National Park Service
U.S. Department of the Interior

Dinosaur National Monument
Colorado and Utah

Dinosaur National Monument

Invasive Plant Management Plan & Environmental Assessment

October 2005

Invasive Plant Management Plan
And Environmental Assessment

Dinosaur National Monument
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Abstract

Non-native, invasive plants are invading our national parks, causing tremendous damage to our resources, thereby threatening the structure, organization, function, and overall integrity of the natural ecosystems we aspire to protect. Controlling invasive species is a serious challenge facing Dinosaur National Monument – 75 species of non-native plants occur in the monument. Of these, 24 are of particular concern because of their aggressive nature and ability to displace intact, native vegetation communities. This Plan and Environmental Assessment outlines weed management strategies (as alternatives) based on principles of Integrated Pest Management that address the use of controls including some or all of the following: mechanical, cultural, chemical, biological, and prevention techniques.

Public Comment

We welcome your comments on this Plan and EA. If we receive important new information, or if significant new issues are raised during the public comment period, we will revise the EA. If you wish to comment on the Plan and EA, you may enter them online at the National Park Service website Planning, Environment, and Public Comment (http://parkplanning.nps.gov/) or you may mail comments to the name and address below. The Invasive Plant Management Plan and Environmental Assessment will be on public review for 30 days ending November 17, 2005. Please note that names and addresses of people who comment become part of the public record. We will make all submissions from organizations, businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses available for public inspection in their entirety. If you wish us to withhold your name and/or address, you must state this at the beginning of your comment.

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List of Abbreviations

ATV	All Terrain Vehicle
APRS	Alien Plants Ranking System
BLM	Bureau of Land Management
BMP	Best Management Practice
CE	Categorical Exclusion
CNAP	Colorado Natural Areas Program
CNHP	Colorado Natural Heritage Program
DINO	Dinosaur National Monument
DO	Director's Order
EA	Environmental Assessment
EPMT	Exotic Plant Management Team
ESA	Endangered Species Act
GPRA	Government Performance Results Act
IPM	Integrated Pest Management
IWM	Integrated Weed Management
MSDS	Material Safety Data Sheet
NCPN	Northern Colorado Plateau Network
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
NRCS	Natural Resources Conservation Service, U.S. Department of Agriculture
LISTED	Threatened and Endangered (also includes sensitive species/species of concern)
SHPO	State Historic Preservation Officer
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS/ FWS	United States Fish and Wildlife Service

Definitions

Several terms are defined to facilitate understanding of this Plan and EA:

Native Plant – The NPS defines native plants as all species that have occurred or now occur as a result of natural processes on lands designated as units of the national park system. Native species in a place are evolving in concert with each other (USDI NPS 2001). A goal of the NPS is to perpetuate native plants and animals as part of the natural ecosystem.

Exotic Plant – The NPS defines exotic species as those species that occupy or could occupy monument lands directly or indirectly as the result of deliberate or accidental human activities. Because exotic species did not evolve in concert with the species native to the place, it is not a natural component of the natural ecosystem at that place (USDI NPS 2001)

Invasive Exotic Plant - An aggressive exotic plant that is known to displace native plant species in otherwise intact native vegetation communities. Invasive exotic species are unwanted plants that are harmful or destructive to humans or other organisms. Not all exotic plants are invasive. This plan addresses only those exotic plants that are determined to be invasive.

State Listed Noxious Weeds – Invasive plants prohibited or restricted by Colorado and/or Utah state law. Many of the invasive plants known to occur in DINO fall into this category (please refer to Table 1 on page 19). Transporting seed or parts of these plants or allowing them to seed on one's property is prohibited.

Integrated Pest Management (IPM) - ***also referred to as Integrated Weed Management (IWM*****) -** A decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage, by cost-effective means, while posing the least possible risk to people, resources, and the environment (USDI NPS 2001).

Eradicate – Completely eliminating all weed plants, including live roots, rhizomes, and seeds. Eradicating a weed species within a management area is very difficult unless it is present in small populations or numbers.

Suppress – To reduce abundance of a weed species, typically as measured or estimated in terms of canopy cover or plants density.

Contain – To confine an infestation so it does not expand, but does not usually mean reducing the current infestation

IPM Control Techniques defined:

Biological: Deliberately introducing insects, mammals or pathogens to stress exotic plants.

Chemical: Applying herbicides according to label requirements to kill or severely stress invasive plants.

Cultural: Cultural control can have a variety of interpretations within IPM. Some managers define it as referring to actions taken that require change in human behavior or thought processes. This definition more closely describes this document's use of prevention strategy implementation and therefore is further expressed as Best Management Practices (BMPs) under prevention techniques. For purposes of this document, cultural control is defined as providing competition, stress, or control of invasive species through the use of prescriptive fire and/or livestock grazing, or by establishing native, desirable vegetation through various means (e.g. restoration, revegetation, etc.).

Mechanical/Manual: Using your hands and/or mechanical or simple tools to uproot or remove the aboveground portion of plants by mowing, digging, pulling, and cutting seed heads and plants.

Prevention: Preventing or reducing the likelihood of future weed infestation establishment.

Invasive Plant Management Plan and Environmental Assessment

Dinosaur National Monument, Colorado-Utah

Summary

Non-native, invasive plants are invading our national parks, causing tremendous damage to our resources, thereby threatening the structure, organization, function, and overall integrity of the natural ecosystems we aspire to protect. Conservation biologists *worldwide* agree now that invasive species are the number two threat to global biodiversity, exceeded only by outright habitat destruction and degradation (Randall 1996; Pimm and Gilpin 1989). Invasive noxious weeds have been described as a raging biological wildfire – out of control and spreading rapidly. All ecosystems – urban, suburban, and rural, including wildlands, rangelands, forests, riparian areas, and wetlands – are vulnerable to invasion.

Called exotics, aliens, non-indigenous species, and weeds, these invasive non-natives get into our national parks by various means. Seeds and plant parts are brought into the parks by wildlife, wind, water, and humans. Fast-growing non-native plants can also encroach from populations established outside park boundaries. Once inside park boundaries, the most aggressive of these non-natives spread quickly into undisturbed as well as disturbed areas. These invasive plants often cause irreparable damage by upsetting the ecological balance plants, animals, soil, and water have achieved over many thousands of years.

In September 1993, the Office of Technology Assessment released the report, *Harmful Non-Indigenous Species In The United States*, which documents the establishment of over 4,500 non-native species in the United States. Severe harm is associated with at least 675, or 15%, of these species in the form of impacts to threatened and endangered plants and animals, fire regimes, watersheds, wildlife habitat, forests, grasslands, soils, recreation, and agriculture. For example, as native plants are displaced, animal populations that rely on the plants for food and shelter also decline. Nonnative plants may reduce or deplete water levels, or alter runoff patterns and increase soil erosion, thus diminishing both the land and water quality. Some nitrogen-fixing non-natives increase soil fertility, allowing other non-natives to outcompete plants that have evolved in the nutrient-poor native soils.

Over the past several decades, there has been a heightened concern at the national and international levels about the impacts of habitat destruction and chemical pollution on biodiversity. In recent years, the impact of invasive species on biodiversity has also become a major concern. It is estimated that non-native species threaten fully two-thirds of all endangered species; devastating impacts have been reported on every continent except Antarctica (Westbrooks 1998). In the United States alone, introduced invasive plants comprise from 8-47% of the total flora of most states (Rejmanek and Randall 1996).

The NPS spends millions of dollars each year combating these plants in an effort to preserve park resources, and still the problem is not solved. Outside park boundaries, federal, state, and local agencies fight the same battles. Farmers and ranchers lose millions more trying to control

nonnative plants that drastically reduce land use and productivity. The following is a brief perspective on the spread and cost of invasive plants:

- Invasive weeds occur on more than 17 million acres of federal lands in the Western U.S (USDA Forest Service 1998) and estimates indicate that nonnative plants infest 4,600 *new* acres of federal land *each day*, spreading into areas larger than the state of Delaware (1.2 million acres) *each year*.
- Scientists estimate that noxious weeds invade nearly as many new acres of federal land each year as are burned by wildfires (Dewey, 2003).
- Invasive nonnative plants infest an estimated 7 million acres of NPS lands.

The economic consequence of invasive species is $1.4 trillion annually worldwide, $137 billion annually in the U.S. alone (David Gann, TNC, 2003, Tamarisk Symposium).

Integrated Pest (Weed) Management and Its Use in National Parks
Excerpted from Creating an Integrated Weed Management Plan, CO Natural Areas

> No single management technique is perfect for all weed control situations. Often times, combinations of multiple types of treatments provide more effective and economical control of weeds with fewer detrimental overall impacts to people and the environment (Sheley et al. 1999a, DiTomaso 2000). IPM is the application of many kinds of technology in a mutually supportive manner that utilizes the strengths of different treatments while minimizing the weaknesses. It involves the deliberate selection, integration, and implementation of effective weed control measures with due consideration to economic, ecological, and sociological consequences. Often, a combination of techniques (mechanical, chemical, cultural, biological) is chosen that together will control a particular weed species or infestation efficiently and effectively, with minimal adverse impacts to non-target organisms.
>
> IPM differs from ordinary weed management in attempting to address the ultimate cause of weed infestation, rather than simply focusing on controlling weeds (typically by using only herbicides) by combining two or more control actions which will interact to provide better control than any one of the actions might provide. It requires a thorough understanding of the biology and ecology of the weed species and the environment before selecting appropriate control techniques as well as more persistence and time than simply addressing the symptoms of weed infestation. However, the long-term rewards are far greater and should lead to greater success in meeting management objectives.
>
> IPM strategies are often species and site-specific, tailored to exploit the weaknesses of a particular weed species, and designed to meet the desired level of control and to be practical with minimal risk to desirable organisms and their habitats. Appropriate control techniques ideally are:
>
> - **Applied at the most effective time**
>
> Most control actions are effective only during certain periods of the target species' life cycle. Treatments should be applied at the point in the life-cycle when it is most vulnerable, and at a time when the least damage will be done to its natural predators and other non-target species.

- **Least damaging to non-target organisms, including natural weed control organisms**

Land managers should carefully consider the likely effects of available control techniques on both target and non-target species before deciding which combination of control measures to use. Non-target organisms may include sensitive species, native plant communities, wildlife, areas revegetated to control weeds, insect pollinators, insects that feed on target weed species, and plant species that compete with the targeted weeds. The select control actions must not significantly damage these non-target organisms or lead to the creation of further problems over the long term.

- **Least hazardous to human health**

Chemicals should be carefully chosen and applied correctly to minimize their potential toxicity to humans. In fact, the reduction of unnecessary pesticide use is one of the driving forces behind the development of IPM. Successful weed management involves more than spraying weeds. Similarly, mechanical tools such as mowers and chainsaws can be dangerous if not handled properly.

- **Least damaging to the general environment**

Careful selection and judicious use of herbicides is important to avoid environmental contamination, especially around water. Certain formulations can be used in or around aquatic situations or where the ground water is close to the ground surface if the product label and best management practices are followed. In addition, timing of herbicide application is important to maximize the effectiveness of the chemical on the target weed, as well as to reduce the possibility of adverse side effects.

- **Most likely to reduce the need for weed control actions over the long-term**

Control techniques fall into two general categories: those that seek to prevent weeds from establishing, and those that deal with weeds that are already present. Preventative and cultural measures to reduce soil disturbances or to reduce the input of weed seeds to an area, re-seeding existing disturbed lands, and altering grazing practices to promote more vigorous stands of perennial plants are actions which work to prevent weed establishment. Actions which address existing weeds include pulling, mowing, applying herbicide, prescribed fire, grazing or releasing biological control insects. Any combination of these actions that address the underlying causes of weed infestation and spread is likely to be the most beneficial for controlling weeds over the long run.

- **Most easily implemented**

Control techniques that are easier to apply are more likely to be completed and repeatable, and therefore most likely to have a beneficial effect.

- **Most cost-effective in the short and long term**

Consider the benefits and costs (both in terms of risk and money) of the possible control actions. For example, is the potential for spreading weed seeds by driving a vehicle into an area infested by weeds outweighed by the increased ease of controlling weeds?

Alternatives

The management of invasive plants requires an Environmental Assessment (EA) to evaluate the impacts of alternatives on the park's natural, cultural, and human resources. There are many different ways to control invasive plant species, including but not limited to digging, mowing and cutting plants, use of prescribed fire, herbicides, and insects. The effectiveness and environmental consequences of these techniques are examined in this Plan and EA. It has been prepared in compliance with the National Environmental Policy Act (NEPA) of 1969 and regulations developed by the Council on Environmental Quality (40 CFR 1508.9). The alternatives being considered are:

ALTERNATIVE I: CONTINUATION OF CURRENT MANAGEMENT PRACTICES - USE OF MECHANICAL, CULTURAL, CHEMICAL CONTROLS, AND LIMITED PREVENTION TECHNIQUES TO MANAGE INVASIVE PLANTS.

DINO is currently using these techniques to control smaller invasive plant infestations within the monument. These activities are categorically excluded from compliance under NEPA. Larger management projects that are proposed using these techniques would be examined by a staff interdisciplinary team using an Environmental Screening Form to determine if the scope of the project is within the allowable limits for categorical exclusion. If this alternative is selected, DINO will continue to conduct invasive plant control on the smaller infestations within the monument as it has for the last five years, without the use of biological control or establishment of additional prevention techniques.

This alternative affords less long-term protection and improvement of the monument's natural and cultural resources than the preferred alternative. Widespread populations of some species such as tamarisk and cheatgrass may never be effectively and efficiently controlled without the complimentary use of biological control agents. Establishment of small, new infestations of invasive species may not be prevented or detected early enough to prevent resource damage if expanded prevention and early detection techniques are not implemented. It is expected that over the long-term, selection of this alternative would have major adverse impacts to DINO's unique resources due to the ineffective management of some invasive species.

ALTERNATIVE II: PREFERRED ALTERNATIVE – FULL USE OF IPM TECHNIQUES (MECHANICAL, CULTURAL, CHEMICAL, BIOLOGICAL CONTROL, AND EXPANDED PREVENTION) TO MANAGE INVASIVE PLANTS.

The preferred alternative would implement the full range of IPM techniques – mechanical, cultural, chemical, biological control, and expanded prevention techniques. The control technique(s) used in prescriptions to treat invasive species would be selected to achieve the best possible combination of control and cost effectiveness while minimizing risks to the environment and public health and safety. The preferred alternative provides park managers the broadest range of "tools" and strategies to successfully manage both a greater number of invasive species as well as infestations of larger size over the long-term to protect existing natural and cultural resources and improve biodiversity.

ALTERNATIVE III: LIMITED USE OF IPM TECHNIQUES (MECHANICAL, CULTURAL, AND EXPANDED PREVENTION AND EARLY DETECTION) TO MANAGE INVASIVE PLANTS.

This alternative allows only certain techniques to be used to manage invasive plants in the monument – mechanical, cultural, and expanded prevention and early detection techniques. If this alternative were selected, DINO would conduct invasive plant management without the assistance of chemicals (herbicides) or biological control agents. This alternative is expected to offer the least long-term protection of the monument's resources because of the type, size, and anticipated spread of invasive species present in and surrounding the monument. Without the use of chemicals, more species would be managed for containment or suppression of the infestation and fewer would be managed with eradication as a goal. Without the potential use of biological control agents, few if any invasive species that are widespread in the monument could be even contained should an acceptable control agent become available. It is expected that over the long term the selection of this alternative would also lead to major, likely irreversible adverse impacts to DINO's unique resources through the loss of native and cultural environments and by further reducing native species biodiversity

Chapter 1: Purpose & Need

Background

Excerpted from USDI 1986, Dinosaur National Monument General Management Plan

Dinosaur National Monument was established by Presidential Proclamation 1313 on October 4, 1915 (39 Stat.1752), as an 80-acre monument to preserve the outstanding fossil resources at the dinosaur quarry north of Jensen, Utah. After establishment, paleontologic excavations and research by the Carnegie Museum and other institutions were more evident than the presence of the National Park Service. This changed as the Park Service began to formulate plans for construction of a facility to exhibit the remaining fossils in place.

In 1938 the monument was enlarged to 203,885 acres by Presidential Proclamation 2290 (53 Stat. 2454). This proclamation cited the act of August 25, 1916, that established the Park Service (the NPS Organic Act), thereby specifically identifying Dinosaur National Monument as an area to be administered for purposes of preservation of natural resources and public use. A major focus of the expansion of the land base was the protection of the river corridors and adjacent viewsheds for the major canyons of the Green and Yampa Rivers. The act states:

> [The National Parks Service] shall promote and regulate the use of Federal areas known as national parks, monuments, and reservations hereinafter specified… by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservation, which purpose is to conserve the scenery and natural historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Based on the proclamation of 1915 and 1938, the purpose of Dinosaur National Monument is to provide for protection and visitor enjoyment of the outstanding fossil resources and the scenic canyon areas of the Green and Yampa Rivers. Although the monument has many recreational opportunities, there are two primary visitor groups who visit the monument – those who come to see the fossils and those who boat through the canyons.

Following a controversy in the 1950s that culminated in decisions not to construct major dams within the monument, Congress enacted legislation that specified direction for future use and preservation of the monument. This act (Public Law 86-729, September 8, 1960; 74 Stat. 857) made minor revisions in the boundary, enlarging the monument to 211,141 acres, authorized acquisitions of land for construction of entrance roads and administrative sites, and established procedures directed toward the eventual elimination of grazing from the monument.

Dinosaur National Monument is located in northwestern Colorado (Moffat County, CO) and northeastern Utah (Uintah County, UT) on the easternmost extension of the Uinta Mountain anticline. It lies at the northern edge of the Colorado Plateau. The monument is shaped somewhat like an inverted "T"; at its widest and longest dimensions it is 22 miles north to south, and 44 miles east to west. The Utah portion of the monument comprises 26% of the total acreage; the remaining 74% is within Colorado. Portions of the monument are approximately 20 miles east of Vernal, Utah; 50 miles west of Craig, Colorado, and about 120 miles north of Grand Junction, Colorado. The monument is surrounded by private, state, and other federally owned (BLM and USFWS) lands.

Lying in the high plateau country of Colorado and Utah, Dinosaur National Monument contains paleontological, geological, archeological, historical, scenic, recreational, and educational resources of national significance. The best-known resource is the world-renowned dinosaur quarry. Displaying Jurassic dinosaurs in relief on the rock face, the quarry has been extensively studied and presents an unrivaled demonstration of paleontological techniques. Landscapes in the lesser known but equally significant plateau/canyon country contain rocks of many other geologic ages spanning 1.1 billion years – a more complete geologic record than that in the Grand Canyon.

Prehistorically, the monument is significant as a transition zone between Desert, Intermontane, and High Plains cultures (8000 B.C. to A.D. 950) and for fine examples of the Fremont culture (A.D. 950-1150). During historic times the area was occupied by Ute and Shoshone Indians and visited by trappers, gold seekers, and scientist / adventurers like John Wesley Powell. Settlement followed exploration, and the monument today retains many remnants of its homesteading, ranching, and outlaw history.

The monument provides unique educational opportunities for visitors, students, and scholars. Recreational opportunities include viewing scenery, hiking, camping, and rafting the Green and Yampa rivers. The Yampa is the only remaining large tributary on the Colorado River system that retains its free-flowing character, giving the river rafter an experience of unusual quality. For this reason, the Yampa River in Dinosaur National Monument may be the single most important area for survival of threatened, endangered, and rare species.

