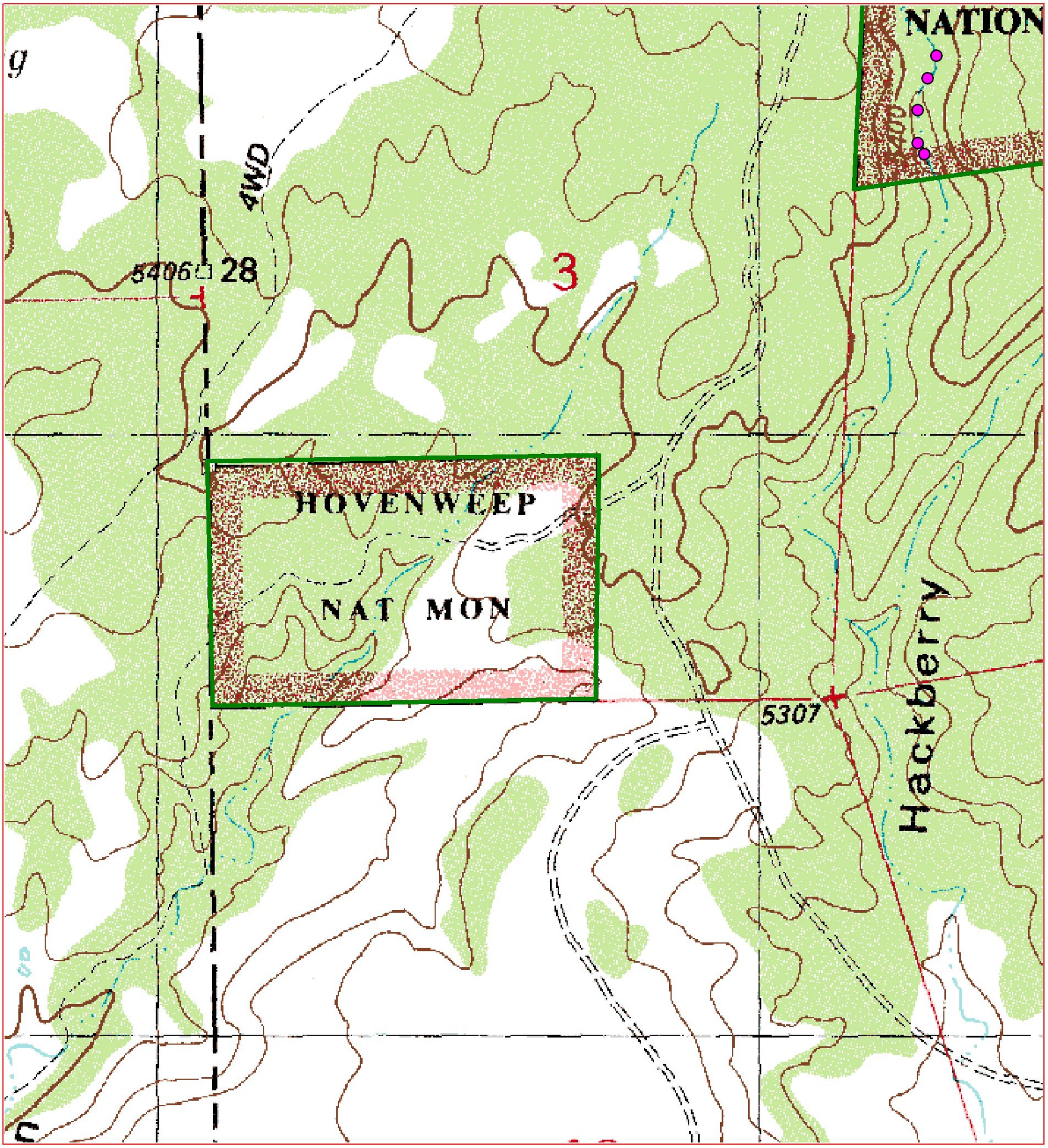
0 500 1000 1500 Feet

1:9,000 Scale

N

Inset H
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Holly Unit (Inset I)