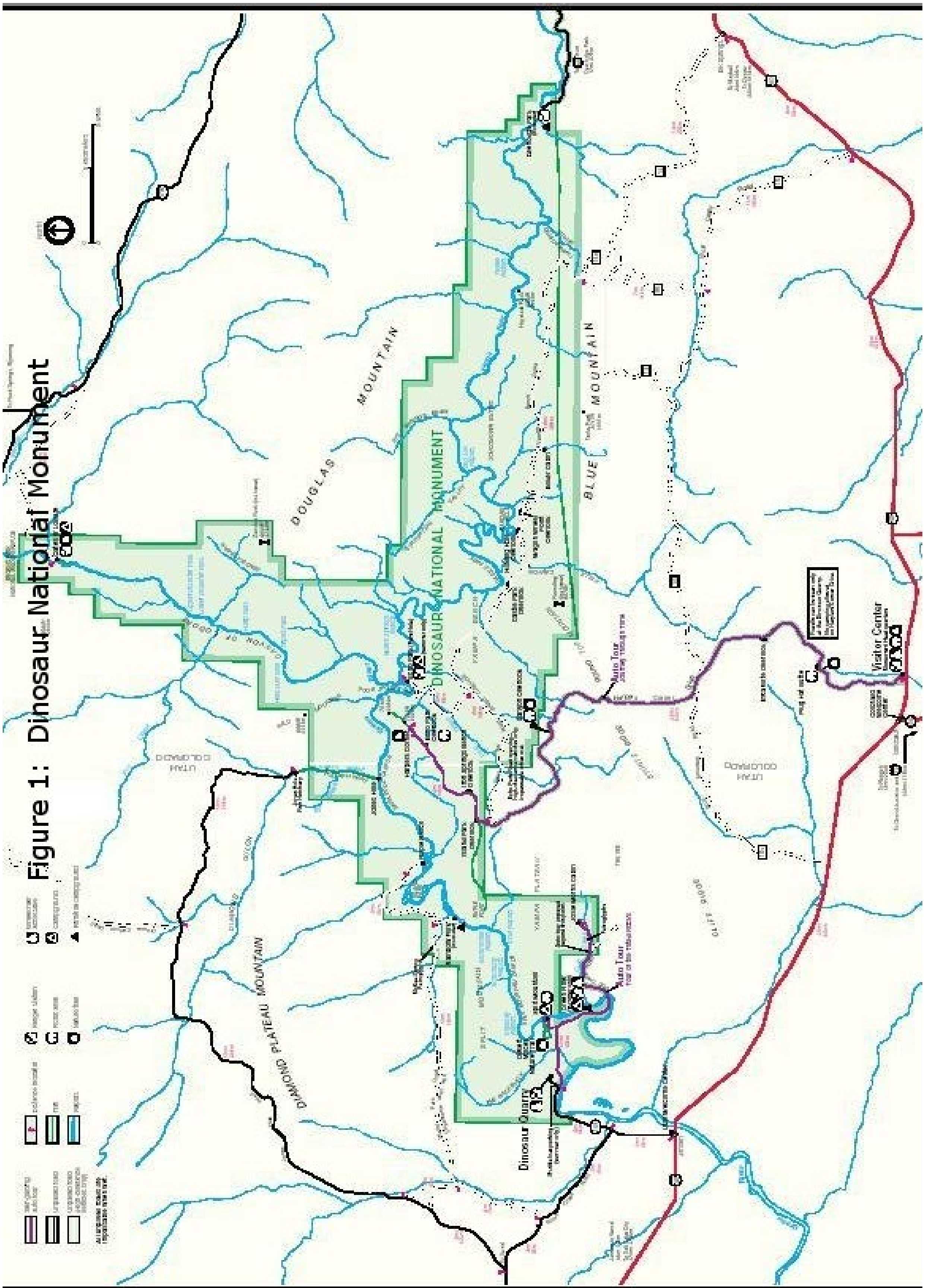


Figure 1: Dinosaur National Monument
DINOSAUR NATIONAL MONUMENT
DOUGLAS MOUNTAIN
BLUE MOUNTAIN
DIAMOND PLATEAU MOUNTAIN
Visitor Center
Dinosaur Quarry
Auto Tour
Auto Tour
UTAH
COLORADO
UTAH
COLORADO

History of Invasive Species and Management in Dinosaur National Monument
The area of what is now Dinosaur National Monument can be described as a sort of 'hub' where several ecoregional provinces converge, making Dinosaur's cold desert flora particularly rich in localized endemic species and diverse native plant communities; over 600 plant species native to the area have been documented within the monument. Great diversity of geologic substrates combines with extreme topographic variation within the monument to produce plant communities that are nearly all transitional to some degree.

Early settlers to the area arrived in the mid 1800s and established homesteads and ranches, introducing some of the first non-native plants to the area for livestock forage. Development of roads, campgrounds, trails, boat ramps, picnic areas, visitor centers, etc. to accommodate increased visitation in the 1960s further contributed to the establishment of non-native species. Today, 75 of the 687 species of flora known in the monument are non-native, some imported accidentally by livestock, maintenance and construction activities, and even visitors. Others have been intentionally introduced for food (chicory, burdock), forage (smooth brome, orchard grass), or bank/soil stabilization (tamarisk, crested wheatgrass, yellow sweetclover).

Dinosaur National Monument began managing for invasive species because of three concerns: threats to native plant communities and the wildlife that depend on them; threats to natural river processes and aquatic resources; and concerns from downriver agricultural producers regarding the increased invasion of perennial pepperweed and Russian knapweed into irrigated pastures (Naumann 2003).

The first organized invasive species inventory occurred in 1996. Approximately 300 affected acres of six target species (perennial pepperweed, Russian olive, tamarisk, Russian knapweed, Canada thistle, and leafy spurge) were identified and mapped along roads and around campgrounds, housing, headquarter areas, and in the river corridors. In 1997, the Weed Warrior program was initiated, with funding provided by a grant from Canon USA, Inc. through the National Park Foundation. That year, the Weed Warrior program reached 500 volunteers, who pulled tamarisk and perennial pepperweed along the river corridors and in campgrounds (Naumann 2003).

Sierra Club, Outward Bound West, and National Outdoor Leadership School volunteers put in 500 hours in 1996 and 1000 hours in 1997 mechanically removing perennial pepperweed and tamarisk using their hands and a variety of hand tools. The Weed Warrior program continues to be highly successful in engaging visitors in invasive species issues. As of 2004, the Weed Warrior program is responsible for over 9,750 hours of volunteer work from 2,790 visitors since 2000.

Some limited chemical spot-treatment was performed in 1997 by Moffat County, CO and Uintah County, UT certified applicators on Russian knapweed in the four housing areas and along Cub Creek road. Additional spot applications are performed occasionally by staff in those same areas. No formal monitoring of invasive treatments has been established, though all weed management activities performed in the monument since 1996 were evaluated internally for NEPA compliance (Naumann 2003).

Downstream agricultural producers, county governments, and both the commercial and private boating communities continue to be the largest advocates of weed management in the monument.

Purpose and Need

The purpose of this planning effort is to develop a monument-wide integrated invasive plant management plan for Dinosaur National Monument that is in compliance with National Park Service's *Management Policies* (2001), Director's Order 12 – Environmental Impact Analysis, and Director's Orders 77-7, which requires that the Service and each park unit use IPM to address pest issues.

The proposed plan is needed to achieve the following:

1. Preserve, protect, and restore natural conditions and ecological processes of Dinosaur National Monument by eradicating, significantly reducing, or containing infestations of 24 known invasive plants,
2. Prevent further introductions of invasive species already present in the monument as well as new species introductions by increasing visitor and staff awareness through education, by identifying mechanisms for cooperation among neighboring agencies and landowners, and by implementation of best management practices,
3. Establish decision-making tools and protocols that will guide treatment plan development for routine and project-based weed management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs)

Scope of Plan

The scope of this Invasive Plant Management Plan/EA is to develop a long-term management plan that would reduce the impacts of (or threats from) invasive plants to native plant communities and other natural and cultural resources within the authorized boundaries of Dinosaur National Monument. Although this EA considers impacts within the monument *and* adjacent areas that could reasonably be impacted by invasive plant management actions, only invasive plant management activities occurring within the 211,141 acres of the monument and that involve NPS resources are within the scope of this document.

This plan is intended to serve as long-term guidance for all invasive plants management activities, therefore the approach is general enough to address management actions without becoming too restrictive by providing resources managers with multiple treatment options and allowing them to select the most appropriate treatment option or combination of treatments included in the plan/EA to minimize potential impacts and maximize overall management success. It is also flexible enough to allow for future use of treatment actions that are not currently available or used by resource management staff. However, the document is specific enough to guide site and species-specific planning considerations.

Relationship of the Proposed Alternative to Other Monument Plans

The proposal to use the full range of IPM techniques in DINO is consistent with previous planning efforts. The *General Management Plan* (1986) includes the following natural resource objectives, which are pertinent to invasive plant management planning:

- Protect, manage, and maintain natural plant communities within the monument.

- Repress the occurrence and spread of invasive species where feasible.
- Protect, manage, and recover endangered species and their habitats where feasible and in cooperation with other federal agencies, state agencies, and participating entities.
- Protect monument resources and values from adverse external influences.
- Encourage qualified research and management studies to increase knowledge of monument resources, to develop a comprehensive resource base inventory, and to provide management with the information necessary to make ecologically sound decisions.

The most recent version of the Fire Management Plan (1991, updated 1998, 2004) provides for the use of prescribed fire to meet specific resource management objectives, including the control of nonnative species when applicable, and includes invasive species in fire effects monitoring activities. Additionally, a Livestock Management Plan for DINO is currently being drafted that considers the effects of grazing activities on vegetation. It will propose mitigation practices for the introduction and spread of invasive species that could result from grazing-related activities.

Scoping Issues

Scoping is a process to identify the resources that may be affected by a proposed action and to explore possible alternative ways of achieving the action while minimizing adverse impacts. The purpose of scoping is to streamline the NEPA process by addressing only the issues that need to be discussed by two or more sides. DINO conducted both internal scoping with appropriate NPS staff and external scoping with the public and interested/affected groups and agencies.

Internal scoping was conducted with the park's Interdisciplinary Team on November 18, 2003. Issues raised in internal scoping included:

- Use of biological control agents may have adverse effects on native vegetation and wildlife.
- Invasive plant management activities may detract from visitors' experience in some locations.
- Consultation should be initiated pursuant to §7 of the Endangered Species Act and §106 of the National Historic Preservation Act to ensure that proposed actions would not adversely affect endangered species and cultural resources.

Public scoping with the general public, tribes, partners, cooperators, and permitting agencies occurred for a 29-day period from January 23 through February 20, 2004. Agencies and cooperators contacted by letter (1/23) are noted in Appendix A. Comments were requested in writing by February 20, 2004, but any comments received after that date were also considered. Sixteen responses and/or inquiries were received from the public and state and local agencies during this initial scoping. Additional issues raised during the initial public scoping process include concern over livestock management within monument boundaries with regards to its impact on native vegetation and the natural fire regime.

Impact Topics

After scoping, issues and concerns were organized into impact topics to facilitate the analysis of environmental consequences, which allows for a standardized comparison between alternatives based on the most relevant information. The impact topics were identified on the basis of federal laws, regulations, and orders; NPS *Management Policies*; and NPS knowledge of limited or easily impacted resources.

Topics analyzed in this EA include soils and vegetation; wetlands and floodplains; wildlife; threatened and endangered species; water quality; Wilderness; air quality; soundscape; historic structures; cultural landscapes; archeological resources; paleontological resources; land use and park operations; and socioeconomics. Each of these impacts topics is addressed later in this EA.

Impact Topics Dismissed from Further Consideration

NEPA and CEQ regulations direct agencies to "avoid useless bulk…and concentrate effort and attention on important issues" (40 CFR 1502.15). Certain impact topics that are sometimes addressed in NEPA documents for other kinds of proposed actions or projects have been judged not to be substantively affected by any of the Invasive Plant Management Plan alternatives considered in this EA. These topics are listed below and in Table 2, and a rationale is provided for dismissing specific topics from further consideration.

Environmental Justice: Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Executive Order 13045 requires federal actions and policies to identify and address disproportionately adverse risks to the health and safety of children. None of the Invasive Plant Management alternatives would have disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the Environmental Protection Agency's Environmental Justice Guidance (1998). Therefore, environmental justice was dismissed as an impact topic in this document.

Prime and Unique Farmlands: In August of 1980, the Council on Environmental Quality directed that federal agencies must assess the effects of their actions on farmland soils classified by the U.S. Department of Agriculture's Natural Resources Conservation Service as prime or unique. Prime or unique farmland is defined as soil that particularly produces general crops such as common foods, forage, fiber, and oil seeds; unique farmland produces specialty crops such as fruits, vegetables, and nuts. According to the NRCS, no soils in the project area are classified as prime and unique farmlands. Thus, the topic of prime and unique farmland will not be addressed as an impact topic.

Museum Collections

According to Director's Order 24 *Museum Collections,* NPS requires the consideration of impacts on museum collections (historic artifacts, natural specimens, and archival and manuscript material), and provides further policy guidance, standards, and requirements for preserving, protecting, documenting, and providing access to, and use of, NPS museum collections. DINO has museum collections stored in 16 facilities throughout the monument. Implementation of any of the alternatives considered in this document is expected to add a nominal amount of reports, plans, and data to be catalogued and/or archived, though these additions are expected to be negligible to minor. Thus, the topic of museum collections will not be addressed further as an impact topic.

Ethnographic Resources: Certain contemporary Native American and other communities are permitted by law, regulation, or policy to pursue customary religious, subsistence, and other cultural uses of monument resources with which they are traditionally associated. No complete study of ethnographic resources exists for the monument and no responses were received by affiliated tribes concerning ethnographic sites during the initial scoping process. Because no sites have been identified by staff or tribes confirming the presence and locations of ethnographic resources, this topic is not addressed further as an impact topic.

Indian Trust Resources: Indian trusts are assets owned by Native Americans but held in trust by the United States. Indian trusts do not occur within Dinosaur National Monument and therefore are not evaluated further in this document.

Visitor Experience and Aesthetic Resources

Of the 290,298 people who visited Dinosaur National Monument in 2003, approximately 40% the visitation (116,614 visitors) was concentrated in the Quarry area on the UT side of the park. River running is the second most popular activity, with 12,983 commercial and private boaters rafting the Green and Yampa Rivers in 2003. Other recreation within the monument includes hiking, fishing, biking on established roads, automobile tours, camping, and limited amounts of horse packing and backpacking.

The General Management Plan (1986) states the national significance and importance of the landscapes and viewsheds of the plateau and canyon country that is Dinosaur National Monument. The rural character of the land and large vistas with few visual intrusions evokes images of how the area looked prior to European settlement.

Some invasive species management techniques, including tree and shrub removal, larger scale restoration projects, and prescribed fire activity have the potential to affect visitor uses and experiences. Temporary closures may be imposed and localized noise may occur in areas where visitors recreate. However, these activities are not expected to be frequent or repetitive enough to substantively interfere with overall visitor use and enjoyment and projects located in such areas would be timed to the degree possible to occur before or after periods of expected visitor use. Nor would such infrequent activities (and accompanying noise and closures) chronically impair (conversely, it is expected to improve) the overall aesthetic value associated with the monument. Therefore, this impact topic is dismissed from further analysis in this EA.

Chapter 2: Alternatives Considered

Regulations Measures Common To All Alternatives
A number of federal, state, local regulatory measures for management of invasive species, noxious weeds, and invasive plants are applicable to all alternatives considered for this project. Regulatory measures include laws, executive orders, presidential proclamations, regulations and policies:

- *Federal Laws* - acts passed by the U.S. Congress and approved by the President. All laws must be consistent with the U.S. Constitution. Federal laws have supremacy over state and local laws. Legislative history (e.g., committee reports, transcripts of congressional debates) clarifies the congressional intent in enacting a law.

- *Executive Orders* (E.O.) - directives from the President to departments and agencies of the executive branch.

- *Presidential Proclamations* - decrees by the President under the Constitution and other authorities (e.g., Antiquities Act).

- *Regulations* - rules for complying with a federal law developed by the authorized department or agency that also include codification of agency policy. For example, Title 36 Code of Federal Regulation (CFR) Section 1-199 contains general and specific regulations for the management and use of the National Park System (these regulations are augmented by the superintendent's compendium for each unit).

- *Policies* - guiding principles or procedures that set the framework and provide direction for management decisions. They may prescribe the process by which decisions are made, how an action is to be accomplished, or the results to be achieved.

The following sections describe the applicable federal, NPS, state, and local regulatory measures.

Federal Regulatory Measures

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
FIFRA and the regulations established by the U.S. Environmental Protection Agency (USEPA) (FIFRA, Sections 116-117, 165, 170-172) act as primary guidance governing pesticide registration, pesticide usage, the training and certification of pesticide applicators, and the criminal and civil penalties associated with misuse of pesticides. FIFRA defines the term pesticide as:

> (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pests, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer, except that term "pesticide" shall not include any article that is a "new animal drug" within the definition of the Federal Food, Drug, and Cosmetic Act.

Both FIFRA and NPS policy use this definition of "pesticide" in their guidance. To maintain consistency, the term "pesticide" is used throughout this document. However, under all alternatives, herbicides are the only class of pesticides that will be used to chemically treat invasive plants. Herbicides are a type of pesticide that control unwanted plants. Selective herbicides control certain target plants while allowing the desired plants to survive.

The USEPA is the agency responsible for registration of pesticides. Pesticide registration is the process through which USEPA examines the ingredients of a pesticide; the site or crop on which it is to be used; the amount, frequency and timing of its use; and storage and disposal practices. USEPA evaluates the pesticide to ensure that it will not have unreasonable adverse effects on humans, the environment, and non-target species. Except for a small number of low-toxicity active ingredients that have been exempted, a pesticide cannot be legally used if it has not been registered with USEPA's Office of Pesticide Programs (USEPA 2003).

Once registered, a label is developed for each pesticide. Pesticide labels include directions for the protection of workers who apply the pesticide, directions for reducing exposure to nonapplicators, and reducing potential impacts to the environment. Violations of pesticide label directions constitute a violation of FIFRA. The storage and disposal of most pesticides is also regulated under FIFRA, with specific direction provided on pesticide labels. Under FIFRA, enforcement of the act is delegated to individual states. Because labels contain important application, safety, and storage and disposal information, labels must be kept with the product.

Occupational Health and Safety (OSHA) Hazard Communication Standard
Under the OSHA Hazard Communication Standard (Section 1910.1200), employers must provide workers with training, protective equipment, and information about hazardous substances. The employer is also required to maintain Material Safety Data Sheets (MSDSs) about these substances and to provide the employee with a copy of the sheets if they are requested. MSDSs for some common chemicals can be obtained at the following websites:

- Greenbook - http://www.greenbook.net/
- Seed Search - http://www.cdms.net/manuf/acProducts.asp

Resource managers must maintain a current set of MSDSs for any pesticides used within The monument. A copy of the label with the MSDS is also maintained.

Executive Order 13112
Section 2 of E.O. 13112 (President 1999) on Invasive Species, signed February 1999, directs federal agencies to identify actions that may affect the status of invasive species and to take action to:

- Prevent the introduction of invasive species
- Detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner
- Monitor invasive species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded

- Conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species, and
- Promote public education on invasive species and the means to address them.

E.O. 13112 also established the Invasive Species Council and authorized the Council to develop and implement a National Management Plan (NMP) for Invasive Species. This first edition of this plan was finalized on January 18, 2001. The plan is updated every 2 years and serves as a blueprint for all federal action on invasive species.

Plant Protection Act of 2000

The Plant Protection Act of 2000 consolidates and modernizes (and thereby replaces) all major statutes pertaining to plant protection and quarantine, including the Federal Noxious Weed Act of 1974 and the Plant Quarantine Act of 1912. Only §2814 of 7 U.S.C 360 of the Federal Noxious Weed Act directing management of undesirable plants on federal lands remains in effect and is now incorporated in the Plant Protection Act.

The Plant Protection Act of 2000 provides APHIS with the authority to regulate biological control agents, or "any enemy, antagonist or competitor used to control a plant pest or noxious weed." APHIS' Plant Protection and Quarantine (PPQ) is responsible for granting permission for the use of biological control agents within the U.S.

Once a target exotic plant and biological control agent are identified, the PPQ goes through extensive host-specificity testing. This testing is designed to ensure that introduced biological weed control agents are limited in host range and do not threaten endangered, native, or crop plants. The plant species tested are chosen from three groups of plants. The first group identified includes those native North America plants in the same family, genus, species, or type as the target weed. The next group is threatened and endangered species in the same family, genus, or species as the target weed. Finally, species in other orders or families that are similar in form or shape or that have historical or chemical similarities to the target weed are tested. This last group of plants would include any economically or environmentally important plants. Precautions are also taken to ensure that the introduced agents are neither parasitized nor diseased so that when an introduction is made, only one organism is introduced. This requires that several generations of the proposed agent be reared in the lab.

The development of a list of host plants for host-specificity testing is aided by the involvement of an interagency committee. The Technical Advisory Group for Biological Control Agents of Weeds (TAG) is a voluntary interagency committee first formed in 1957 to provide advice to researchers. TAG members review petitions for biological control of exotic plants and provide an exchange of views, information and advice to researchers and those in APHIS responsible for issuing permits for importation, testing, and field release of biological control agents of exotic plants. Members in TAG include weed managers from the Bureau of Land Management (BLM), NPS, Bureau of Reclamation, National Plant Board, Agricultural Research Service, U.S. Army Corps of Engineers (USACE), National Biological Control Institute, USGS, Forest Service, USEPA, APHIS, USFWS, Citrus Research and Education Center, Bureau of Indian Affairs, and the Weed Science Society.