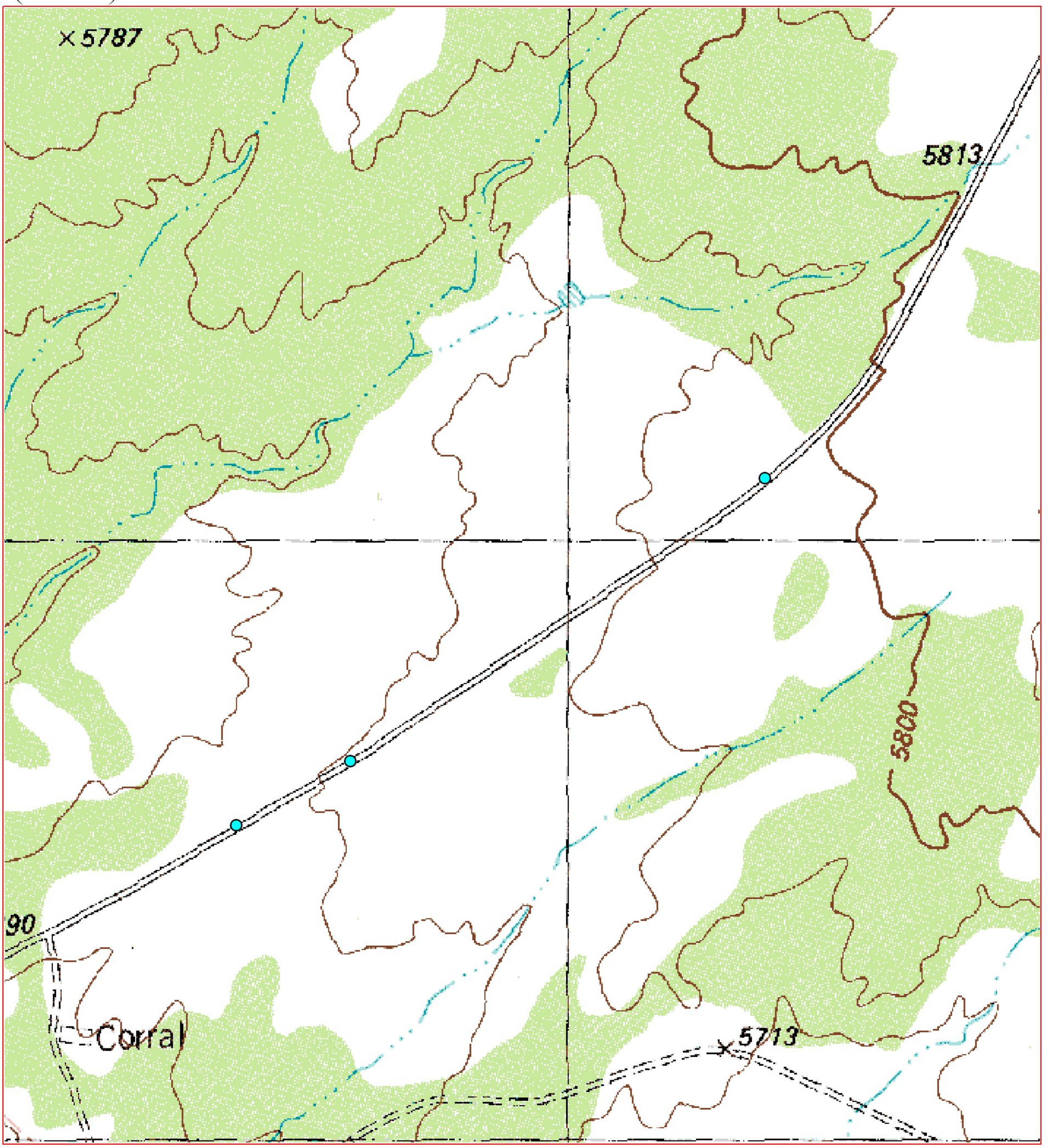



*Tamarix ramosissima*

Monument boundary

Inset I
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Road Section 3 (Inset J)