Once the USDA has approved an exotic biological control agent, a permit must also be obtained if this agent will be transported across state lines. In some instances, biological control agents may not be available from within the state, but can be obtained from sources located in other states. An application to transport a biological control agent must be prepared to obtain a permit from the USDA. The PPQ will review the request, assess the risk, and assign mitigating safeguards. Next, the request is faxed to the appropriate State Plant Regulatory Official for review and comment. After the State Official responds, the PPQ considers the comments and either issues or denies the permit.

Government Performance Results Act of 1993 (GPRA) – The purpose of GPRA is to improve the confidence of the American people in the capability of the Federal Government by systematically holding Federal agencies accountable for achieving program results.

To meet GPRA requirements, NPS has developed strategic performance goals, most recently updated for FY 2004 – 2008, that reflect and expand upon larger Department of the Interior Strategic Plan goals. These goals serve as indicators to show the National Park Service's success in fulfilling its mission. Each park unit is required to select those goals that represent what can be measured as accomplished and reported quarterly. The following is a description of the service-wide GPRA goals (excerpted from Technical Guidance (Manual) for National Park Service Strategic Goals 2004b) that Dinosaur National Monument expects this plan to address:

> ***Goal Category 1: Preserve Park Resources***
> *The mission and long-term goals in Goal Category I are inclusive of the mandate regarding parks in the NPS Organic Act "...to conserve the scenery and the natural and historic objects and the wild life therein...".*
>
> ***Mission Goal 1a:*** Natural and cultural resources and associated values are protected, restored and maintained in good condition and managed within their broader ecosystem and cultural context.
>
> ***Servicewide (NPS) Goals Relevant to This Planning Effort:***
> Ia1A – Disturbed Lands: calls for restoration of targeted park lands that are disturbed by development or agriculture.
> Ia1B – Invasive (non-native) Plants: calls for effective control of park lands that have invasive (non-native) plant invasions.
> Ia1C – Land Health: Wetland Areas: requires wetlands achieve desired conditions where conditions are known and where desired conditions are specified in management plans consistent with applicable substantive and procedural requirements of State and Federal water law.
> Ia1D – Land Health: Riparian and Stream Areas: requires stream/riparian areas achieve desired conditions where conditions are known and where desired conditions are specified in management plans consistent with applicable substantive and procedural requirements of State and Federal water law.
> Ia1E – Land Health: Upland Areas: requires upland areas achieve desired conditions where condition is known and as specified in management plans consistent with applicable substantive and procedural requirements of State and Federal water law.

Ia2A – Federally Listed T&E Species: requires progress toward recovery of federally listed species that occur or have occurred in parks.
Ia2B – Species of Management Concern: requires populations of native plant and animal Species of Management Concern are managed to self-sustaining levels in cooperation with affected States and others, as defined in approved management documents.

***Mission Goal 1b**:* The National Park Service contributes to knowledge about natural and cultural resources and associated values; management decisions about resources and visitors are based on adequate scholarly and scientific information.

Servicewide (NPS) Goals Relevant to This Planning Effort:
Ib3A – Vital Signs Identified: requires parks with significant natural resources to identify all vital signs for natural resource monitoring.
Ib3B - Vital Signs Monitoring: requires parks with significant natural resources to implement natural resource monitoring of key vital signs parameters.

State Regulatory Measures
Implementation of the Invasive Plant Management Plan and EA will conform to applicable state laws. It is the NPS's general policy to comply with more stringent state requirements, where applicable. For example, some states have established legislation and regulations that further define pesticide registration, pesticide usage, training and certification of pesticide applicators, and the criminal enforcement and civil penalties associated with the misuse of pesticides. All pesticide application will be conducted by or under the supervision of a certified pesticide applicator in accordance with state laws. All NPS employees that apply or have pesticide application as a significant element of their job descriptions are encouraged to obtain state certification for pesticide application. Some states have passed legislation that requires applicators to post information to identify treated areas. Some legislation also specifies that areas proposed for treatment must be posted for a minimum period before the area is treated.

DINO boundaries span two states. Both Colorado and Utah have legislation that identifies noxious weeds. A noxious weed is specified by law as being especially undesirable, troublesome, and difficult to control. Definitions vary from state to state and according to legal interpretations. Current noxious weed lists for Colorado and Utah are compiled on page 3-12.

Local Regulatory Measures
Implementation of the Invasive Plant Management Plan and EA will conform to applicable local laws. Under the Plan and EA, the monument will comply with more stringent local requirements, where applicable. For example, cities and counties may have established local ordinances and regulations that further define pesticide use. Some parks are located in more than one county. Under all alternatives, parks will review all applicable local regulations on a regular basis.

National Park Service Policies and Guidelines
The NPS has a strong and clear policy on managing exotic plants in the parks. Parks are guided by three primary internal documents to manage exotic plants:

- NPS Management Policies 2001
- Natural Resources Management Guidelines (NPS-77)

- Individual Park's Natural Resource Management Plans and Exotic or Invasive Plant Management Plans

NPS Management Policies 2001
General policies for management of exotic plants are provided in the *NPS 2001 Management Policies* (NPS 2001:37), Section 4.4.4 - Management of Exotic Species. The most relevant sections are summarized below.

Definition of Native and Exotic Species
Page 34, Section 4.4.4.3 includes the definitions of native species and exotic species that were adopted for the EPMP/EA (see Chapter 1, Section 1.1).

Management of Exotic Species
Page 37, Section 4.4.4 requires parks to manage exotic species to prevent the displacement of native species. This section states, "Exotic species will not be allowed to displace native species if displacement can be prevented."

Removal of Exotic Species Already Present
Page 37, Section 4.4.4 allows parks to remove exotic species that are already present within parks. NPS management policies list specific criteria that must be met before an exotic species may be managed. These criteria include the following:

> "All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed - up to and including eradication - if (1) control is prudent and feasible, and (2) the exotic species:
>
> - Interferes with natural processes and the perpetuation of natural features, native species or natural habitats; or
> - Disrupts the genetic integrity of native species; or
> - Disrupts the accurate presentation of a cultural landscape; or
> - Damages cultural resources; or
> - Significantly hampers the management of park or adjacent lands; or
> - Poses a public health hazard as advised by the U.S. Public Health Service (which includes the Centers for Disease Control and the NPS Public Health Program); or
> - Creates a hazard to public safety."

For a species determined to be exotic and where management appears to be feasible and effective, superintendents should: (1) evaluate the species' current or potential impact on park resources, (2) develop and implement exotic species management plans according to established planning procedures, (3) consult, as appropriate, with federal and state agencies, and (4) invite public review and comment, where appropriate. Programs to manage exotic species will be designed to avoid causing significant damage to native species, natural ecological communities, natural ecological processes, cultural resources, and human health and safety.

Page 37, Section 4.4.4.2 also provides guidance to the parks on how to determine exotic plant management priorities:

> "High priority will be given to managing exotic species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controlled. Lower priority will be given to exotic species that have almost no impact on park resources or that probably cannot be successfully controlled. The decision to initiate management should be based on a determination that the species is exotic."

Pest Management
Page 37, Section 4.4.5 provides guidance on general pest management. Pests are living organisms that interfere with the purposes or management objectives of a specific site within a park, or that jeopardize human health or safety. Exotic pests will be managed according to the exotic species policies provided on page 37, Section 4.4.4. All park employees, concessionaires, contractors, permittees, licensees, and visitors on all lands managed or regulated by the NPS will comply with NPS pest management policies.

Integrated Pest Management Program

Pesticide Use
Page 38, Sections 4.4.5.3 and 4.4.5.4 address the use of chemicals and biological control agents. A pesticide, as defined by the FIFRA, is any substance or mixture that is used in any manner to destroy, repel, or control the growth of any viral, microbial, plant, or animal pest. A park resource management specialist must first determine that the use of pesticides or biological control agents is necessary, and that all other available options are either not acceptable or not feasible.

Once a resource management specialist determines that use of a chemical or biological control agent is necessary, its use must then be approved. Apart from few exceptions (see discussion of NPS 77 below), all prospective users of pesticides in parks must submit a pesticide use proposal, which is reviewed on a case-by-case basis by the Regional and possibly the National IPM Coordinator, as required. These proposals take into account environmental effects, cost and staffing, and other relevant considerations. The application or release of any biological control agent must also be approved by a National IPM Coordinator in accordance with DO 77-7, and must conform to the exotic species policies in page 37, Section 4.4.4.

Pesticide Purchase and Storage
Section 4.4.5.5 provides guidance on the storage of pesticides:

> "No pesticides may be purchased unless they are authorized and are expected to be used within one year from the date of purchase. Pesticide storage, transport, and disposal will comply with procedures established by the Environmental Protection Agency, the individual states in which parks are located, and Director's Order #30A: Hazardous and Solid Waste Management, Director's Order 77-1: Wetland Protection, and Director's Order 77-7: Integrated Pest Management (IPM) (in preparation)."

Natural Resources Management Guideline - NPS-77

NPS-77: Natural Resource Management Guideline (NPS-77) (NPS 1991) provides resource managers with an overview of the integrated pest management concept, summarizes NPS policies regarding pesticide use, and provides directions for applying for approval to use pesticides. NPS-77 also provides general guidelines and recommendations for exotic plant management.

In addition, the NPS is developing *Director's Order 77-7 (DO 77-7): Integrated Pest Management (IPM)*. The purpose of DO 77-7 is to supplement and clarify existing NPS policies on IPM. The NPS Associate Director for Natural Resources Stewardship and Science will also develop and issue Reference Manual 77-7 (RM 77-7). RM 77-7 will provide parks with additional information and procedures for carrying out NPS responsibilities included in NPS-77, DO 77-7, and Management Policies 2001. Once formalized, policy and guidance included in DO 77-7 and RM 77-7 would apply to any actions taken under the EPMP/EA. Since DO 77-7 has not been approved, the EPMP/EA was developed based on existing policy included in NPS-77 and Management Policies 2001. However, some concepts that are included in draft versions of DO 77-7 were incorporated into the EPMP/EA to provide additional guidance, where appropriate.

Review and Approval to Use Pesticides

NPS-77 provides guidance on the review and approval process for pesticides, biological control, and other treatments. The natural resource manager at the park can approve treatments that do not involve the use of pesticides or biological control. However, if pesticides or biological control treatments will be used, a use proposal must be sent to the Regional IPM Coordinator. The Regional IPM Coordinator may then forward requests to the National IPM Coordinator in Washington D.C., as necessary. Parks that propose the use of pesticides or biological control agents must also follow established state and federal regulations.

Pesticides must be reviewed and approved prior to use if they:

- Are applied to any lands, waters, or structures that are owned, managed, or regulated by the NPS; or
- Are purchased by NPS or cooperating association funds; or
- Are used on privately owned lands or lands managed by another government agency and are located within a park boundary, and NPS approval is required under the terms of a legally binding agreement between the park and the landowner; or
- Are purchased by the park for employees (e.g., insect repellants and bear deterrents).

The following pesticides do not require approval (unless approval is required by a regional director or superintendent):

- Personal insect repellants and bear deterrents that are purchased by park employees or visitors from their own funds and applied to their own persons, pets, and privately owned livestock;
- Personal insect repellants and bear deterrents sold by concessionaires; and
- Disinfectants and cleaning solutions used in restrooms and restaurants, even though these products have USEPA pesticide registration numbers.

To obtain approval for pesticide use, each park is required to prepare a pesticide use proposal. An Intranet Based System has been developed whereby resource managers can submit these requests electronically. The Regional and, as necessary, the National IPM Coordinator then reviews these requests.

Except as noted below, Regional IPM coordinators review pesticide use proposals and either approve them, approve them with conditions, or deny them (and provide alternative methods). Currently, the following pesticide use proposals also require a second level of review by the National IPM Coordinator:

- Pesticide uses that involve aquatic applications or situations in which the applied pesticide could reasonably be expected to get into waters or wetlands;
- Pesticide uses that may affect rare, threatened, or endangered species or associated critical habitat;
- Pesticide use involving aerial application; and
- Restricted-use pesticides as defined by the USEPA.

In the future, broadcast applications over a specified acreage may also require approval from the National IPM Coordinator under DO 77-7. While not yet formally approved, Terry Cacek (National IPM Coordinator) has indicated that, in practice, approval should be obtained from the National IPM Coordinator for any chemical treatment of 400 or more contiguous acres.

The decision by either the Regional IPM Coordinator or National IPM Coordinator to approve a pesticide use proposal is based on its conformance with NPS policies and guidelines, a determination of whether other alternatives are available or feasible, and whether the pesticide is registered for the proposed use. If proposals are denied, the Regional or National IPM Coordinator will provide a written explanation of the denial and suggestions for suitable alternatives.

Pesticide use proposals are approved on an annual basis, with each approval expiring on December 31 of the year of approval. However, approval can also be obtained for situations where the pesticide need was not anticipated at the beginning of the year, including emergency situations. These “emergency” pesticide use proposals may be submitted via telephone, fax, or email to the Regional IPM Coordinator, or in their absence, the National IPM Coordinator.

Reporting Pesticide Use

Under NPS-77, parks are required to maintain records of pesticide use, including presticide use reports, during the year. Pesticide use reports are submitted electronically using the Intranet Based IPM System. Pesticide use reports must be entered into this system by March 15 of each year.

Review and Approval to Use Biological Control Agents

Any park proposing to release a biological control agent must receive approval from the Regional or National IPM Coordinator. Biological control use requests are first submitted to the Regional IPM Coordinator. The Regional IPM Coordinator may deny the proposal, modify the proposal in cooperation with the park and forward the modified request, or forward the request (without modification) to the National IPM Coordinator for review and approval. State permitting may also be required prior to the release of a biological control agent.

Other Pesticide Related Guidelines
NPS-77 also provides guidelines for the following activities: pesticide purchase, pesticide storage, disposal of pesticides, pesticide safety, and contracted pest management services. These guidelines have been incorporated into the health and safety practices provided in Appendix I.

Exotic Species Management
NPS-77 also provides guidance on a number of exotic species management topics. These topics include prevention of exotic species invasions, management of established exotic species, biological control, IPM and pesticide use, and environmental compliance and planning documents. This guidance has been used to develop the Plan and EA.

NPS-77 also includes guidance for NPS concessionaires that manage pests on NPS property or in NPS buildings. Based on NPS-77, the NPS has developed guidance to help educate concessionaires on NPS procedures for managing pests. The guidance document is titled, *Understanding the National Park Service's Integrated Pest Management Program* (NPS 2003i) and can be accessed at:

http://www.planning.nps.gov/concessions/document/CoEMPGuidanceIPM.pdf

This guidance focuses on procedures and requirements governing pesticide use in national parks. All concessionaires are required to review and comply with this document or subsequent versions prior to conducting any exotic plant management activities.

This Invasive Plant Management Plan and EA is consistent with the USDI Strategic Plan for Managing Invasive Nonnative Plants on National Park Service Lands. Adopted in 1999, the plan described the impacts of invasive nonnative plants on NPS natural resources and outlines strategies and tactics to help prevent and manage their spread on NPS lands. It requires consideration of nonnative plant management in all levels of planning and project development and implementation as well as adoption and application of an integrated pest management program throughout the NPS system.

Invasive Plant Management Planning Considerations
In compliance with the National Environmental Policy Act (NEPA), this EA describes for comparative purposes the potential side effects of implementing alternative invasive plant management programs at DINO. At the conclusion of the NEPA process, future site management prescriptions will be written and approved in accordance with the selected alternative.

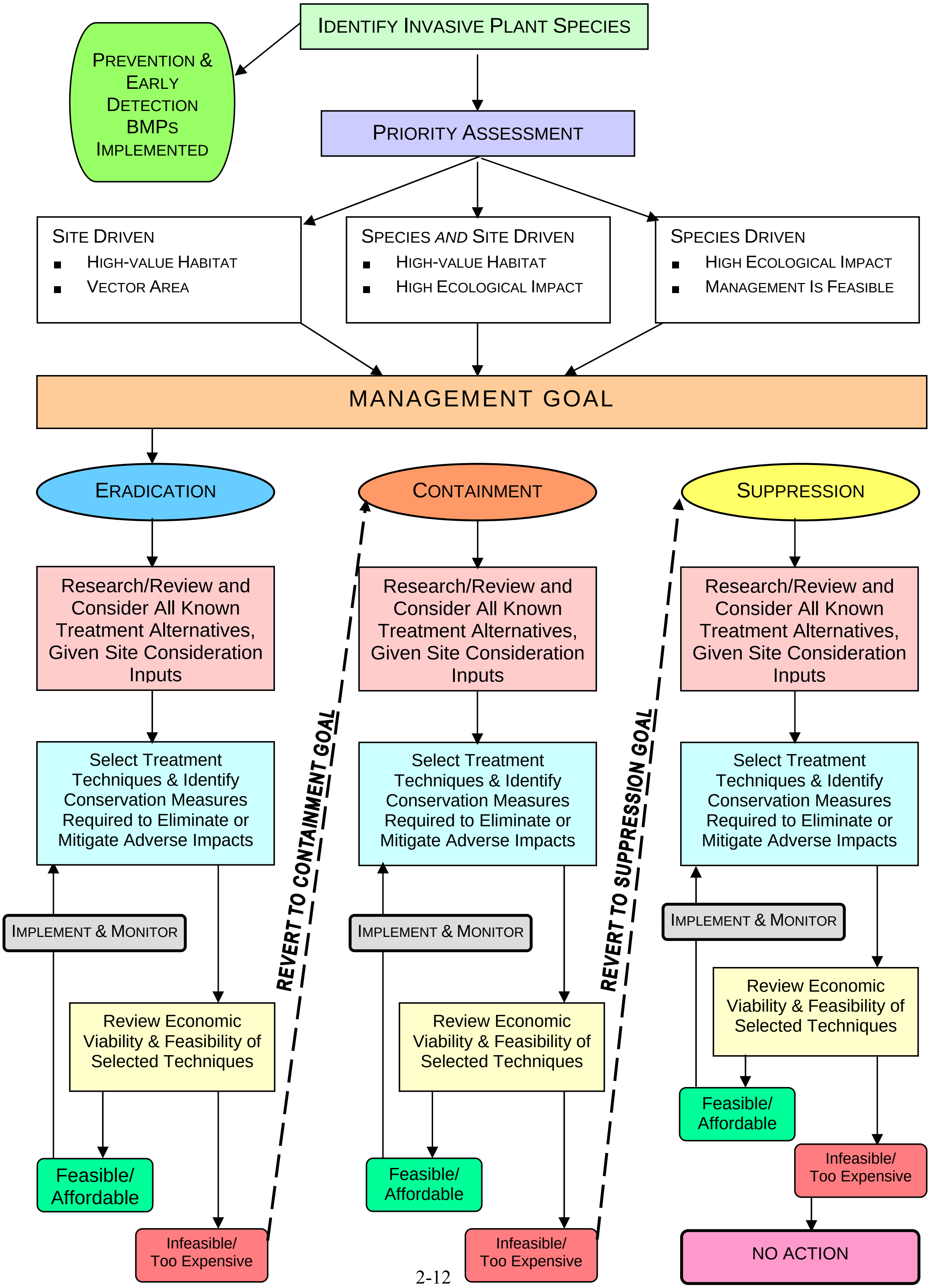
It is a purpose of this EA to provide the framework, guidance, and considerations necessary for the thoughtful *development* of weed management project and operating (work) plans for invasive plant management and control, rather than to provide detailed prescriptions and predictions of actions that may or may not occur. Figure 2 illustrates the decision-making process and considerations a resource manager uses in implementing true IPM to arrive at the most effective and efficient solution to an invasive species problem. A Users Guide for Figure 2 is found in Appendix B to further explains the flow and context of the process.

As an example of the types of projects this plan and EA is intended to support, a *draft* site management prescription and work plan for Cub Creek (Appendix C) is included. Cub Creek is a small tributary of the Green River. Weed inventories performed during the summer of 2002 revealed the presence of 15 weed species that were designated for priority management. Proposed management includes mechanical, cultural, and chemical controls and, once approved, is expected to be implemented over the course of up to five years. Long-term monitoring and maintenance are expected to occur indefinitely. The final Cub Creek Management Plan and any updates will be consistent with the program objectives and the selected alternative defined in the Invasive Plant Management Plan and EA. Other areas of focus for future management prescription development include (in order of current priority): Yampa and Green River corridors, Echo Park, Deerlodge Park, Rainbow and Island Park, Gates of Lodore.

In this way, the IPM program incorporates an adaptive management approach into its planning and program implementation. To ensure on-going compliance with specific laws, such as the National Historic Preservation Act and Endangered Species Act, requisite consultation for resource impacts is performed on a project-by-project basis where a programmatic agreement has not been developed.

Site-specific plans that include treatments and associated potential impacts considered in this EA would not require additional NEPA compliance outside of the required project or annual monument NEPA-staff interdisciplinary team review. It is possible that during annual IPM program evaluations and updates changes in monument conditions or in policy and law may require management actions that are beyond the scope of this plan. It is also possible that IPM staff may propose a treatment prescription or plan that is inconsistent with the IPM plan and EA. If Dinosaur NM staff proposes actions that would result in new impacts not considered in the original IPM plan and EA, then such a program change would necessitate additional NEPA analyses. Please note that regardless of whether changes result from new regulatory requirements, new threatened and endangered species listing, or changes to the environment, additional compliance through consultation would be required to continue implementing the program.

Figure 2: Integrated Pest Management Decision Matrix



Invasive Plant Management Plan
These 10 proposed management actions comprise the Invasive Plant Management Plan and are briefly discussed below. A more detailed description of these actions, as well as invasive species maps for the monument, can be found in Appendix L. The actions are designed to be relevant and applicable in achieving some level of invasive plant control strategy regardless of the alternative selected for implementation in Dinosaur National Monument. Only the degree to which each management action is implemented (i.e. techniques employed, scale of activity) varies among the alternatives according to the constraints of each alternative.

The actions are modeled after and designed to expand upon the six management strategies put forth by the NPS Strategic Plan for Managing Invasive Nonnative Plants in National Parks: Prevent invasion; Increase public awareness; Inventory and monitor nonnative plants; Conduct research and transfer technology; Integrate planning and evaluation; and Manage invasive non-native plants.

1. Prevent new infestations by employing prevention and early detection techniques

The most effective, economical, and ecologically sound approach with zero risk to resources of value in managing invasive species is to prevent their invasion in the first place. Often, managers direct limited resources to fighting firmly established infestations. By that stage, management is expensive and eradication is likely impossible. Certainly it is necessary to manage infestations to limit the spread of invasive plants into non-infested areas. However, limited resources might be spent more efficiently on proactive weed management that contains existing weed infestations but also focuses strongly on prevention or early detection of new invasions (Center for Invasive Plant Management 2003).

In this plan, Dinosaur National Monument seeks to adopt a set of invasive plant prevention guidelines, or Best Management Practices (BMPs), as outlined in Appendix D. These practical and proactive techniques are designed to prevent invasion and permanent establishment of invasive plants during the course of daily or routine activities and operations. Many of these practices will also be the core component of a handbook that the NCPN is in the process of producing entitled *Northern Colorado Plateau Network Handbook for Invasive Plant Prevention and Management* that can be used by all other parks on the Northern Colorado Plateau. General objectives of these BMPs include:

- Incorporating weed prevention and control into project planning
- Avoiding or removing sources of introduction and spread of weed seed and propagules to prevent new weed infestations and the spread of existing weeds
- Avoiding the creation of environmental conditions that promote weed germination and establishment
- Re-establishing vegetation to prevent conditions conducive to establishment of weeds when project disturbances create bare ground.
- Improving the effectiveness of prevention practices through weed awareness and education.

Early detection of invading plants minimizes spread, enhances opportunities for eradication, and is most effectively done at the local level by land managers and landowners. DINO will monitor heavily developed or high use areas ("hot spots") such as campgrounds, parking lots, housing and administrative areas, road shoulders, river corridors, and trails and trailheads every 1-5 years to detect new invasive species establishment.

Dinosaur is also committed to supporting and working cooperatively with the State of Colorado's Early Detection and Eradication Specialist who is charged with adapting and implementing the National Early Detection and Rapid Response framework to Colorado.

2. Educate visitors and staff about invasive plants and their management in Dinosaur National Monument

There are several programs already in place that make connections with the public regarding invasive species. The Weed Warrior program engages hundreds of young adults every year in a program that combines invasive species education followed by a short service project involving mechanical removal of species such as tamarisk and perennial pepperweed. Interpretive staff on both the CO and UT sides of the monument lead visitor and volunteer programs that focus on invasive species in campgrounds and along the river canyons. Several short articles about invasive vs. native species have also been featured in the monument newspaper *Echoes*.

DINO will increase efforts to inform the public and staff about invasive plants and the monument's strategy for managing them. Some ideas for expanding awareness among visitors and staff include:

- Visitor center displays and brochures on invasive species and management in the monument
- Partnering with other neighboring agencies in regional educational awareness efforts
- Developing an invasive species website within the Dinosaur National Monument home page dedicated to current information on monument activities, regional news, and technical information on management
- Initiate staff project days where monument staff can learn about a particular weed problem in the park and then participate in a short work project focusing on a particular goal or species, such as improving rare plant habitat or eradicating a new invader.
- Hold informal annual meetings with grazing permittees and staff (maintenance, fire, other resource management staff) potentially impacted by weed management activities to give updates and discuss effectiveness of treatment techniques and inform of upcoming annual work plan.

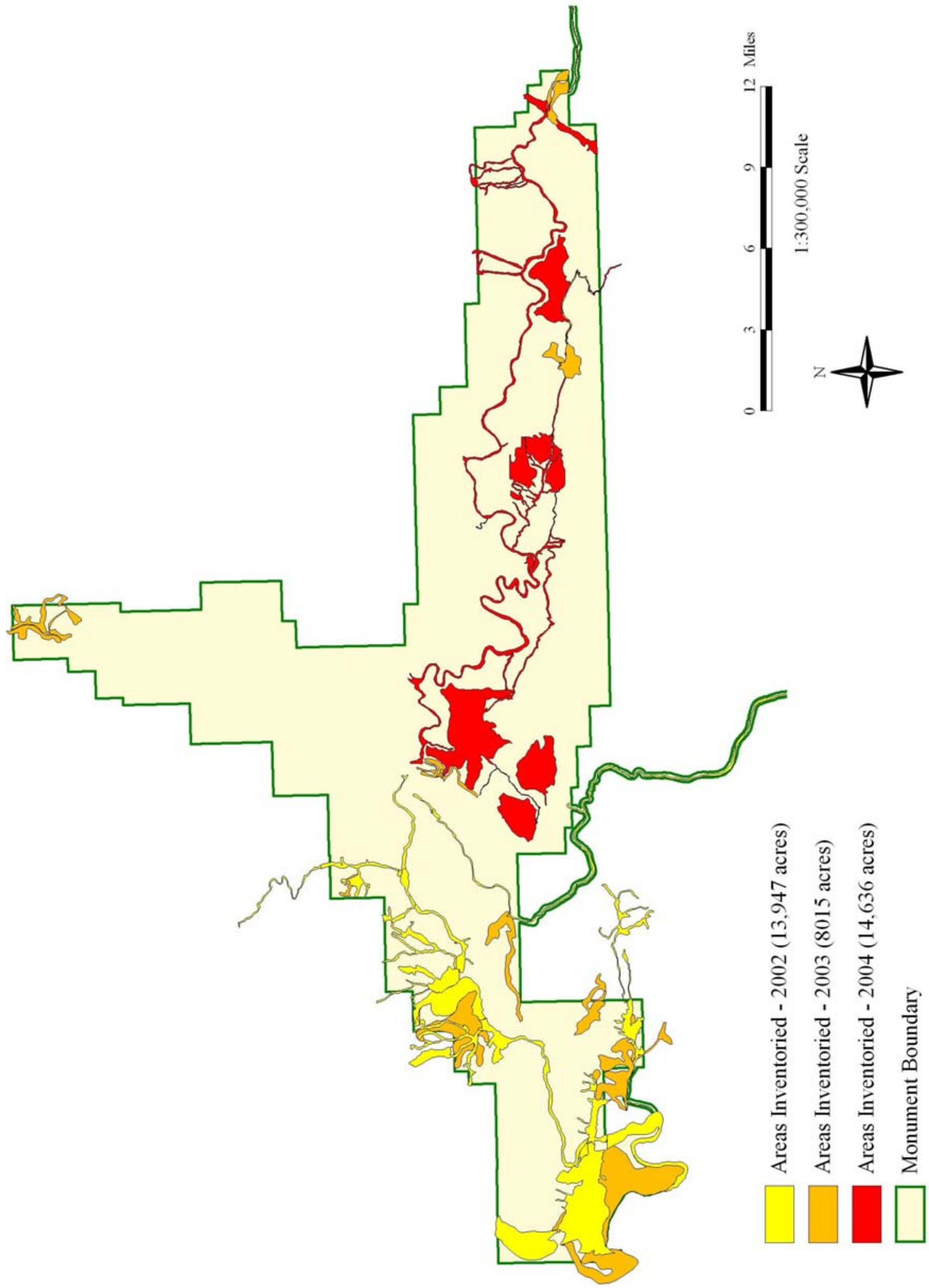
3. Inventory invasive plants in Dinosaur National Monument

This action calls for the completion of a base inventory of non-native invasive plants in Dinosaur National Monument. Knowing which invasive species are present, their location, and abundance or distribution is the basic building block in any weed management plan and is the information on which all other efforts hinge. Incomplete information on the location and abundance severely limits the monument's ability to achieve habitat management and restoration goals.

An invasive species inventory is currently in progress in the monument and began in 2002. The results of the survey performed by Utah State University between 2002-2004 clearly show that the overwhelming majority of invasive species problems are concentrated in high-(human)use areas (campgrounds, housing areas, trailheads, visitor centers) and along transportation corridors (river corridors, trails, roads). With the exception of the Morris Ranch (that has a documented history of agriculturally-based invasive species introductions), portions of grazing allotments and more remote areas that have been mapped (Mantle, Island Park, Docs Valley, Green River) do not have significant infestations of high priority invasive species, indicating that permitted agricultural activities and large ungulate movement within the monument are not a significant source or vector for invasive species introduction or spread.

In summer 2005 USU will complete the base inventory for the majority of priority areas, including Lodore Canyon, Zenobia Basin and Wild Mountain, within the monument. This will conclude a 4-year effort representing current and valuable information on invasive species in the range of habitats occurring within the monument (over 50,000 acres). Monument staff will then assume responsibility for scaled back re-inventory efforts, focusing on those areas identified as important points of introduction or spread, using a similar data collection protocol every 10-15 years as part of a prevention and early detection program, subject to availability of funds.

Figure 3. Total area inventoried for Invasive Plants in Dinosaur National Monument ifrom 2002-2004.



4. Monitor effectiveness of control efforts

Monitoring is the repeated collection and analysis of information to evaluate progress and effectiveness in meeting resource management objectives (Elzinga et al. 1998) and is an essential part of an integrated weed program. Based on inventory and ranking criteria, a good monitoring program saves time and money by telling managers which control techniques are working and which ones are not. Monitoring programs can range from simple, such as taking photo points, to more complex plot and transect data collection, but all are ongoing processes that will detect useful trends with each year of repetition. Without monitoring, there is no way of knowing whether control efforts are contributing to fulfillment of desired management objectives (CNAP 2000).

The NCPN is currently researching and developing invasive species treatment effectiveness monitoring protocols that will be employed by all NCPN parks, including Dinosaur National Monument, in 2006. These will likely include techniques such as photo points, transects, and/or plots. A minimum monitoring standard will be established for consistency and comparability of results across NCPN parks. Data generated from the park monitoring programs will be entered into a monitoring module in the forthcoming NCPN invasive species management database described in Proposed Action #5.

5. Track invasive plant management efforts

The NCPN is in the process of developing its own repository for all data collected concerning invasive species management efforts, such as inventory, control, and monitoring. The purpose of this database is to standardize and facilitate any required annual reporting that individual parks do on species, date, location, treatment technique(s) employed, type and amount of chemicals used, and staff time used, etc. It can also be used as part of a treatment effectiveness monitoring program, as it will eventually provide important treatment histories of particular areas that can be selected for more intensive analysis and monitoring efforts. In addition, the database will be able to hold any verified, complete treatment and inventory data collected prior to 2005 (referred to as 'legacy data') that meets the current required reporting fields to further support its use as an effectiveness monitoring tool.

The NCPN database will be designed to support the Alien Plant Control and Monitoring (APCAM) database that is used by all EPMTs for nationwide invasive species control reporting requirements. It is expected the new database will be ready for implementation by the time most parks in the NCPN have NEPA-compliant invasive plant management plans in place.

6. Prioritize both invasive plant species and locations to be controlled

Because it is impossible to control every weed, invasive or otherwise, that occurs in Dinosaur National Monument, it makes sense to focus management efforts on those species that have or *could* have the greatest impact to monument resources or neighboring agro/economic activities. Prioritizing management activities both by species and their location will help guide the most efficient use of resources (specifically staff time and budget), according to predetermined weed management objectives.

For the purposes of identifying pest plant species, many states and the USDA have created regulatory noxious weed lists focusing federal and state attention to species that threaten agricultural production and wildlands or natural areas. In some cases, such as in Colorado, the weed lists have been prioritized to guide coordinated state and county efforts and even provide management recommendations for individual species. Colorado's weed list and law can be found at http://www.ag.state.co.us/DPI/weeds/Weed.html. Utah has a significantly shorter state weed list that at this time focuses primarily on agricultural plant pests. Utah's list can be found at http://ag.utah.gov/plantind/nox_utah.html.

The NCPN of parks (16 parks, including DINO) is currently compiling species lists and reviewing and comparing several ranking systems in order to select the one that best meets the network's goals for future inventory, control, and monitoring needs. The end result will be a list and supporting documentation of priority species as well as a "watch list" for all northern Colorado Plateau parks.

It is expected that development of a NCPN-wide list of invasive species and ranking system will be completed by 2007. Although DINO has not analyzed its list of 75 non-native species using an established ranking system to date, it has identified 24 of those species for active or opportunistic management. These species were identified as priority based on previous inventories, their known impacts in other parts of the western U.S., regional and state mandates, and personal observations and experience of monument staff. DINO will use the forthcoming NCPN priority list plus any additional species unique to the monument to create a monument-specific prioritized list using the ranking system chosen by the network. No major changes to current monument priority species are expected, though site priorities may change as a result of this process.

7. Work with adjacent landowners, local, state and federal agencies, local interest groups, weed cooperative networks, and others to develop and achieve common goals of invasive plant management

The spread of invasive plants throughout Utah and Colorado poses a serious environmental and economic threat to public land, ranchland, farmland and private property in Uintah and Moffat counties. Because success of a weed management program is, in part, only as successful as your neighbors, DINO has joined with other federal, state and local government agencies, non-profit organizations, and private landowners to develop joint strategies for curbing this silent threat.

The following agencies, organizations, and landowners have expressed interest in invasive species in DINO and have active partnerships with the monument concerning invasive species management:

- Uintah Basin Cooperative Weed Management Area
- Dinosaurland RC&D
- Uintah County, Utah
- Moffat County, Colorado
- Routt County, Colorado
- Rio Blanco County, Colorado

- Uintah County weed board
- Chew Family Ranch
- U.S. Bureau of Reclamation
- U.S. Bureau of Land Management
- U. S. Fish and Wildlife Service
- Tamarisk Coalition
- The Nature Conservancy
- Outward Bound West
- National Outdoor Leadership School
- Sierra Club
- Friends of the Yampa
- Utah State University
- Colorado State University
- Colorado Division of Wildlife
- Colorado State Parks
- Colorado Department of Agriculture

Examples of existing partnerships and projects include:

- DINO's Weed Warrior Program has worked for 7 years with over 5000 Colorado Outward Bound and National Outdoor Leadership School students removing tamarisk along the Green and Yampa River canyons while exchanging educational and interpretive opportunities concerning national and local invasive species issues and concerns. Friends of the Yampa, a local volunteer group from Steamboat Springs, CO, has volunteered over 1650 hours removing tamarisk in innovative ways from the river canyons in DINO for the last four years while advocating for invasive species awareness in local communities.
- DINO has actively participated in supporting and organizing several Uintah Basin Cooperative Weed Management Area and Dinosaurland RC&D workshops, meetings, and workdays to help focus multi-agency weed education and control efforts in the Uintah Basin.

Potential project partnerships include:

- Cooperative Russian olive and tamarisk removal with the Chew Family on adjacent monument and private land along the Green River in Utah - partners may include cooperative extension services, Uintah County, NRCS, and other private landowners along the Green River.
- Yampa River Tamarisk and Russian Olive Management Cooperative Initiative, Routt and Moffat Counties, Colorado– partners include BLM, Moffat and Routt counties, The Nature Conservancy, CO Division of Wildlife, and CO State Parks, volunteer organizations, and private landowners.

DINO continues to participate in Colorado Weed Management and Utah Weed Control Associations – organizations dedicated to statewide invasive species issues, and remains committed to pursuing new partnerships with interested entities to manage weeds cooperatively in northwestern CO and northeastern UT.

8. Identify control techniques most appropriate for each species

Using the NEPA process, control techniques will be selected that achieve maximum effectiveness in control while minimizing risks to humans and natural and cultural resources. The selected control actions should ideally be ones that are:

Effective at killing invasive plants or managing infestations at an acceptable threshold level. There are five basic categories that all management techniques fall into: mechanical control, cultural control, chemical control, biological control, and prevention. Each category is described below and provides the definitions for impact analysis in Chapter 3.

Mechanical Control
Mechanical techniques for control of weeds in DINO include mowing, cutting/sawing, digging, pulling, spudding (severing of roots below the root crown), discing/plowing and smothering. Mechanical techniques can be especially effective in preventing seed production in annual and biennial forbs and exhausting root reserves in perennial plants (Meunscher 1980), and timing of these controls can be extremely important in determining outcome. For example, mowing cheatgrass in the “red” stage (post-flowering [“green”] but pre-curing [“tan”]) has proven to be very effective in some types of habitats. For perennial plants that reproduce vegetatively from root parts, mechanical treatments are generally not expected to provide complete control, even when repeated. Most often, they can be used as a tool for stressing the plants, making other treatments more effective (Derscheid et al. 1961, Renz and DiTomaso 1998).

Cultural Control
Cultural controls consist of actions that managers can take to indirectly impact weed populations. They can often be very cost-effective and therefore useful on large scales. Proposed treatments that have been shown to be effective on weeds in DINO include: prescribed grazing of domestic livestock, prescribed fire, and restoration/revegetation.

Land managers can use domestic livestock to selectively overgraze certain weed species to prevent seed set or weaken plant structure. In general, sheep and goats prefer forbs and can be used to graze broad-leaved weeds, while cattle prefer grasses and can be used to manage undesirable grasses (Tu et al. 2001). Both can be effective in reducing litter build-up prior to herbicide applications.

Prescribed burning consists of planning, setting, and managing fire to accomplish resource management objectives (CNAP 2000). Fire is sometimes necessary to prompt germination of some plants, but it can also reduce the abundance of some species. The most successful uses of fire for invasive species control result from burns that try to mimic or restore historical (natural) fire regimes, which have been disrupted by land use changes, suppression practices, fire breaks, or development (Tu et al. 2001).

Restoration can be defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2002). In the context of this EA, damage or degradation refers to the presence of weeds, while the establishment of desirable native vegetation is the recovery that we are trying to assist. Assisting the establishment of desirable vegetation through revegetation practices contributes to the larger goal of restoration as well as the goal of weed management (Jacobs et al. 1998). The establishment of a diverse community of desirable vegetation can prevent weed encroachment by utilizing all or most available resource niches (Sheley et al. 1996). Revegetation practices include seedbed preparation, broadcast seeding, drill seeding, container planting and sprigging live branches (Roundy 1996).

Chemical Control

Chemical control in this document refers to the use of herbicides to kill or injure target plants, as well as chemicals applied with herbicides that improve their efficacy (adjuvants).

Some techniques used for mechanical, cultural, and chemical applications involve the use of motorized vehicles, such as ATV's and tractors. There is a monument-wide ban on off-road uses of these types of vehicles, including for use in routine park operations, except under special circumstances that requires additional scrutiny by monument staff. Weed management is no different than other park operations and use of motorized vehicles for weed control will be considered only in areas appropriate for their use (larger infested areas of highly disturbed or altered vegetation with easy accessibility) and on a project-by-project basis.

Aircraft is commonly used in executing prescribed fire projects. As stated elsewhere in this plan, prescribed fire is one of the techniques available for invasive plant management. Any use of aircraft during prescribed fire will be considered and addressed in the burn plan that is required for all prescribed fire use and will be subject to all policies directing aircraft use in national park units. All reference within this invasive plant management document to aircraft noise or aerial application refers to prescribed fire activities only, as there will be no aerial application of pesticides in the monument.