0 500 1000 1500 Feet

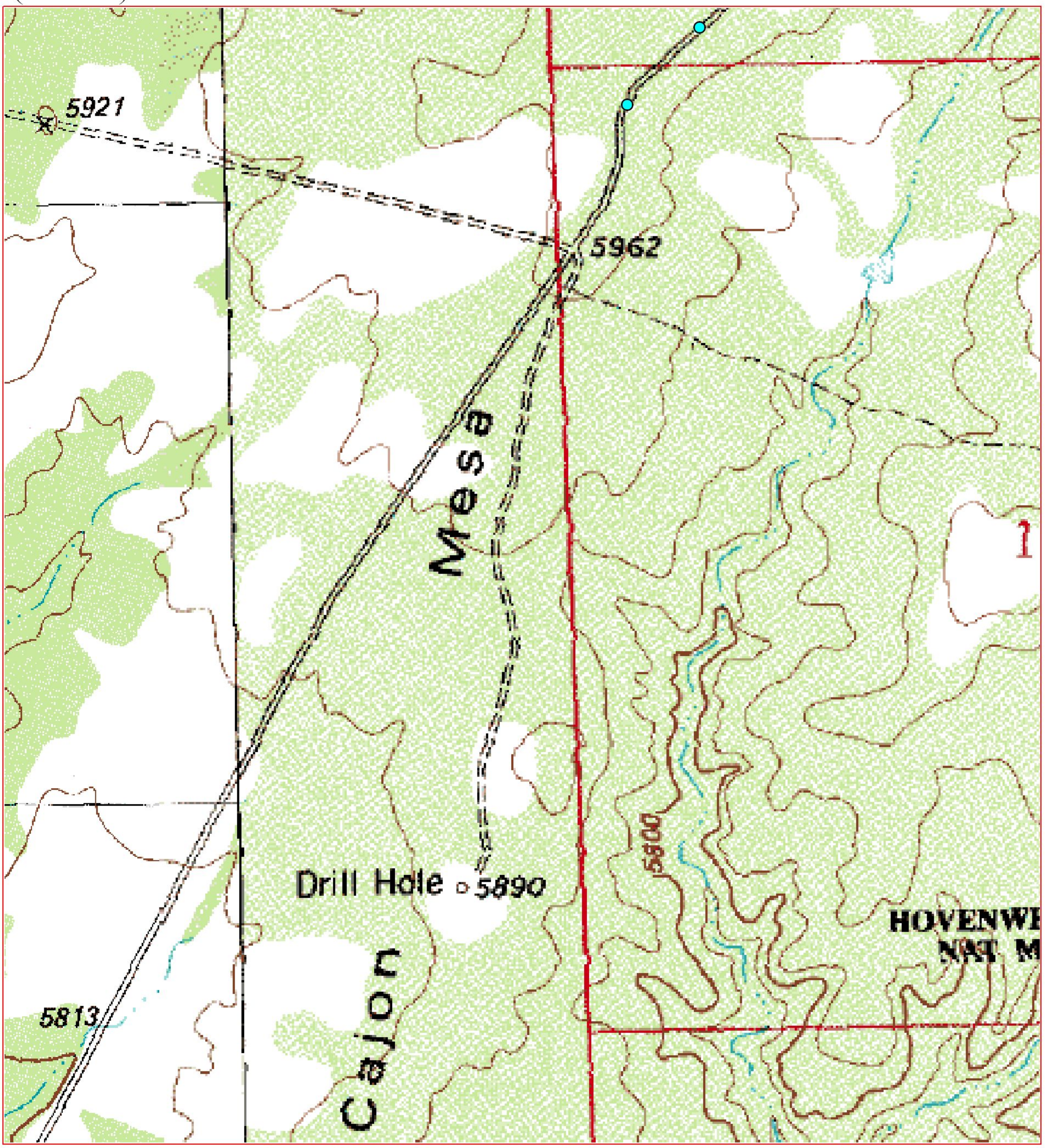
1:9,000 Scale

N

● *Marrubium vulgare*

Inset J
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

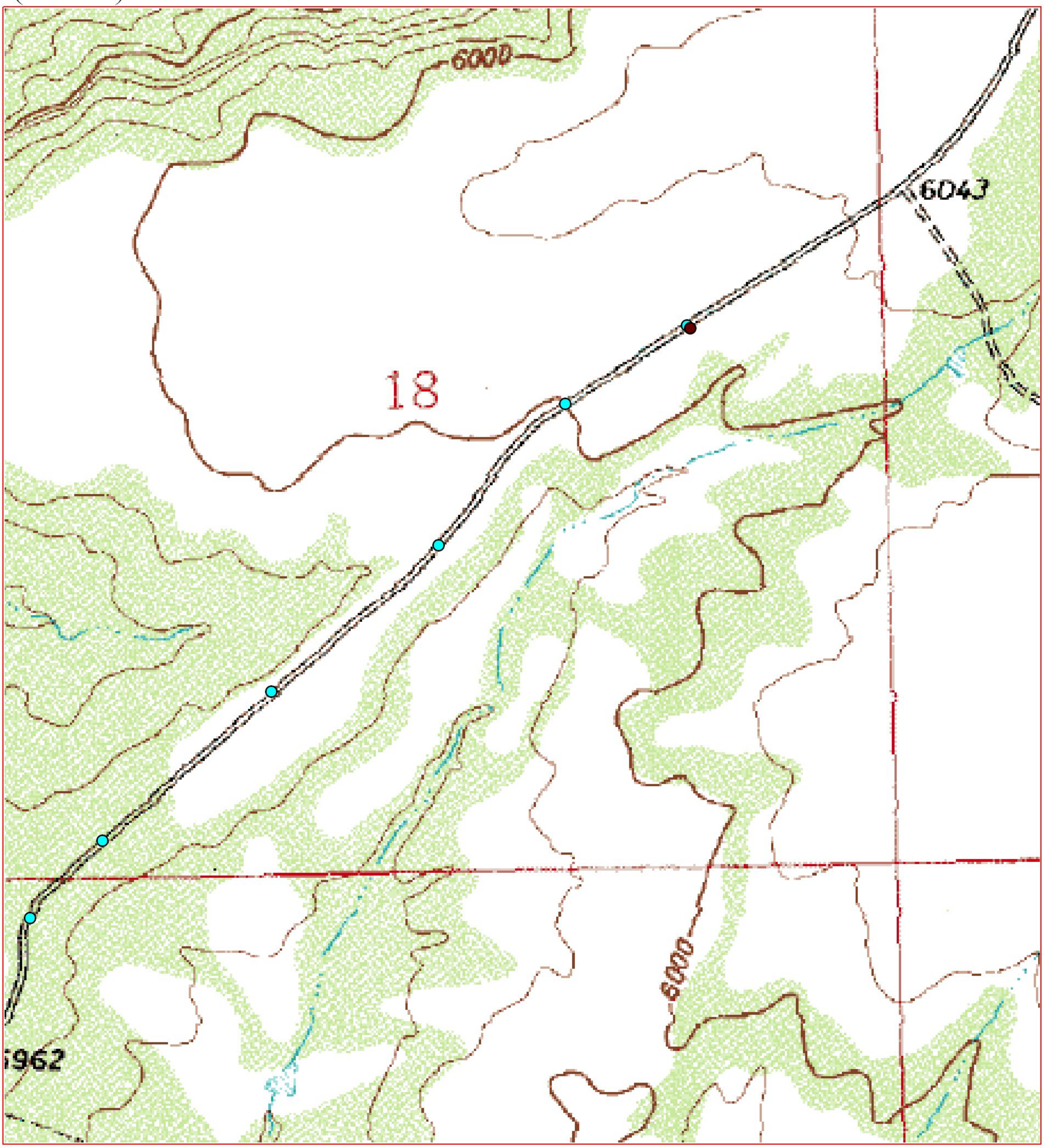
# Appendix I. Weed Species Detected in Inventoried Areas - Cajon Mesa (Inset K)




● *Marrubium vulgare*

Inset K
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Road Section 4 (Inset L)