Biological Control

Biological control can be defined as the deliberate introduction or manipulation of a pest's natural enemies (such as insects and pathogens) with the goal of suppressing the pest population (Wilson and Huffaker 1976). The theoretical framework for the use of biological controls is based on the hypothesis that the success of many non-native invasive weeds is the result of their release from predators or pathogens from their native range when they are introduced in a new range (Cronk and Fuller 1995). By introducing predators or pathogens, usually from the weeds' native range, their success can be curbed, allowing native plants to compete on more equal terms. Bio-control agents are not capable of completely eradicating a weed population, because as the number of host plants declines, so does the population of bio-control agents. However, bio-control can be a useful tool in reducing the initial size or density of a weed infestation, making other treatments more feasible.

Prevention

IPM also includes actions that don't directly impact weed populations and don't require environmental analysis (and thus are not analyzed in the impact analysis in Chapter 4), but are an integral part of a successful weed management plan. These actions include prevention and early detection of weed introductions and spread, inventory, monitoring, and education.

Prevention is generally agreed to be the most effective and economic form of weed management (Sheley et al. 1999b, DiTomoso 2000). There are countless ways of preventing weed introductions, such as minimizing unnecessary soil disturbance, containing neighboring weed infestations, and establishing and properly maintaining desirable vegetation. General prevention measures such as these are also known as Best Management Practices and are outlined in Proposed Management Action 1. Proposed education, inventory, monitoring efforts for DINO are also addressed in Proposed Actions 2, 3, and 4, respectively.

The control technique poses little to no risk to native vegetation, wetlands, wildlife, or other natural resources.
Dinosaur National Monument will continue to make a good faith effort and use extreme care in evaluating treatment options and ensuring all environmental compliance standards are met, especially in protecting water quality and aquatic resources. DINO will continue to review new relevant scientific literature and references and support research to ensure a control technique is biologically sound. Examples of work in DINO that addresses natural resource protection include:

- Experiment using repeated hand pulling in river floodplains to reduce overall density and cover of perennial pepperweed. Most literature does not list handpulling as a recommended treatment, but repeated pulling for 3+ years in the same location has dramatically reduced patch size and density (Naumann 2003).

- Manual removal of entire tamarisk plants down to the root crown along river corridors is releasing sediment trapped over time in the branches of tamarisk, slowly restoring cobble bars and returning that sediment to the river system to shape and nurture riparian systems downstream. Research by Dr. Jack Schmidt and Greg Larson of Utah State University investigates the relationship between tamarisk and fluvial geomorphic form in the dam-regulated Green River and the relatively unregulated Yampa River that will contribute to our understanding of those areas where tamarisk removal, in conjunction with planned dam operations, is most likely to be successful (and unsuccessful) in the long-term restoration of portions of these rivers.

Dinosaur National Monument will also adopt a hazardous materials spill plan within 6 months of this plan's adoption that will outline response, cleanup, and reporting actions of any hazardous material (herbicide) spills in both terrestrial and aquatic environments. DINO's spill plan will be modeled after ones created by USFS Arapaho/Roosevelt National Forests and Pawnee National Grasslands as well as guidelines in place for tamarisk management along the Colorado River in Grand Canyon National Park. Pending approval of herbicide use in DINO, the spill plan will be added as an appendix to this plan.

The control technique poses little to no risk to cultural resources.
Dinosaur National Monument will continue to make a good faith effort to evaluate treatment options and ensure all Section 106 compliance standards are met. DINO will continue to review

new relevant scientific literature and references to ensure control technique is sound for use in areas of cultural significance.

The control technique poses little to no risk to the human environment or to the safety of park visitors or park employees.
Some techniques have the potential to harm humans. Injuries can occur when using everything from a shovel or saw to fire and herbicide. Visitors and other staff can be harmed as well if management is occurring in areas where the public frequent.

For this reason, job hazard analyses are developed for many techniques, such as sawing and using herbicide. The purpose of these analyses is to define the technique and tools required for the activity, identify potential hazards for each step or phase of the technique, and mitigate for problems and injuries while performing the particular technique. These are reviewed every year for thoroughness and are required reading for anyone (volunteer or staff) participating in the activity.

Other precautions for reducing and eliminating risk to humans during weed activities include posting notice of the activity in high use areas or timing the technique (when possible) during low visitor use to the area (both time of day and time of year). DINO is committed to complying with the requirements of Colorado's Pesticide Applicators' Act, Title 35, Article 10, C.R.S. that notifies individuals of the Registry of Pesticide Sensitive Persons. This registry is updated annually and as of February 2004, no person in Moffat County is on the list. The state of Utah does not have a similar registry, however, any person in Uintah County wanting to be notified of specific pesticide application activities will be updated as requested. DINO will continue to review and refine treatment activities to avoid negatively impacting human use and safety in and near treatment areas.

The control technique is cost-effective to implement.
Cost is not the only driving factor in selecting control techniques, but is considered in the context of size, location, integrity of resources threatened, and management goal (eradication, suppression, containment) for a particular infestation or area. Choice of techniques and management strategy has both short and long-term cost implications. Short-term impacts are mostly negative and include the cost of the initial treatments and possibly foregoing an activity (closing hiking trails, removing livestock for a period of time) while the area recovers. However, protecting the larger surrounding non-infested areas or ecosystem functions in the long-term is a key in realizing and understanding the actual versus potential future costs of weed management for the entire monument and surrounding lands and not just the acreage actually infested.

9. Create annual work plans to guide invasive plant management activities

There are specific recommended control techniques for most of the 24 species of invasive plants found in DINO outlined in Proposed Action #8. Using this guidance as well as considering the size, location, and management objective for the area (if complete eradication is not feasible, the management objective [by area or by species] will be to suppress or contain the infestation below the threshold level with consideration to any federal and state management directives on the particular species), a monument-wide annual work plan will be created to guide control, monitoring, restoration, and prevention/education efforts. Appendix A is an example of a draft invasive plant management work plan for a particular area of the monument - the Cub Creek drainage. The Cub Creek area is one of the more challenging areas for weed management in the monument because of the complexity of natural and cultural resource issues that need to be considered for potential impacts by weed management activities.

The annual work plan will also be used to guide sources of labor to weed projects of appropriate size and nature. Staff and volunteers are the primary source of weed management labor in the monument. However, adoption of a weed plan will also enable the monument to make use of the Exotic Plant Management Team (EPMT), a new invasive species removal resource to the Colorado Plateau.

10. Restoration

Restoration is defined as a method to mitigate disturbed areas or control weed problems by restoring native vegetation communities to conditions existing prior to disturbance or invasion. In many cases, no active restoration may be necessary if bare ground /rock is the desired condition or if there is enough desired vegetation in proximity to occupy niches opened by weed control procedures (James 1992). However, when desired vegetation canopy is nonexistent or inadequate for the site conditions, active restoration is required to speed recovery of a healthy and competitive plant community.

Many weed management efforts focus on simply controlling weeds, with limited regard to the existing or resulting plant community. Before any weed control takes place, a stewardship plan that establishes desired future condition objectives relevant to anticipated land use must be considered. Strictly killing weeds is an inadequate objective, especially for large-scale infestations. However, a generalized objective might be to develop a healthy plant community that is relatively weed-resistant, while meeting other land-use objectives such as listed species habitat, roadside, or recreational use maintenance (Jacobs et. al. 1999).

In dry, desert environments like those at Dinosaur National Monument, restoration in general has the potential to be costly and has a high risk of failure, even when properly planned. Depending on the site and characteristics of the infestation(s) to be treated, DINO will identify a strategy for larger, active restoration projects that considers factors such as creating a self-sustaining and persistent desirable plant community that meets management objectives, involving neighboring landowners/managers when necessary, species and seeding method, and follow-up treatments that will best achieve desired conditions (Jacobs et. al. 1999). Restoration techniques used in DINO may include, but are not limited to, seeding, shrub/sapling plantings, soil amendments, and or irrigation.

Alternatives
Alternatives were framed through discussions among Dinosaur NM staff and Zion NP staff, with assistance from Intermountain Region Planning and Environmental Quality personnel. The alternatives cover the range of what is physically possible, acceptable by policy, and feasible for local managers; i.e. all reasonable alternatives. Criteria used in the selection of reasonable alternatives include:

- Potential for protecting the park's natural and cultural resources,
- Effectiveness, efficiency, and economy of eradicating or controlling invasive plant infestations
- Ability to ensure human safety

Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, chemical control and limited prevention techniques to manage invasive plants.

This alternative represents a continuation of current management practices using these techniques to control invasive plant infestations within Dinosaur National Monument. Because these activities and projects have been relatively small in scale, they meet criteria for categorical exclusion (CE) under NEPA.

In 1999, several of the first and only standard operating procedures (or best management practices) to address invasive species spread and introduction during routine park operations were codified in the monument. In compliance with Executive Order 13112 on Invasive Species enacted earlier that year, the Superintendent signed a memo requiring all park staff and contractors to minimize the potential for weed introduction and spread through actions that include borrow pit inspections and cleaning of construction or other heavy equipment. It also requires NEPA projects from all divisions be evaluated for appropriate measures to prevent weed introduction and spread. To date, no other additional SOPs/BMPs addressing weed management in the monument have been officially adopted.

If this alternative is selected, Dinosaur National Monument would not have an approved monument-wide Invasive Plant Management Plan and would continue to conduct small-scale invasive plant control management as it has using mechanical, cultural, and chemical control techniques within the framework of CEs and programmatic compliances completed for other programs within the monument or intermountain region.

This alternative does not provide for the proactive or full implementation of most of the 10 actions common to Alternatives II & III and therefore allows for continued inadequacy of components important in a successful IPM program such as treatment effectiveness monitoring, restoration plan development, and proactive early detection efforts. Therefore, it offers a limited ability to successfully address individual and/or unique invasive species situations in both infestation size and potential combinations of available techniques.

Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The preferred alternative proposes to consider the use of the full range of appropriate IPM techniques available both now and in the future for proactive, responsible integrated weed management. This more comprehensive approach incorporates current management practices with use of biological control agents and actions for increased education and monitoring activities to address prevention of the introduction and spread of invasive species in the monument. It is anticipated that more acres will be managed under this alternative than under either Alternatives I and III since staff would have the option of selecting from the full range of available management techniques and strategies. Therefore, this alternative is most likely to be successful in preventing unacceptable levels of invasive plants using the most economical means while posing the least hazard to people, property, and the environment.

This alternative most clearly meets the directive established in DO 77-7 that calls for "IPM procedures to be used to determine when to control pests and whether to use mechanical, physical, chemical, cultural, or biological means…". It allows the most flexibility and creativity in using available techniques to address invasive species situations in both size and scope of infestations. Each infestation or common areas of infestations would have a treatment implementation plan, which in turn will direct the development of annual operating plans to achieve desired management objectives.

Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention / early detection) to manage invasive plants.

This alternative proposes the consideration of a more limited range of tools, eliminating potentially controversial techniques such as herbicides and biological control. The analysis for this alternative examines the impacts of not using biological and chemical control. Under this alternative, it is anticipated that fewer acres will be treated annually than under the other two alternatives because of the labor-intensive nature and site and species-specific limitations of mechanical and cultural control techniques. While prevention and early detection efforts will be increased under this alternative, goals for eradication or containment of new invasive species in the monument are expected to be more difficult to achieve depending on location, ecology, and infestation size of the new invader.

The monument will not be able to successfully implement several of the 10 proposed management actions under this alternative. For example, applying the most appropriate control technique for each species cannot be achieved if chemical and/or biological controls are found to be most effective and appropriate for the level of control desired. The monument may also have difficulty fulfilling and maintaining cooperative management agreement goals with surrounding landowners and agencies if effective techniques and strategies are limited.

Table 1: Summary of Alternatives

Alternative Elements/ Actions	*Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
Prevent new infestations by employing prevention and early detection techniques	LIMITED IMPLEMENTATION: The few existing prevention measures would continue to be implemented and no proactive early detection efforts would occur.	FULL IMPLEMENTATION: A comprehensive set of BMPs for prevention would be adopted (which includes existing prevention measures) and proactive early detection efforts (rapid assessment inventory, education, tracking) would be implemented.	FULL IMPLEMENTATION: A comprehensive set of BMPs for prevention would be adopted (which includes existing prevention measures) and proactive early detection efforts (rapid assessment inventory, education, tracking) would be implemented.
Educate visitors and staff about invasive plants and their management in DINO	LIMITED IMPLEMENTATION: Monument would continue with current education and information programs through Weed Warrior and interpretive staff programs.	FULL IMPLEMENTATION: Monument would expand current education and outreach programs to improve visitor, staff, partner, and stakeholder awareness of monument and regional invasive species issues.	FULL IMPLEMENTATION: Monument would expand current education and outreach programs to improve visitor, staff, partner, and stakeholder awareness of monument and regional invasive species issues.
Inventory invasive plants in DINO	LIMITED IMPLEMENTATION: Monument-wide base inventory completed in 2005 but no scaled-back reinventory efforts (every 2-4 years) would occur.	FULL IMPLEMENTATION: Monument-wide base inventory completed in 2005. Scaled-back re-inventory of priority areas surveyed every 2-4 years would occur.	FULL IMPLEMENTATION: Monument-wide base inventory completed in 2005. Scaled-back re-inventory of priority areas surveyed every 2-4 years would occur.
Monitor effectiveness of control efforts	LIMITED IMPLEMENTATION: Monitoring would continue on a limited basis.	FULL IMPLEMENTATION: Monitoring programs would be designed for all major treatment	FULL IMPLEMENTATION: Monitoring programs would be designed for all major treatment

Alternative Elements/ Actions	*Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
		projects to determine whether management objectives are being met. Overall treatment success would be evaluated, and adaptive management would be used to modify treatments as appropriate.	projects to determine whether management objectives are being met. Overall treatment success would be evaluated, and adaptive management would be used to modify treatments as appropriate.
Track invasive plant management efforts	LIMITED IMPLEMENTATION: Tracking and reporting would continue on a limited basis and would be in compliance with NPS guidelines, including annual pesticide use.	FULL IMPLEMENTATION: In addition to annual pesticide reporting, monument will adopt and implement system to organize and track management efforts for analysis and effectiveness monitoring.	FULL IMPLEMENTATION: In addition to annual pesticide reporting, monument will adopt and implement system to organize and track management efforts for analysis and effectiveness monitoring.
Prioritize both invasive plant species and locations to be controlled	LIMITED IMPLEMENTATION: Current prioritizations for some species and locations would stand. Efforts to reprioritize would be considered following any changes in NPS, state, or local priorities.	FULL IMPLEMENTATION: All species considered invasive in the monument will be prioritized using an established ranking protocol to create a list that is monument specific. Treatment locations would be identified and prioritized based on supporting documentation created by the ranking process.	LIMITED IMPLEMENTATION: Availability of techniques will have an influence on the sites and species able to be treated, thereby limiting the guidance and purpose of the ranking process.
Work with adjacent landowners, local, state and federal agencies, local interest groups, weed cooperative networks, and others to develop and achieve common goals of invasive plant management	LIMITED IMPLEMENTATION: Monument would continue to collaborate invasive plant management efforts with existing established partnerships	FULL IMPLEMENTATION: Monument would expand collaboration efforts and new partnerships with neighboring landowners, other parks, park visitors, invasive plant management experts, other resource managers, and local,	LIMITED IMPLEMENTATION: Monument would seek to expand collaboration efforts and new partnerships with interested parties, however it will likely be limited in its ability to create, fulfill, and maintain these partnerships because of a limited use of

Alternative Elements/ Actions	*Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
		state, and federal officials.	techniques.
Identify control techniques most appropriate for each species	LIMITED IMPLEMENTATION: Monument would continue invasive plant management using only a portion of all treatments and techniques available. These techniques would be implemented in accordance with mitigation measures identified in this chapter.	FULL IMPLEMENTATION: The monument would have an IPM plan. The IPM plan would assist resource managers to coordinate knowledge of invasive plant biology, the environment, and all available technology to prevent unacceptable levels of invasive plant damage, using environmentally sound, cost-effective management strategies that pose the least possible risk to people, park resources, and the environment. Monument resource managers would have access to all treatments and techniques. These techniques would be implemented in accordance with mitigation measures identified in this chapter.	LIMITED IMPLEMENTATION: Monument would conduct invasive plant management using only a portion of all treatments and techniques available. These techniques would be implemented in accordance with mitigation measures identified in this chapter.
Create annual work plans to guide invasive plant management activities	NO IMPLEMENTATION: No annual work or management plans would be created beyond projects already scheduled with work crews (youth corps, SCA, OBW, NOLS) as part of the Weed Warrior program.	FULL IMPLEMENTATION: Monument resource managers would have a standardized process in place to assist with invasive plant management planning. The process (see Figure 2) will guide annual work or site-specific plans to identify invasive plants, determine invasive plant management priorities, identify and evaluate the efficacy and environmental effects of the proposed treatment,	FULL IMPLEMENTATION: Monument resource managers would have a standardized process in place to assist with invasive plant management planning. The process (see Figure 2) will guide annual work or site-specific plans to identify invasive plants, determine invasive plant management priorities, identify and evaluate the efficacy and environmental effects of the proposed treatment,

Alternative Elements/ Actions	*Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
		consider alternative treatments having less impacts, justify why a treatment was selected, and confirm compliance with applicable policies and regulations. The monument would also be able to submit annual invasive plant mgmt. requests to the CO EPMT.	consider alternative treatments having less impacts, justify why a treatment was selected, and confirm compliance with applicable policies and regulations. The monument would also be able to submit annual invasive plant mgmt. requests to the CO EPMT.
Restoration	LIMITED IMPLEMENTATION: Restoration following treatments would occur on an as-needed and as-funded basis.	FULL IMPLEMENTATION: Additional emphasis on restoration planning and implementation following treatments as part of IPM planning would occur.	FULL IMPLEMENTATION: Additional emphasis on restoration planning and implementation following treatments as part of IPM planning would occur.

Alternatives Considered and Rejected

One additional alternative was identified and considered in the scoping process. It was regarded as unreasonable within the context of NPS policies (Director's Order 12, Section 2.7B) and was therefore eliminated from further analysis. Section 2.7B identifies as unreasonable those alternatives that could not be implemented if they were chosen, that cannot be implemented for technical or logistical reasons, that do not meet park mandates, that are not consistent with management objectives, or that may have severe environmental impacts.

Alternative IV was called the "no invasive plant management or control" (or "do nothing") alternative. Without active management or control, invasive species would continue to cause irrevocable damage to the monument's resources, and severely degrade visitor use and enjoyment of DINO as well as surrounding and adjacent land use and values. This alternative was rejected because it does not meet the requirements of the park's enabling legislation to protect natural resources, the NPS Organic Act, NPS policies, or federal, state, and county noxious weed acts and provisions.

Mitigation Measures

Soils and Vegetation; Wetlands and Floodplains

- Type of mowing equipment will be selected based on the patch size, density of the target species, and terrain. Large, dense patches are suitable for vehicle-drawn mowing equipment, while small, dispersed patches are more suitable for control with hand-held equipment, such as a weed-whip.
- Tractor-drawn equipment will also be limited to use in areas where access is not restricted.

- Off-road vehicles used for control will avoid wetland areas with standing water or saturated soils, to the extent practical and will be operated to minimize disturbance to vegetation and soils. They will not be operated where soil is susceptible to compaction, erosion, or creation of wheel ruts.
- Off-road vehicles will be transported by trailer from one general area of the monument to another to avoid unnecessary cross-country travel and tracks.
- All mowing activities will be timed so that they are performed before there is a danger of contributing to the spread of viable seed.
- Cut plant material will be removed from the site if it may prevent establishment/growth of desirable vegetation and appropriately transported and disposed of in a way so that no propagules are spread. If plant material can or must be left, it will be piled or scattered in a way that it does not re-root or interfere with desirable vegetation.
- Revegetation will be implemented as quickly as possible to large areas of bare soil to reduce the danger of erosion caused by any loss of vegetative cover. Small areas that are adjacent to healthy native vegetation will be allowed to recover naturally, whenever possible.
- Smothering will only be used on infestations that are pure or nearly pure monocultures of target species.
- Heavy equipment use will be limited to areas where there is no danger of major compaction and tire ruts will be raked out.
- Damage to soils will be minimized by using existing access routes, when possible, avoiding sensitive soils and moving supplemental water sources to spread out congregating livestock.
- Where soil destabilization is not desired, the full removal of root systems will not be employed.
- Spudding will not be utilized in large or high-density patches to prevent excessive soil disturbance, unless all other potential treatments are deemed unfeasible.
- Any plowing or discing will be limited to sites and to depths where there is evidence of historic plowing or discing and will be limited to very specific conditions in areas where all other treatments are deemed ineffective or have a higher probability of negative effects.
- If deemed necessary, erosion control techniques, such as wetting to promote soil structure formation, biodegradable fiber-based erosion control netting or vegetal-based soil tackifiers will be used to stabilize soils.
- Temporary and existing permanent fencing will be used to ensure that grazing does not occur in areas where it is not intended.
- In plant communities composed of target and desirable species, prescribed grazing will only be used where a difference in phenology or palatability is sufficient to protect desirable species from damage or when litter removal is the management goal.
- To prevent the unintentional introduction of weed species through feces, livestock will be quarantined for a minimum of 48 hours prior to entering Dinosaur National Monument, where they will be fed a weed-free diet. Required quarantine periods could be longer depending on prior location of the animals, invasive species present in that area, biology of weed seeds and length of time required for animals to pass them, or at the request of the allotment permitee. At this time they will be inspected for weed seed attached to fur and cleaned sufficiently.
- Revegetation will be implemented as quickly as possible where necessary to reduce the risk of undesirable erosion.