0 500 1000 1500 Feet

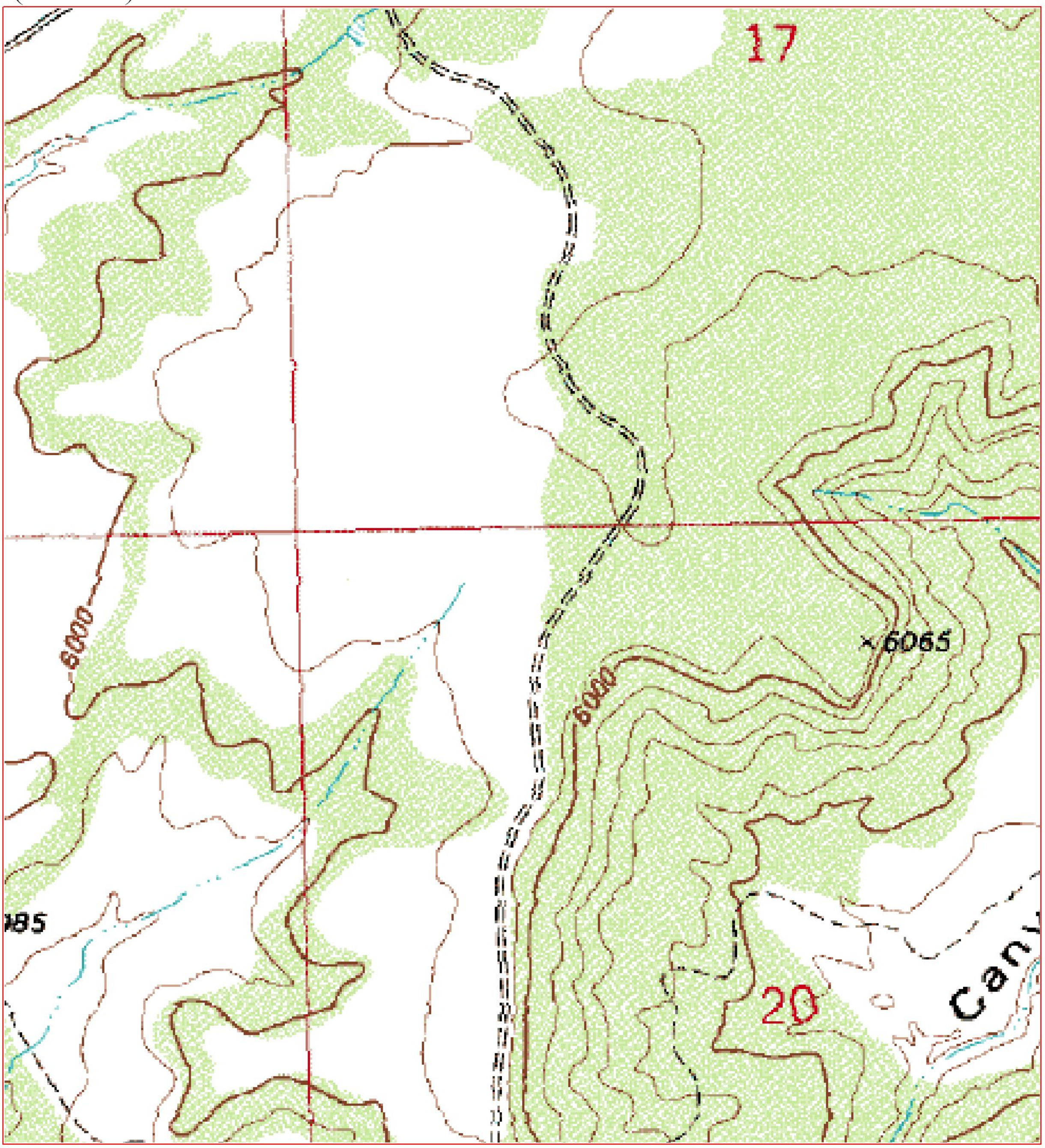
1:9,000 Scale

N

- *Centaurea repens*
- *Marrubium vulgare*

Inset L
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Road Section 5 (Inset M)