- Selection of restoration species will be limited to native species that exist naturally in the region to prevent the accidental introduction of new invasive species. To minimize genetic contamination, propagules will be collected or propagated from the closest sites possible, as long as the collection site remains healthy and resilient to future disturbance. The benefits of local propagule collection must be weighed against the need for prompt revegetation. In many cases it may be more important to prevent establishment of non-desirable species and stabilize soils than to wait for sufficient seed to be collected locally. Planning will be utilized to assure that appropriate seed is available at the necessary time, and local collections will be prioritized based on available information concerning each species' genetic site-specificity.
- The use of non-native species will only be considered if it can be justified based on the need to establish vegetation under conditions that are not suitable for native species and if the non-native species is known to be non-invasive. Reference sites will be used whenever possible to help guide species selection and composition (SER 2002).
- Only certified weed-free seed will be used.
- All prescribed fires for weed management will be coordinated by a qualified fire management officer and be conducted in accordance with existing fire policy at Dinosaur National Monument.
- When possible, prescribed burns for invasive species management will be limited to monotypic stands of target species that respond negatively to fire or mixed communities where desirable vegetation benefits and target species are negatively impacted.
- Areas with sensitive soils and where excessive fuel build-up is likely to lead to high intensity fires will be excluded from burning.
- Erosion will be minimized by taking into account soil type and slope before burning, and by implementing any necessary revegetation afterwards as quickly as possible.
- All equipment will be washed prior to entering DINO and will be cleaned before leaving the site to prevent the spread of viable propagules to other sites.
- The use of a seed drill will be limited to species and project sites that require it for successful establishment. Multiple perpendicular passes will be performed to prevent the formation of rows, and drill use will be limited to soils that are not prone to compaction. Decompaction treatments will only be used if necessary for the establishment of vegetation (i.e. road removal) or if performed as an initial weed management treatment.
- Harrowing will be limited to sites where there is no risk to desirable vegetation or danger of soil compaction.
- Hand raking will be used in smaller-scale sites if there are potential impacts to desirable vegetation or soil.
- In order to insure that herbicides do not cause damage to existing desirable plant communities, all applications will be performed in accordance to the manufacturers specification label and by qualified applicators. In addition, the following guidelines will be observed:

Herbicide:	Mitigation to limit impacts to desirable vegetation due to selectivity:	Mitigation to limit impacts due to herbicide persistence and soil activity:
Chlorsulfuron	Limit use to painting/wicking/ squirting, spot spraying, monocultures or communities	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include dicots or annual grasses or to time of year when

Herbicide:	Mitigation to limit impacts to desirable vegetation due to selectivity:	Mitigation to limit impacts due to herbicide persistence and soil activity:
	composed of undesirable dicots and annual grasses and desirable perennial grasses.	revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Clopyralid	Limit application to painting/wicking/squirting, spot spraying, monocultures, or to communities composed of undesirable dicots and desirable grasses.	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include dicots or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Fluazifop-p-butyl	Limit use to painting/wicking/squirting, spot spraying, monocultures or communities composed of undesirable grasses and desirable dicots.	None
Glyphosate	Limit use to painting/wicking/squirting, spot-spraying or monocultures.	None
Hexazinone	Limit use to painting/wicking/squirting, spot-spraying or monocultures.	Limit use to sites where active revegetation is not necessary or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Imazapyr	Limit use to painting/wicking/squirting, spot spraying, monocultures or communities composed of undesirable dicots and perennial grasses and desirable annual grasses.	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include dicots or perennial grasses, or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Imazameth/ Imazapic	Limit use to painting/wicking/squirting, spot spraying, monocultures or communities composed of undesirable dicots and annual grasses and desirable perennial grasses.	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include dicots, annual grasses or affected perennial grasses (see herbicide label) or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Metsulfuron	Limit use to painting/wicking/squirting, spot spraying, monocultures or communities composed of undesirable dicots and annual grasses and desirable perennial grasses.	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include dicots or annual grasses or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Sulfometuron-methyl	Limit use to painting/wicking/squirting, spot spraying or	Limit use to sites where active revegetation is not necessary or to time of year when revegetation will

Herbicide:	Mitigation to limit impacts to desirable vegetation due to selectivity:	Mitigation to limit impacts due to herbicide persistence and soil activity:
	monocultures.	not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
Triclopyr	Limit use to painting/wicking/ squirting, spot spraying, monocultures or communities composed of undesirable woody or annual dicots and desirable grasses and perennial forbs.	Limit use to sites where active revegetation is not necessary, sites where revegetation does not include woody or annual dicots, or to time of year when revegetation will not be affected. Follow label directions to prevent damage to susceptible nearby desirable vegetation.
2,4-D	Limit use to painting/wicking/ squirting, spot spraying, monocultures or communities composed of undesirable dicots and desirable grasses.	Limit use to sites where active revegetation is not necessary, to sites where revegetation does not include dicots, or wait at least 10 days after application to revegetate. Follow label directions to prevent damage to susceptible nearby desirable vegetation.

- Adjuvants that include fertilizers will be excluded from use. Adjuvants are, for the most part, unregulated since they are considered "inert" ingredients; however, Washington and California do regulate them along with all pesticides. Therefore, only adjuvants that are registered with the state of California will be used (Tu et al. 2001, CDPR 2004).
- *Painting/wicking/squirting*: Affects to non-target species will be minimized by using an appropriately scaled application device. Damage from spills will be minimized by limiting the amount of concentrated herbicides to 1 liter in any one container carried into areas composed of non-target vegetation. In addition, procedures established by DINO for responding to hazardous material spills will be adhered to.
- *Backpack sprayer*: Damage caused by over spray will be minimized by adjusting the spray nozzles to deliver the appropriate droplet size and spray area for the scale of the target plant. Spray nozzles will be held as closely as possible to the target plants and application will be limited to days with negligible wind (Bussan and Dyer 1999).
- *Granular application*: Because of the lack of selectivity of this treatment technique, it will be limited to monocultures of target species or to communities composed of target species and desirable species that are not susceptible to the herbicide. A buffer zone is required when applying herbicide in granular form in the vicinity of desirable susceptible vegetation. For monocultures, revegetation will be implemented as quickly as possible to prevent re-colonization by undesirable species and reduce the risk of erosion.
- *ATV/tractor-mounted sprayer*: Damage caused by overspray will be minimized by adjusting the spray nozzles to deliver the appropriate droplet size and spray area for the scale of the infestation. Spray nozzles will be mounted closely as possible to the target plants and application will be limited to days with no appreciable wind (Bussan and Dyer 1999). Use of heavy equipment will be limited to soils that are not prone to compaction. Tire ruts will be raked out. Revegetation will be implemented where necessary in a timely manner to prevent re-colonization by undesirable species and reduce the risk of erosion.

- In order to minimize the risk to desirable vegetation, Dinosaur National Monument will only use bio-control agents approved for release by APHIS and the Biological Pest Control Section of the Colorado Division of Plant Industry and supported by USFWS.

Wildlife

- DINO staff will be consulted so that invasive species control occurring in sensitive wildlife habitat will not occur during critical times of year, such as nesting or calving.
- Domestic livestock used for prescribed grazing will be contained during the grazing event (pen, fenced pasture) and wildlife/large animal veterinarians will be consulted before each prescribed grazing event to ensure any risks to domestic animals and wildlife are negligible.
- Use of domestic livestock for prescriptive management purposes will be limited to times of the year when disturbance will not disrupt critical wildlife activity. Critical habitat and food sources will also be protected during grazing events, though wildlife will not be excluded from these areas.
- Prescribed fire will be implemented in weed monocultures or in plant communities that will benefit from burning.
- Critical wildlife habitat features, such as snags or nonfire-adapted vegetation will be excluded from burning through the use of fuel breaks or other protective measures (Riggs et al. 1996).
- Streams, rivers, and ponds will be avoided when applying fire suppressant agents other than water.
- Restoration activities will be timed to the extent possible so that the least disturbance to wildlife occurs.
- Where possible, natural recolonization of habitat will be the preferred restoration technique unless substantial risk of erosion or reinfestation is present.
- All of the herbicides considered for use in DINO have a slight to low toxicity rating for wildlife and those with shorter half-lives will be used preferentially. If an herbicide with a long half-life is deemed necessary for use near wildlife, all efforts will be made to use it a time of year when the least amount of exposure will result and/or applied in the most selective manner to reduce the amount of herbicide used.
- Only adjuvants registered with the State of California will be used (see Appendix G).
- Only ground-based equipment, including backpack sprayers and spray units on ATV, trucks, etc. will be used in low wind conditions. There will be no aerial pesticide applications.
- Herbicide will be applied in spot applications using hand equipment (backpack sprayer) during the post-flood stage in low-wind situations where particular riparian invasive species (namely tamarisk and Russian olive) grow up to the water's edge and indirectly threaten habitat for riparian and aquatic wildlife. No applications will be made along the major river corridors within 6 months prior to the earliest peak flow date (May 15) to ensure an immeasurable amount to no active ingredient remains in the vegetation or soil when natural floods return.
- Biocontrol agents will only be considered when high value wildlife habitat is substantially threatened by the target weed and the scientifically predicted risk to non-target native vegetation and wildlife is acceptably low.

Threatened and Endangered Species
(See also Appendix E for conservation measures specific to listed species.)

- All areas where weed management activities (including access routes) are proposed, that coincide with potential habitat for listed species, will be surveyed prior to implementation. Staff will also consult monument botanist or plant database, if available, to identify known locations of rare plants.
- Surveys will be conducted at a time of year when the listed species can be readily detected, and individuals or areas where they exist will be marked.
- All invasive plant personnel and crews removing plants will be able to identify invasive species and at least one crewmember will be able to identify rare species expected to be present in the area.
- After comprehensive surveys have been completed, the control technique that best fits the characteristics of the plant community will be chosen. Efforts will be made when possible to time herbicide applications when the target species is vulnerable but the listed species is not. If there is a need to use herbicide in a community composed of both target and listed species the label will be followed and the application technique that poses the least risk of application to non-target species will be used. It isn't possible to plan for every combination; however, the following chart can provide basic guidelines for appropriate tool selection:

	Listed Plant Species Density		
Target Sp. Density	**High**	**Medium**	**Low**
High	Mechanical controls may not be appropriate; spray selective herbicide (do test section first).	Mark listed species. Weed-whip, pulling, spudding or cutting; spray selective herbicide (do test section first).	Mark listed species. Plowing, mowing, weed-whip, pulling, spudding or cutting; spray selective herbicide (do test section first).
Medium	Mark listed species. Weed-whip, pulling, spudding or cutting; wick application or cut-stump.	Mark listed species. Weed-whip, pulling, spudding or cutting; wick application or cut-stump.	Mark listed species. Weed-whip, pulling, spudding or cutting; wick application, spot-spraying or cut-stump.
Low	Pulling, spudding or cutting; cut-stump or wick application.	Pulling, spudding or cutting; cut-stump or wick application.	Mark listed species. Pulling, spudding or cutting; wick application, spot-spraying or cut-stump.

If mechanical controls appear likely to cause damage to listed species from trampling or soil disturbance caused by operator foot traffic, other techniques will be considered. If herbicides are used modifications to the guidelines will need to be made depending on the size and growth form of both target and listed species, soil characteristics and proximity to water.

- Prior to implementation of mechanical controls, areas that are potential habitat for listed wildlife species will be surveyed. If they are found in the vicinity of the treatment area, treatments will be limited to ones that are unobtrusive or to times of year when the listed species are not present or less affected by disturbance.
- Domestic livestock used for prescriptive management of invasive species will be excluded from sites (including access routes) where listed plants are known to occur or during seasons when listed plants are vulnerable to damage or where there is a risk of transmitting diseases to wildlife or during critical times of the year.
- Prescribed fire will only be used at sites where listed plants or animals are known to benefit from burning. Otherwise, fire will be excluded, either spatially or temporally to prevent damage to listed plant or wildlife species habitat values.
- Fire suppressants (foams) will not be applied on or near open water (rivers, streams, ponds).
- Selection of restoration species will be limited to native species that exist naturally in the region, or non-native species that are known to not spread, to prevent the accidental introduction of new invasive weeds that would endanger listed plant or wildlife values.
- Seed must be certified weed free, and all equipment used must be washed prior to entering the monument.
- Larger equipment associated with restoration, such as seed drills, seedbed preparation equipment or harrowing equipment will not be used in the vicinity of listed plant species unless there is a direct benefit to the listed species.
- Restoration activities will be timed so that negligible disturbance to listed wildlife occurs.
- Herbicide use will be avoided in the vicinity of listed plant species.
- All restrictions outlined on herbicide labels will be followed.
- Chemical controls will be used in the vicinity of listed wildlife or their habitat when other weed management techniques might cause undue disturbance to listed wildlife or their habitat or are deemed infeasible.
- Herbicides that are of low toxicity to wildlife and/or that will degrade before wildlife are likely to encounter them will be used and will be applied in a manner that uses the least amount, but still remains effective and that best protects habitat for listed species.
- Herbicides that are toxic to aquatic species and/or have high mobility in soils and/or persist in the environment will not be applied to soils or sprayed on foliage near water. Instead, when a particular herbicide is deemed necessary for control of the target species, it will be applied either as a cut-stump application or to foliage with a wick or during periods when its potential to impact aquatic species is at a minimum (e.g. post-flood stage in river corridors, after critical spawning or nursery periods). No applications will be made along the major river corridors within 6 months prior to the earliest peak flow date (May 15) to ensure an immeasurable amount to no active ingredient remains in the vegetation or soil when natural floods return.
- Only ground-based equipment, including backpack sprayers and spray units on ATV, trucks, etc. will be used in low-wind conditions. There will be no aerial pesticide applications.
- Only biocontrols that are deemed host-specific and have been approved by APHIS and USFWS are approved for release. Biocontrol agents for target species closely related to

native plants of the Colorado Plateau, and especially listed species, will be excluded from intentional release in DINO.

- Populations of listed wildlife that are considered at risk of competition from other wildlife will be evaluated for the effect of a biocontrol release. If a biocontrol release is expected to cause an increase in such competition, based on the size of the target infestation, the type of biocontrol agent, the proximity of listed wildlife to the infestation and the proximity of competing wildlife, it will be excluded from use in DINO.

Water Quality

- Treatments will be avoided that create large areas of bare soil near open water to reduce the risk of increased turbidity from mechanical controls in areas where vegetated banks are desirable. If they cannot be avoided they will be stabilized with erosion-control methods and bare soil will be revegetated as quickly as possible, where appropriate. In some instances (within or along the river channel) the desired outcome may be unvegetated sand, gravel, or cobble.
- Vegetated buffer strips may be maintained between denuded areas and riparian corridors where appropriate to reduce the danger of increased turbidity from cultural controls in areas where vegetated banks are desirable. If these cannot be maintained, artificial erosion control measures will be installed to act as a buffer strip.
- Revegetation, if needed, will be implemented as quickly as possible.
- Impacts to water quality from livestock will be minimized by preventing access by livestock to open water or saturated soils.
- All herbicide labels will be followed to ensure that contamination of water does not occur.
- All herbicide applied to soil as a spray or granules or applied to foliage with a spray within 500 ft. of open water or with a depth to groundwater of less than 50 ft. will be evaluated using the RAVE system for assessing risk to water quality (see Appendix F). If a site scores above 65, then a wick, basal bark, or cut-stump application will be used. Consideration will be given to toxicity, soil mobility, persistence and selectivity in evaluating risk.
- Applications of pesticides within 50 feet of surface water bodies (including streams, rivers, lakes, and waterways) would be done by hand or with vehicle mounted ground equipment to minimize the potential impacts to surface waters.
- Pesticides would only be applied when meteorological conditions at the treatment site allow for complete and even coverage and would prevent drifting of spray onto non-target sensitive resources or areas used by humans.
- If possible, infestations near or in water will be treated with glyphosate (marketed as Rodeo) or imazypyr (marketed as Habitat) since they are two of the few herbicides registered for use in or near water. If glyphosate or imazypyr are not effective against the target species and no other effective techniques are feasible for the infestation, the next effective herbicide with the lowest risk to aquatic organisms will be applied with a wick or as a cut-stump or basal bark application.
- Only adjuvants registered with the State of California will be used (see Appendix G).

Wilderness

- A minimum tool analysis will be conducted to determine the least intrusive tool, equipment, device, force, or practice that will achieve both Wilderness and invasive weed management objectives. Planned actions that involve the use of mechanized tools or equipment (e.g.

chainsaws) will be subjected to a minimum tool analysis by the monument's interdisciplinary team (IDT) that is described in Appendix H.
- If Wilderness is designated in the future, IPM practices will be evaluated to ensure consistency with an approved Wilderness management plan.
- Where grazing is permitted within the monument, use of domestic livestock for prescribed grazing will be managed under conditions and requirements identified within any future Wilderness plan and the corresponding allotment management plan.
- Only biocontrols that are deemed host-specific by APHIS and other associated federal agencies using the best available science and monitoring techniques will approved for release in Dinosaur National Monument, should they match the monument's need for management of a particular species.
- Efforts would be made to minimize the number and duration of trips and reduce the visibility of IPM activities.
- Unavoidable impacts, such as vehicle tracks, will be mitigated immediately after invasive plant control activities are completed. Mitigation methods will be included in the administrative record for the Minimum Requirement Analysis.
- Whenever possible, invasive plant management activities in Wilderness will be timed to avoid peak visitor use periods.
- DINO will disseminate information to the public and staff on various control projects as to how and why particularly loud techniques, such as ATVs and aircraft, are necessary to accomplish project goals.
- Visitor complaints regarding management activities in Wilderness will be directed to the Chief of Research and Resource Management. Whenever possible, the Chief will contact the visitor directly to try to resolve the complaint. The Chief and resource management staff will then review the Minimum Requirement Analysis, re-evaluate alternatives and, if appropriate, consider implementing additional mitigation measures to address visitor concerns.

Air Quality
- Most pesticides recommended for use have a low volatility. Those pesticides with higher volatility will be used at low concentrations and will be used in conditions and in a manner consistent with product labeling, as required by law.
- Pesticides would only be applied when meteorological conditions at the treatment site allow for complete and even coverage and would prevent drifting of spray onto non-target sensitive resources or areas used by humans.
- Pesticides with high volatility would not be used to treat areas located adjacent to sensitive areas because of the potential for unwanted movement of pesticides to these areas.
- Prescribed fire plans would be developed for each prescribed fire. Appropriate signing would be posted if smoke would affect roadways or designated visitor areas (visitor centers, campgrounds, river canyons) and the appropriate authorities would be contacted regarding smoke or visibility.
- Any off-road vehicles used for control treatments will be transported by trailer from one general area of the monument to another and trailers would be used to avoid unnecessary cross-country travel.

Soundscape

- Any use of mechanized equipment for management in more closed canyon environments will be limited to less than four hours per day, less than 3 days/week, and scheduled (to the degree practicable) during low visitor use seasons (late summer through fall) to reduce impacts to park visitors.
- DINO would disseminate information to the public and staff on various control projects as to how and why particularly loud techniques, such as ATVs and aircraft, are necessary to accomplish project goals.

Historic Structures, Cultural Landscapes, and Archeological Resources

- Weed management personnel will be briefed about working in and protecting cultural resources sites.
- Consultation will occur with the staff archeologist and SHPO, if necessary, during the planning phase of invasive species management projects to determine sensitive areas and acceptable levels of disturbance will reduce or eliminate any potential adverse effects to historic and cultural resources.
- When practical and possible, a temporary fence would be installed to protect historic and cultural resources structures while grazing animals are present.
- Equipment used for revegetation and restoration projects would be evaluated and chosen that is determined to be the most effective to accomplish restoration goals while causing the least disturbance to historic and cultural resources.
- Severity of fire-related effects would be controlled where possible by controlling the fireline intensity in resource-rich areas at the time of the burn and inventories of previously unsurveyed areas will be conducted prior to the prescribed burn.
- Structures or features in or near proposed prescribed burn footprint would be protected when practical and without causing damage by 'blacklining', treating with fire retardant, and or/ establishing sprinkler systems prior to fire ignition.
- Fire crews would be briefed about working in and protecting cultural resources sites and any slash would be disposed of in areas lacking cultural sites.
- Ground disturbance would be avoided during preparation and fire mitigation in cultural resource areas.
- Structure surfaces would be washed off as soon as possible after exposure to foam fire suppressants.