0 500 1000 1500 Feet

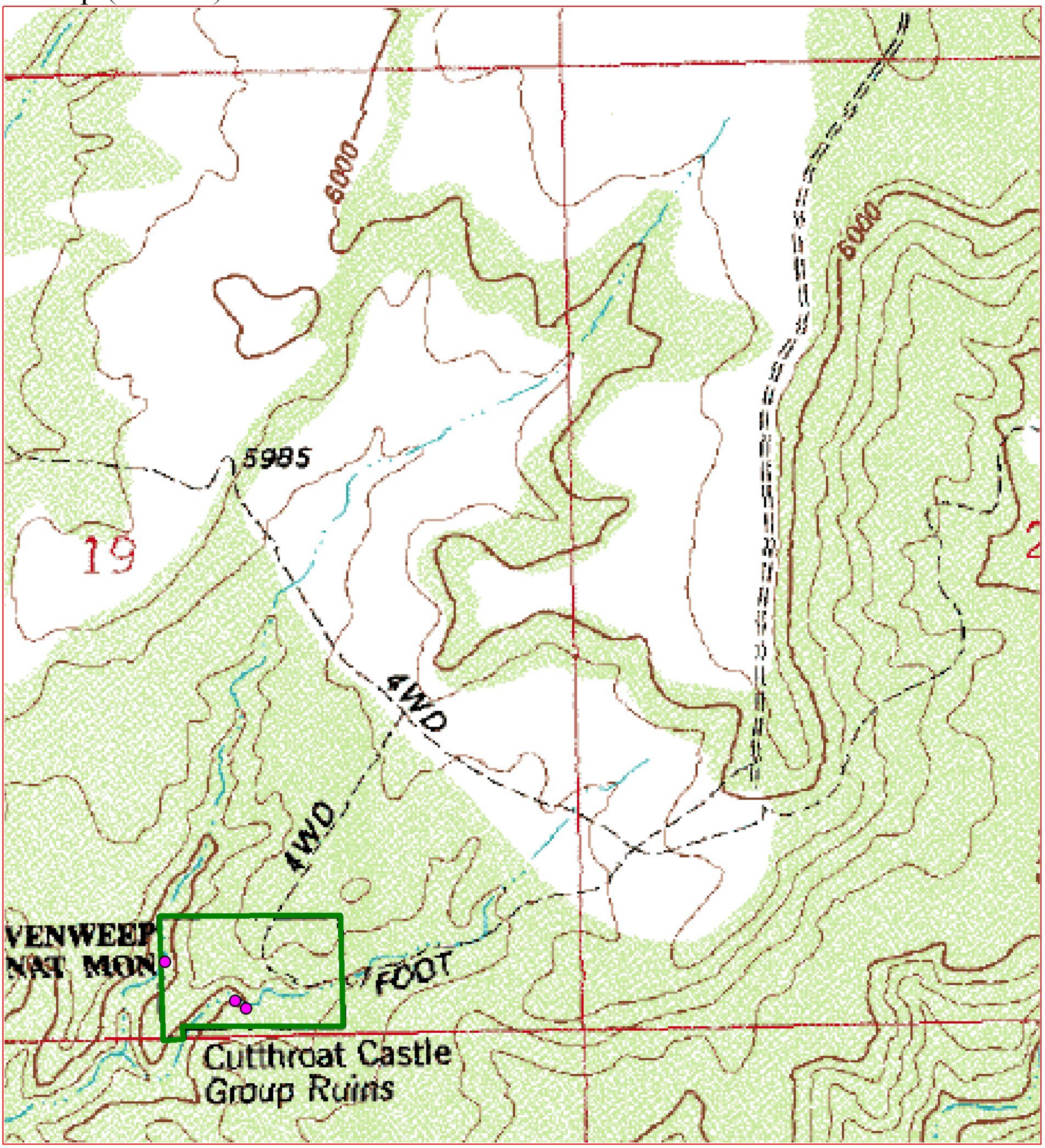
1:9,000 Scale

N

* No Targeted Weed Species Detected

Inset M
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

# Appendix I. Weed Species Detected in Inventoried Areas - Cutthroat Castle Group (Inset N)




0 500 1000 1500 Feet

1:9,000 Scale

N

*Tamarix ramosissima*

Monument boundary

Inset N
Utah State University
Hovenweep National Monument
2003 Invasive Non-native Plant Inventory
Northern Colorado Plateau Network

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

EPMT COURTHOUSE WASH PROJECT

Arches National Park
March 9 – 14, 2004

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

**Weed Seed/Propagule Decontamination Procedures:**

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

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

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

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

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

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

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

| 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* | | | | X | |
| *Chenopodium album* | | | X | | | | | | | | |
| *Cirsium arvense* | X | | | | | **Other:** | | | | | |
| *Cirsium vulgare* | | | | X | | *Amaranthus albus* | | | X | | |
| *Conium maculatum* | | | | X | | *Amaranthus retroflexus* | | | X | | |
| *Convolvulus arvensis* | X | | | | | *Lactuca serriola* | | | X | | |
| *Cynoglossum officinale* | | | | X | | *Melilotus officinalis* | | | X | | |
| *Dactylis glomerata* | | | | | X | *Portulaca oleraceus* | | | X | | |
| *Elaeagnus angustifolia* | | | | X | | *Sisymbrium altissimum* | | | X | | |
| *Euphorbia esula* | | | | X | | *Verbena bracteata* | | | 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

* Species found outside of the Monument boundaries but has considerable potential to spread onto Monument lands.