Paleontological Resources

- Foot and vehicle traffic should be limited to vegetated areas where possible to protect vulnerable paleontological resources.
- Consultation with staff paleontologist during planning phase of invasive plant management projects will help to determine sensitive areas and acceptable levels of disturbance.
- When practical and possible, areas rich in resources will be temporarily fenced during grazing events.
- Equipment used for revegetation and restoration projects will be evaluated and chosen that is determined to be the most effective to accomplish restoration goals while causing the least disturbance to paleontological resources.

- Severity of fire-related effects will be controlled where possible by controlling the fireline intensity in resource-rich areas at the time of the burn and inventories of previously unsurveyed areas will be conducted prior to the burn.
- Sites in or near proposed prescribed burn footprint will be protected when practical and without causing damage by 'blacklining', treating with fire retardant, and or/ establishing sprinkler systems prior to fire ignition.
- Fire crews will be briefed about working in and protecting paleontological sites.
- Ground disturbance will be avoided during preparation and fire mitigation in paleontological resource areas.
- Weed management personnel will be briefed about working in and protecting cultural resources sites.

Land Use and Park Operations

- Capital improvement and natural resource funding will be sought to implement necessary improvements in facilities or park operations to help alleviate any additional cost burden on the monument caused by proposed invasive plant management requirements.

Environmentally Preferred Alternative

The environmentally preferred alternative is determined by applying the criteria suggested in the National Environmental Policy Act of 1969 (NEPA), which is guided by the Council on Environmental Quality (CEQ). The CEQ provides direction that "the environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA's Section 101" (*Forty Most Asked Questions Concerning Council on Environmental Quality's National Environmental Policy Act Regulations*, 1981.)

Section 101 of the National Environmental Policy Act states that "…it is the continuing responsibility of the Federal Government to …

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

(3) attain the widest range of beneficial uses of the environment without degradations, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The environmentally preferable alternative for this project is based on these national environmental policy goals.

A discussion of how each alternative relates to these goals follows:

Alternative I: Continuation of Current Management Practices – Use mechanical, cultural, chemical control and limited prevention techniques to manage invasive plants.
This alternative seeks to meet the environmental policy goals by using several, but not all, of the available IPM techniques to manage invasive plant species. Without the use of biological control agents or development of more proactive prevention and early detection programs, certain invasive species are likely to be introduced and/or spread more widely throughout the monument. Environmental degradation already occurring as a result of the spread and eventual dominance of several particular species is likely to increase exponentially, which fails to meet three of the environmental policy goals. For example, two to three new non-native species are discovered in the monument every year, most of which occur in small, isolated infestations along or near transportation corridors and places where people gather such as parking lots and campgrounds. New species are expected to continue to appear on a regular basis (despite attempts of spot control using mechanical and chemical techniques) as visitors, equipment, and animals visit, move, and migrate to and from places outside DINO. Another example is the march of tamarisk (saltcedar) up relatively uninfested main and side river canyons and its establishment on cobble and sand bars in the Green and Yampa Rivers, despite the efforts of staff and over 500 volunteers employing mechanical, chemical, and cultural techniques every year. Therefore, this alternative would not result in the same level of protection of natural and cultural resources and people over the long-term as would occur with the preferred alternative. Consequently, the continuation of current management practices alternative does not satisfy provisions 1-5 of NEPA's Section 101.

Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.
This alternative provides the greatest flexibility in mitigating and responding to the unique and individual nature of all invasive species problems that are present in DINO by using the full range of available IPM techniques, including those available now and yet to be shown as effective in the future. Using true integrated pest management reduces dependence on one or few techniques to manage invasive species, thereby lessening any repetitive and potentially cumulative adverse impacts of those same techniques to the safety, health and integrity of resources, visitors, and staff.

It provides opportunities for selection and tailoring of individual or combined treatments of invasive species, and thus should be most effective in managing the most infestations. Protecting and restoring native vegetation communities and natural processes altered by invasive species through IPM would ultimately provide for better health, safety, and enjoyment of visitors and employees and protection of natural and cultural resources for succeeding generations. This alternative further provides for invasive species management prescriptions intended to contribute to the maintenance of long-term stability and diversity in native vegetation communities and would protect people and cultural and natural resources with minimum disturbance. This alternative would satisfy each of the provisions of the national environmental policy goals.

Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/ early detection) to manage invasive plants.

Like Alternative I, this alternative also seeks to meet environmental policy goals using a limited range of available IPM techniques to manage invasive plants. The two techniques eliminated in this alternative, chemical, and biological control, are most useful and efficient in managing large and/or widespread weed infestations. Several species exist in DINO on this scale and dominate the communities in which they occur. Herbicide applications are also very useful when applied in spot treatments to small, isolated infestations of many species of new invaders.

Although this alternative limits the use of potentially controversial management techniques because of their potential damage to resources and people if used or considered improperly, its implementation is expected to increase the rate of natural and cultural resources degradation as well as visitor safety and enjoyment over time as new invaders gain a foothold in the monument and already widespread weed species increase their range and amplitude both within and outside monument boundaries. Consequently, Alternative III does not satisfy any of the provisions of NEPA's Section 101 as well as the preferred alternative.

The environmentally preferable alternative is Alternative II because it surpasses the continuation of current management alternative (Alternative I) and Alternative III in realizing the full range of national environmental policy goals as stated in Section 101 of the National Environmental Policy Act. Alternative I does not provide for comprehensive weed management planning on a larger monument-wide scale and does not provide guidance for long-term maintenance, monitoring, and evaluation of primarily reactive-based treatment techniques. While Alternative III does provide for a more proactive preventative approach and may result in the least amount of public controversy over perceived potential impact to resources and humans, it does not result in decreased risk to long-term health of native communities and natural processes in comparison with the other two alternatives.

Table 2: The Degree to Which Each Alternative Meets Invasive Plant Management Plan Objectives

Plan Objective	***Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants***	***Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.***	***Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.***
Preserve, protect, and restore natural conditions and ecological processes of DINO by eradicating, significantly reducing, or containing infestations of 24 known invasive plants.	Some resources and natural processes will be protected and expansion of some weed populations already present may be slowed, but likely only for the short term. The continuation of current management practices alternative does not provide the guidance for the long-term preservation, protection, and restoration of resources degraded by invasive species. Implementation of Alternative 1 will partially meet this	The maximum number and type of resources and processes will be preserved, protected, and restored over the long-term through the implementation of a flexible and comprehensive invasive species management planning process. Implementation of Alternative 2 will fully meet this objective.	Some resources and natural processes will be protected, and expansion of some weed populations already present may be slowed, but likely only for the short term. This alternative does not provide the guidance or tools for the long-term preservation, protection, and restoration of resources degraded by invasive species. Implementation of Alternative 3 will minimally meet this objective.

Plan Objective	Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants	Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.	Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.
	objective.		
Prevent further introductions of invasive species already present in the monument as well as new species introductions by increasing visitor and staff awareness through education, by identifying mechanisms for cooperation among neighboring agencies and landowners, and by implementation of best management practices.	Introductions/expansions of new and existing invasive species will not be adequately addressed under the continuation of current management practices alternative because it does not provide for increased cooperation and education nor does it require DINO to establish and implement Best Management Practices. Implementation of Alternative 1 will partially meet this objective.	Monument-wide management activities and planning efforts will involve elements of prevention and early detection, including the use of Best Management Practices, aimed to prevent further introductions and/or spread of invasive species under this alternative. Implementation of Alternative 2 will fully meet this objective.	Monument-wide management activities and planning efforts will involve elements of prevention and early detection, including the use of Best Management Practices, aimed to prevent further introductions and/or spread of invasive species under this alternative. Implementation of Alternative 3 will partially meet this objective.
Establish protocols, decision-making tools, schedules, and treatment methods for routine weed management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs).	A limited amount of treatment by park employees and volunteers will occur under the continuation of current management practices alternative since it does not provide the compliance, structure, and scheduling required by NPS EPMTs and does not seek to establish priorities, protocols, and effective treatment methods for all invasive species present in the monument. Implementation of Alternative 1 will partially meet this objective.	Annual operating plans under this alternative will guide and utilize available staff, volunteers, and NPS EPMTs to the fullest extent possible using the full range of IPM management techniques and tools. Implementation of Alternative 2 will fully meet this objective.	Annual operating plans under this alternative will guide and utilize available staff, volunteers, and NPS EPMTs to the fullest extent possible using a limited number and type of invasive species techniques and tools. Implementation of Alternative 3 will minimally meet this objective.

Table 3: Environmental Impact Summary by Alternative

Impact Topic	*Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
Soils and Vegetation	There would be a slightly beneficial effect for	Use of proactive prevention/ early detection measures and full use of available techniques would	While proactive prevention measures would be used, the tools to manage new and existing infestations most effectively and efficiently

Impact Topic	***Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants***	***Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.***	***Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.***
	maintaining/restoring soil and vegetation communities, however success in identifying new infestations would be minimal. Overall effect on resource would be beneficial, short-term, site-specific, and minor.	have the most long-term and widespread success at treating widespread infestations and new species introductions. Overall effect on resource would be beneficial, monument-wide, long-term and moderate.	may not be. The two techniques used most frequently to manage such infestations are eliminated so species such as tamarisk will continue to spread unchecked. The least number of acres would be treated. Overall effect on resource would be adverse, monument-wide, long-term, and moderate.
Wetlands and Floodplains	Structure and function would be nominally improved with the removal of invasives, particularly tamarisk and Russian olive. Any adverse impacts caused by techniques would be negligible to minor, though overall success of restoration/maintenance of resources would be lower because of the scale of riparian infestations present. Overall effects to the resource would be beneficial, site-specific, short-term and negligible to minor.	Beneficial effects to the maintenance and restoration of structure and function would be greatest since all tools to address scale of riparian invasive problems are available. Minor short-term impacts caused by most management techniques would be outweighed by long-term benefit of habitat restoration. Overall effects to resource would be beneficial, monument-wide, long-term, and moderate.	While proactive prevention and early detection measures would be used, species already present in large infestations seriously threaten structure and function, particularly in riparian areas. Species such as tamarisk and Russian olive that threaten this resource the most will continue to spread unchecked since two of the most effective tools for these widespread species would be eliminated. The least number of acres would be treated. Overall effect on resource would be adverse, monument-wide, long-term, and moderate.
Wildlife	Effects to wildlife in the form of maintained/ improved habitat may not be as great or long lived without the implementation of expanded prevention and early detection techniques and the option to use biocontrol agents. Overall effect to resource would be	Effects to wildlife would be detectable and greater because techniques available are able to address scale of management necessary to affect positive long-term improvements in desired habitat. Any adverse impacts would be minor and short-term. Overall effect to resource would be	Potential indirect impacts to wildlife by use of only these techniques are likely to be incompatible with desired goals of wildlife management. Some invasive species that are unable to be controlled with only mechanical and cultural techniques would cause further habitat degradation. Overall

Impact Topic	*Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
	beneficial, site-specific, short-term, and minor.	beneficial, monument-wide, long-term, and moderate.	effects on resource would be adverse, monument-wide, long-term and moderate.
Threatened and Endangered Species	Effects to T&E species in the form of maintained/ improved critical habitat may not be as great or long lived without the implementation of expanded prevention and early detection techniques and the option to use biocontrol agents. Overall effect to resource would be beneficial, site-specific, short-term, and minor.	Effects to T&E species would be detectable and greater because techniques available are able to address scale of management necessary to affect positive long-term improvements in critical habitat. Any adverse impacts would be minor and short-term. Overall effect to resource would be beneficial, monument-wide, long-term, and moderate.	Potential indirect impacts to T&E species by use of only these techniques are likely to be incompatible with desired goals of wildlife management. Some invasive species that are unable to be controlled with only mechanical and cultural techniques would cause further degradation of critical habitat. Overall effects on resource would be adverse, monument-wide, long-term and moderate.
Water Quality	Removal of invasive plants that indirectly impact water quality could have a beneficial effect by returning surface and groundwater to natural flows, reducing visual obstructions along watercourses, and reducing erosion. These effects would not be as great or as long-term without the implementation of proactive prevention and early detection effort or use of biocontrol agents where appropriate. Overall effect on the resource would be beneficial, site-specific, short-term and negligible to minor.	Addition of expanded prevention and early detection efforts and use of biocontrol agents would increase amount of acres able to successfully treated. Beneficial effects to resource may be more detectable and greater because the scale of invasives problem impacting water quality is better addressed. Overall effect on resource is beneficial, monument-wide, long-term, and moderate.	Tools available are likely not adequate to efficiently and effectively manage the scale of invasive plant threats to the resource. The least amount of acres would be treated. Surface and ground water flows, visibility, and quality habitat along watercourses would deteriorate while erosion would increase as infestations degrade soil and native vegetation communities. Overall effect to resource would be adverse, monument-wide, long-term, and minor.
Wilderness			Elimination of chemical and biological controls may be incompatible with

Impact Topic	*Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
	There would be a minor beneficial change in naturalness and Wilderness character as a result of reduction or elimination of invasive plants. Overall effects to resource would be beneficial, site-specific, short-term, and minor.	Beneficial changes to Wilderness character would be more noticeable and widespread as more acres are treated. Proactive prevention techniques and biocontrol agents enhance long-term management options. Overall effect to resource would be beneficial, monument-wide, long-term, and minor to moderate.	many aspects of Wilderness management. In particular, the repetition required for the success of many mechanical treatments may cause unacceptable levels of disturbance to natural and cultural resources as well as to visitors. There are invasive species that cannot be controlled with only mechanical or cultural techniques and would therefore persist in the environment, compromising the integrity of areas the Wilderness Act is designed to protect.
Air Quality	Potential for herbicide volatilization is greatest and air quality in certain areas may be reduced by equipment more than in Alternative II when repeated treatments are necessary. Overall effects to resource would be adverse, site-specific, short-term, and negligible to minor.	Reduction in air quality because of equipment used in mechanical, cultural, and chemical activities would occur least often because of the diversity of tools available. Herbicide volatilization may be less than under Alternative I. Overall effect to resource would be adverse site-specific, short-term, negligible to minor.	Potential for herbicide volatilization does not exist. Air quality in certain areas may be reduced most often due to more frequent and widespread use of equipment in mechanical and cultural techniques. Overall effect to resource would be adverse site-specific, short-term, negligible to minor.
Soundscape	Potential for noise is higher than in Alternative II since many types of mechanical, cultural, and chemical techniques use mechanized equipment. Overall effects to resource would be adverse, site-specific, short-term, and negligible to minor.	Potential for noise is reduced since a diversity of techniques are available. Overall effects to resource would be adverse, site-specific, short-term, and negligible to minor.	Potential for noise is greatest since frequent and repeated treatments using mechanical and cultural techniques require use of mechanized equipment. Overall effects to resource would be adverse, site-specific, short-term, and negligible to minor.
Historic Structures	Removal of invasive species using these	Control of invasives would improve or restore	Likelihood of damage to structures is increased due

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	techniques would result in some level of improvement to soil and vegetation communities that supports historic structure preservation, but because of the lack of expanded prevention techniques or biocontrol agents, remaining techniques available would not be the most effective at adequately preventing new species introductions or managing range expansions of existing species that continue to destabilize and degrade structure context. Overall effects to resource would be adverse, site-specific, short to long-term, and minor	conditions and context for historic structures. Techniques available are expected to most effectively and efficiently treat the most acres of species that compromise historic structures. Overall effects to resource would be beneficial, site-specific, long-term, and minor	to necessity of repeated control. Overall effects to resource would be adverse, site-specific, long-term, and minor to moderate.
Cultural Landscapes	Control of invasives will have a beneficial effect of restoring the context of cultural landscapes, though effects may not be as long lived or as widespread using available techniques. Overall effects on resource would be beneficial, site-specific, short-term, and minor.	Restoration of cultural landscapes would be the longest-lived and most widespread when the most techniques are available. Overall effects on the resource would be beneficial, site-specific, long-term, and minor to moderate.	Ability to manage invasive species in order to maintain or improve context is significantly reduced using available techniques. Overall effect on resource would be adverse, site-specific, long-term, and minor to moderate.
Archeological Resources	Current management practices would help in preventing or reducing invasive species potential destabilizing and degradation of archeological sites and artifacts, though effects may not be as long-lived or as widespread as in Alternative II. Overall effects to resource would be beneficial, site-specific,	Removal of invasive species using the full range of tools would have long-term benefits for the protection, stabilization, and context of archeological resources by enhancing pre-European plant and soil communities. Overall effects to resource would be beneficial, site-specific, long-term, and minor to	Potential for damage to archeological resources is increased due to necessity for more frequent treatments using available techniques. Maintenance or improvement of stabilizing environment is reduced. Overall effects to resource would be adverse, site-specific, long-term, and minor to moderate.

Impact Topic	*Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants*	*Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.*	*Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.*
	short-term, and minor.	moderate.	
Paleontological Resources	Current management practices would help in preventing or reducing invasive species potential destabilizing and degradation of paleontological sites though effects may not be as long-lived or as widespread as in Alternative II. Overall effects to resource would be beneficial, site-specific, short-term, and minor.	Removal of invasive species using the full range of tools would have long-term benefits for the protection, stabilization, and context of paleontological resources by enhancing plant and soil communities. Overall effects to resource would be beneficial, site-specific, long-term, and minor to moderate.	Potential for damage to paleontological resources is increased due to necessity for more frequent treatments using available techniques. Maintenance or improvement of stabilizing environment is reduced by increased erosion. Overall effects to resource would be adverse, site-specific, long-term, and minor to moderate.
Land Use and Park Operations	Control costs for the monument and lessees are expected to rise steadily without expanded early detection and prevention efforts. Condition of leased range and areas along transportation corridors would deteriorate. Some lessees may become frustrated by the monument's lack of proactive approach. Monument would be excluded from some sources of financial and technical support without a more comprehensive plan. Overall effects would be adverse, monument-wide, long-term, and negligible to moderate.	Proactive and comprehensive invasive plant management efforts over time would cost the monument and lessees less and improve the monument's relations with users. The most acres are treated and use of biocontrols for widespread species such as tamarisk would decrease labor and equipment costs in some cases. Overall effects would be beneficial, long-term, monument-wide, and moderate.	Cost of labor and equipment would rise significantly for lessees and staff to control infestation without the use of chemicals or biocontrols, thereby likely preventing successful long-term management of invasives. Relations with lessees, neighbors, and regional interests would quickly deteriorate. Overall effects would be adverse, monument-wide, long-term, and moderate.
Socioeconomics	Current level of control would do something to decrease spread onto neighboring lands, though there would likely be some additional financial burden to neighbors and regional interests to identify and control species the monument is unable to	Effects would be most beneficial to the region since the most acres would be treated and result in the most safe, efficient, and effective management of invasives both inside and outside monument boundaries. Access to all management techniques	Financial burdens of neighbors and regional interests would increase dramatically in their attempt to address species that the monument cannot successfully control with control techniques available. Monument may not be able to uphold

Impact Topic	***Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, and chemical controls and limited prevention techniques to manage invasive plants***	***Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, and expanded prevention/early detection) to manage invasive plants.***	***Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.***
	address through early detection and prevention methods. Overall effect would be beneficial, region-wide, short-term, and minor.	allows the most flexibility in addressing regional issues. Overall effect would be beneficial, region-wide, long-term, and moderate.	existing agreements with partners on invasive species control projects and opportunities for future partnerships would be limited. Overall effect would be adverse, long-term, region-wide, and moderate.

Chapter 3: Affected Environment and Environmental Consequences

Chapter Organization
This chapter contains the methodology for assessment and analyses of all potential impacts to Dinosaur National Monument natural resources, cultural resources, and land use/park operations that could occur as a result of implementing any of the three alternatives outlined in Chapter 2. It is organized by impact topic and contains the following information for each topic:

Affected Environment (description of the resource (topic) potentially impacted)
Methodology (factors and sources used to estimate potential impacts)
Regulations and Policies (current laws and policies that require that certain conditions be achieved relevant to the impact topic)
Impact Analysis (benefits and risks of implementing each alternative)
Conclusion (summary of intensity and duration of effects for each alternative)
Cumulative Effects (effects of combined impacts of past, present, and reasonable foreseeable future actions regardless of agency for each alternative
Impairment (determination if action would, or is likely to, impair monument resources or values)

Methodology for Assessing Impacts
Applicable and available information on known natural and cultural resources was compiled. Alternatives were evaluated for their effects on the resources and values determined during the scoping process. The impact analyses were based on professional judgment using information provided by monument staff, relevant references and technical literature and subject matter experts. Information on total acres infested by species, future rate of spread projections, past and future treated acres, and treatment methods were also used to estimate impacts. For each impact topic, the analysis includes a brief description of the affected environment and an evaluation of effects. Potential impacts are described in terms of type (are the effects beneficial or adverse?), context (are the effects site-specific, local or even regional?), duration (are the effects short-term or long-term?), and intensity (are the effects negligible, minor, moderate or major, or would the effects constitute impairment of Dinosaur National Monument's resources and values?). Because definitions of intensity (negligible, minor, moderate or major) vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this environmental assessment in Table 4.

Direct, indirect and cumulative effects are discussed in each impact topic. Predictions about direct and indirect effects are based on previous studies, monitoring information, effects of invasive species management that have occurred in Dinosaur National Monument or in similar environments and the expertise and judgment of resource management specialists.

When appropriate, mitigation measures that may be employed to offset or minimize potential adverse impacts have been identified.

Definitions of intensity levels varied by impact topic, but, for all impact topics, the following definitions were applied:

Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct: An effect that is caused by an action and occurs in the same time and place.

Indirect: An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.

Short-term: An effect that within a short period of time would no longer be detectable as the resource is returned to its predisturbance condition or appearance. Short-term impacts, depending on impact topic, may range from a few hours up to 10 years (see table below).

Long-term: A change in a resource or its condition that does not return the resource to predisturbance condition or appearance, and for all practical purposes is considered permanent.

Intensity of Effects Defined

The following table defines impact thresholds, by impact topic, for each level of intensity included in this assessment.

Table 4: Impact Threshold Definitions

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
Soils and Vegetation	The change in soils & native vegetation communities would be so small that it would not be of any measurable or perceptible consequence.	Changes in soils and native vegetation communities would be small, localized and of little consequence. Response to treatments would be within the range of normal treatment effects. Any adverse effects can be effectively mitigated.	A large area of soils or segment of one or more plant species populations would exhibit effects that are of consequence, but would be relatively localized. Response to treatments would be within the normal range of expected treatment effects. Mitigation could be extensive, but likely effective.	Severely adverse, and possibly permanent effects to soils and native plant communities. Response to treatments would be outside the normal range of expected treatment effects. Mitigation to offset adverse effects may be required and extensive, and success not assured.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.
Wetlands and Floodplains	Any effects to wetlands or floodplains would be below or at the lower levels of detection. Any detectable effects would be slight. No USACE 404 permit would be necessary.	Effects to wetlands or floodplains would be detectable, site-specific and relatively small and short-term to individual plants. No USACE 404 permit would be necessary.	The effects to wetlands or floodplains would be detectable and readily apparent. The effect could be site-specific or monument-wide.	Effects to wetlands or floodplains would be observable over a relatively large localized or regional area. The character of the wetland or floodplain would substantially change.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.
Wildlife	The change in wildlife populations and/or habitats would be so small that it would not be of any measurable to perceptible consequence.	Changes in wildlife populations or habitats would be small, localized and of little consequence. Response to treatments would be within the range of normal treatment effects. Any adverse effects can be effectively mitigated.	Changes in wildlife populations or habitats would be of consequence, but would be relatively localized. Response to treatments would be within the normal expected range of normal treatment effects. Mitigation to offset adverse effects to native species may be extensive but likely successful.	Severely adverse and possibly permanent effects to native wildlife populations or habitats. Response to treatments would be outside the normal range of expected treatment effects. Mitigation to offset adverse effects may be required and extensive, and success not assured.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
Threatened, Endangered, or Sensitive Species	Listed species would not be affected or the change would be so small as to not be of any measurable or perceptible consequence to the population.	There would be a measurable effect on one or more listed species or their habitats, but the change would be small and relatively localized.	A noticeable effect to a population of a listed species. The effect would be of consequence to populations or habitats.	Noticeable effect with severe consequences or exceptional benefit to populations or habitats of listed species.	Short-term refers to a period of 1-3 years. Long-term refers to a period longer than 3 years.
Water Quality	Neither water quality nor hydrology would be affected, or changes would be either non-detectable or if detected, would have effects that would be considered slight.	Changes in water quality or hydrology would be measurable, although the changes would be small and likely localized. No mitigation measure associated with water quality or hydrology would be necessary.	Changes in water quality or hydrology would be measurable but would be relatively localized. Mitigation measures associated with water quality or hydrology would be necessary and the measures would likely succeed.	Changes in water quality or hydrology would be readily measurable, would have substantial consequences and would be noticed on a regional scale. Mitigation measures would be necessary and their success would not be guaranteed.	Short-term refers to recovery in less than several days. Long-term would refer to recovery, following treatment, requiring longer than several months.

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
Wilderness	Visitor experience and physical character would not be affected or the change would be so small as to not be of any measurable or perceptible impact to Wilderness values.	Changes to character of Wilderness values are detectable but small, localized and of little consequence. Any mitigation needed to offset adverse effects would be standard, uncomplicated and effective.	Changes to character of Wilderness are readily apparent and of consequence. Changes may be evident over large portion of proposed/recom-mended Wilderness. Mitigation measures to offset adverse effects would probably be necessary and likely successful.	Impacts to Wilderness character are severe over a wide area of proposed/recom-mended Wilderness area. Mitigation to offset adverse effects would be needed, but its success not assured.	Short-term refers to a transitory effect, one that largely disappears over a period of hours or days. The duration of long-term effects is months or years.
Air Quality	Any changes in air quality would be below or at the level of detection, and if detected, would have effects that would be considered slight and short-term.	Changes in air quality would be measurable, although small, short-term, and site-specific. No air quality mitigation measures would be necessary.	Changes in air quality would be measurable and would have consequences, although the effect would be relatively local. Air quality mitigation measures would be necessary and likely successful.	Changes in air quality would be measurable, would have substantial consequences, and would be noticed regionally. Air quality mitigation measures would be necessary and their success could not be guaranteed.	Short-term refers to a transitory effect, one that largely disappears over a period of hours or days. The duration of long-term effects is months or years.
Soundscape	Noise may be generated by invasive plant management activities during daylight hours. Noise is rarely audible at 100 feet or more from the source. When noise is present, it is at very low levels in most of the area.	Noise generated by invasive plant management activities may predominate during daylight hours, but for the majority of the time the noise is at low levels. When noise is at medium or high levels, it occurs only in site-specific areas. Human-caused noise is rarely audible at 500 feet or more from the source.	Noise generated by invasive plant management activities predominates during daylight hours, but it is at medium or lower levels for a majority of the time. Localized areas may experience noise at medium to high levels during half of the daylight hours.	Noise generated by invasive plant management activities predominates during daylight hours, and is at greater than medium levels a majority of the time. Large areas may experience noise at medium to high levels during a majority of the daylight hours.	Short-term refers to a transitory effect, one that largely disappears over a period of minutes or hours. The duration of long-term effects is days or weeks.

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
Historic Structures **Cultural Landscapes** **Archeological Resources**	Impacts to historic/cultural sites either beneficial or adverse, are at the lowest levels of detection, barely perceptible and not measurable. For purposes of Section 106, the determination of effect would be *no adverse effect*.	The impact affects a historic/cultural site or feature with little data potential. The context of the affected site(s) would be local. The impact would not affect the contributing elements of an eligible or listed structure eligible for the National Register of Historic Places. For purposes of Section 106, the determination of effect would be *no adverse effect*.	The impact affects a historic/cultural site with modest data potential. The context of the affected site(s) would be state-wide. For a National Register eligible site, the adverse impact would affect some of the contributing elements of the site but would not diminish the integrity of the resource and jeopardize its National Register eligibility. For purposes of Section 106, the determination of effect would be *adverse effect*.	The impact affects a historic/cultural site with high data potential. The historic context of the affected site(s) would be national. For a National Register eligible or listed site, the impact would affect the contributing elements of the site by diminishing the integrity to the extent that it is no longer eligible for listing on the National Register. For purposes of Section 106, the determination of effect would be *adverse effect*.	Short-term refers to a transitory effect, one that largely disappears over a period of days or months. The duration of long-term effects is essentially permanent.
Paleontological Resources	Impacts to paleontological resources would not be measurable or of any perceptible consequence.	Changes to character of fossil-bearing strata are detectable but small, localized and of little consequence. Any mitigation needed to offset adverse effects would be standard, uncomplicated and effective.	Changes to character of paleontological resources are readily apparent and of consequence. Changes may be evident over large portion of the fossil-bearing strata. Mitigation measures to offset adverse effects would probably be necessary and likely successful.	Impacts to paleontological resources are severe over a wide area. Miti-gation to offset adverse effects would be needed, but its success not assured.	Short-term refers to a transitory effect, one that largely disappears over a period of days or months. The duration of long-term effects is essentially permanent.
Land Use and Park Operations	An action that could cause a change in land use and/or park operations, but the change would be so small that it would not be of	An action that would affect some lessees, employees, or visitors and cause a change in their activities, but the change would be small and	An action that would cause a substantial, measurable change in land use and park operations. Mitigation to offset adverse effects would be necessary	An action that would cause a severe change or exceptional benefit to land use and park operations. The change would have substantial	Short-term refers to a period of up to 5 years. The duration of long-term effects is essentially permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
	any measurable or perceptible effect. Few lessees, employees, or visitors would be affected.	localized. Mitigation would not be necessary.	but effective.	and possibly permanent effects on lessees, employees, or visitors. Mitigation to offset adverse effects would be needed, though success is not assured.	
Socio-economics	Any effects to socioeconomic conditions would be below or at the level of detection. The effect would be slight.	The effects to socioeconomic conditions would be detectable. Any effects would be small, and if mitigation were needed to offset potential adverse impacts, it would be simple and successful.	The effects to socioeconomic conditions would be readily apparent. Any effects would result in changes to socioeconomic conditions on a local scale. If mitigation is needed to offset potential adverse impacts, it could be extensive, but would likely be successful.	The effects to socioeconomic conditions would be readily apparent and would cause substantial changes to socioeconomic conditions in the region. Mitigation measures to offset potential adverse impacts would be extensive and their success could not be guaranteed.	Short-term refers to a period of up to 5 years. The duration of long-term effects is essentially permanent.

Cumulative Effects Methodology

From CEQ regulations (1508.7), a “cumulative effect” is the effect on the environment that results from the incremental effect of the action(s) when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such action.

Cumulative impacts will be determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions. Therefore, it is necessary to identify other ongoing or reasonably foreseeable future projects in Dinosaur National Monument and, if applicable, the surrounding area.

Other Past, Ongoing, and Proposed Projects in the Area

Several other activities and projects which may contribute to cumulative impacts have been identified in the surrounding environs. Grazing by domestic livestock occurs in Dinosaur National Monument and also on private and BLM lands both surrounding and within the monument. Oil and gas exploration and development is widespread on BLM and private land in northwestern Colorado and northeastern Utah. Such activities are proposed to occur next to monument boundaries in some areas in the near future. Mule deer, elk, pronghorn antelope, moose, and grouse utilize habitats in and adjacent to the monument. Hunting continues outside the monument on BLM and privately owned land. Fire management and roadside maintenance operations occur annually, mostly between April and November. Recreation within the monument occurs potentially year-round and includes river running, hiking, fishing, automobile tours, camping, horsepacking, backpacking, and biking on established roads. The Flaming Gorge Dam is 46 miles above the monument boundary (Gates of Lodore) on the Green River and is operated by U.S. Bureau of Reclamation. Drought in the last six years has been the primary cause for a change dam operations (i.e. reduced peak flows and elevated base flows), which is being shown to accelerate tamarisk invasion and establishment downstream. The monument plans to prepare a livestock management plan and Wilderness stewardship plan over the next several years. It is anticipated that those plans will be consistent with actions described in the preferred alternative.

Compliance with Section 106, National Historic Preservation Act

In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the NHPA (36 CFR Part 800, *Protection of Historic Properties*), impacts to cultural resources and the cultural landscape will be identified and evaluated by (1) determining the area of potential effects, (2) identifying cultural resources present in the area of potential effects that were either listed in or eligible to be listed in the National Register of Historic Places, (3) applying the criteria of adverse effect to affected cultural resources which are unevaluated, listed in, or eligible to be listed in the National Register, and (4) considering ways to avoid, minimize, or mitigate adverse effects.

CEQ regulations and the NPS's *Conservation Planning, Environmental Impact Analysis and Decision-making* (Director's Order #12) also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact, for example, reducing the intensity of an impact from major to moderate or minor. However, any reduction in intensity of impact resulting from mitigation is an estimate of the effectiveness of mitigation under NEPA only. It does not suggest that the level of effect as defined by Section 106 is similarly reduced. Although adverse effects under Section 106 may be mitigated, the effect remains adverse.

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* also must be made for affected National Register-eligible cultural resources. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register, e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by an alternative that would occur later in time, be farther removed in distance or be cumulative (36 CFR Part 800.5, *Assessment of Adverse Effects*). As noted earlier, although adverse effects under Section 106 may be mitigated, the effect remains adverse. A determination of *no adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the National Register.

DINO will conduct compliance with the respective SHPO(s) and monument NEPA IDT for each control project that is separate from, but developed under the guidance of, this plan. With respect to Section 106, this Invasive Plant Management Plan is meant to serve only as an analysis of potential effects to cultural resources in general. It does not provide site-specific analysis for particular resources and artifacts. This type of information will be found in the site management plans that will be written for each project prior to implementation. An example of such a plan can be found for Cub Creek in Appendix C.

Impairment Methodology

National Park Service's *Management Policies* (2001) require analysis of potential effects to determine whether or not actions would impair park resources. The fundamental purpose of the National Park System, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. National Park Service managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adversely impacting park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within a park, that discretion is limited by the statutory requirement that the National Park Service must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible National Park Service manager, would harm the integrity of park resources or values. An impact to any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- key to the natural or cultural integrity of the park; or
- identified as a goal in the park's general management plan or other relevant NPS planning documents.

Impairment may result from National Park Service activities in managing the park, visitor activities or activities undertaken by concessionaires, contractors and others operating in the park. A determination on impairment is made in this chapter by alternative under each resource topic.

Soils and Vegetation

Affected Environment

Soils

Seventy-six soil combinations are known to occur in the monument, varying widely in erodibility and productivity depending on topographic position, parent material, local hydrology, slope, and other factors influencing soil formation processes (USDA NRCS 2002). Soils were formed from bedrock exposed at the surface (e.g. Weber sandstone, Morgan formation, Madison limestone, and Moenkopi formation) and by flowing water. Soil texture consists primarily of variations of loam and sand, although heavier soils occur on slopes and mountains. Gravels are present in river wash associated with streambeds and floodplains.

Generally formed from shale, limestone, and sandstone, badlands and rock outcrops have little or no soil development due to their predominant erosive features. Shallow soils (< 20 inches) occur throughout the monument on canyon slopes, hill slopes, mountains, cuestas, mesas, and plateaus underlain by shale, limestone, and sandstone bedrock. Moderately deep to deep soils (>20 inches) are found on alluvial fans, basins, valley alluvium, and some areas of residual upland plains.

Most of the soils in the monument have moderate permeability and are likely to form a surface crust, especially if the vegetative cover deteriorates. Precipitation is the main controlling factor for soil productivity, resulting in naturally low soil productivity for most areas of the monument. Average annual precipitation in the monument ranges between 8-12 inches/year, depending on elevation (USDA 2002). Relatively low precipitation rates produce limited vegetative cover and, consequently, limited organic matter for the soil. Soil susceptibility to water erosion is generally slight to moderate, but can be severe in areas with low permeability. Runoff potential is medium overall.

Cryptobiotic crusts, found in the arid and semi-arid areas of the world, are found in the monument on sandy upland soils (USDI 2001), occupying most soil spaces not occupied by vascular plants. Cryptobiotic crusts are an important resource and have been shown to increase soil stability and decrease susceptibility to erosion from wind and water. They also increase nitrogen and organic carbon levels in soils, increase water infiltration, lower fire intensity, and can aid some native seeds in germination and plant growth, especially during fire recovery periods (Miller 2002).

Native Vegetation

The native vegetation of Dinosaur National Monument is adapted to the semiarid climate. A diversity of plant species results from the wide variations in elevation, slope, exposure, soils, and moisture availability. Five major vegetative community types exist in the monument, of which sagebrush/grassland and pinyon/juniper woodland are the most extensive. The other major community types include desert shrub, Douglas fir/ponderosa pine, and riparian.

Sites with deep, well-developed soils on level to moderately rolling terrain are occupied primarily by the big sagebrush/grassland community. The dominant species is big sagebrush interspersed with perennial grasses and diverse shrubs and forbs.

Pinyon/juniper woodland is the most common community in the monument and occupies shallow and/or rocky soils in lower montane areas at elevations between 4,000 – 6,000 feet. The understory vegetation is usually sparse and commonly includes mountain mahogany, black sage, and perennial grasses.

The desert shrubland community occurs at several elevations on soils ranging from well-developed to shallow and poorly developed. Shrub species include big sagebrush, greasewood, shadscale and perennial grasses.

The mountain shrub community occurs at several elevations on soils ranging from well-developed to shallow and poorly developed. Shrub species include serviceberry, mountain mahogany, bitterbrush, sagebrush, snowberry, snowbrush, chokecherry, currant, and aspen.

Dry sites at high elevations on moderate slopes with shallow rocky soils are often occupied by ponderosa pine. These stands are relatively open and have sparse understories typical of adjacent communities, such as mountain mahogany and serviceberry.

Small dense stands of Douglas fir can be found at high elevations on scattered sites with steep slopes and northern exposure. These stands usually have little understory vegetation and heavy litter layers. Groves of aspen are also found in these environments.

Riparian and other mesic vegetation communities are found along perennial and some ephemeral drainages, at spring locations, and in seep and hanging garden locations. Cottonwood/willow communities are found in open floodplain environments along main drainages such as creeks and the Green and Yampa rivers. Canyon environments are characterized by boxelder, willow, reed, and scouring rush. Other common species are sumac, hackberry, and non-native tamarisk, the last of which is found in almost pure stands in some areas along the Green River. Rare mesic habitats such as hanging gardens form around springs and moist cracks in the canyon walls of the Colorado Plateau. Many of these mesic communities also qualify as wetlands and are subject to protection according to NPS policy and the Clean Water Act.

It is estimated that pre-settlement lightning-ignited summer fires returned to this area of the northern Colorado Plateau area every 10-70 years for big sagebrush/grassland habitat and less than every 35 years in pinyon pine/juniper stands (Petersburg 2004). Fire frequency was likely higher in mountain and basin big sagebrush communities (5-15 years, 14-40 years, respectively) (Sapsis 1990; Arno 1983; Burkhardt 1976; Miller 1995) where these species occur at higher elevations than Wyoming big sagebrush (10-70 years) (Sapsis 1990). Sagebrush historically burned in mosaic patterns, creating openings for and maintaining grasslands characterized by bluebunch wheatgrass and Indian ricegrass stands (Petersburg 2004). Fire also played an important role in creating different age stands of sagebrush, which are important for sagebrush reproduction and sagebrush obligate wildlife species. Regular fire intervals also prevented pinyon/juniper stands from encroaching into sagebrush/grasslands. However there are pinyon/juniper stands in the monument that are estimated to be between 200-400 years old. Their age may be due to a combination of chance fire-free pockets and grazed understories that have left little surrounding groundcover to carry fire over longer distances (Petersburg 2004).

Ranching began on a larger scale in the 1880s and the area was heavily used by livestock through the 1920s. With settlement came suppression of naturally ignited fires, which began around the 1940s. The combination of fire suppression and repeated spring and summer grazing pressure has resulted in near type-conversions of perennial sagebrush/ grasslands to monotypic, decedent Wyoming big sagebrush stands with invasive annual understories (Petersburg 2004). Fire suppression has also resulted in the increase and resulting encroachment of juniper at lower elevations and may account for loss of some range of habitat for Wyoming big sagebrush (Petersburg 2004).

Non-native Vegetation

Table 5 is a compilation of the state noxious weed lists for Colorado and Utah. **Bolded** species have been identified as the top 10 prioritized weed species for the state of Colorado and are recognized to be the most widespread and to cause the greatest economic impact in the state. Species that are both ***bolded and italicized*** make up the State of Colorado's 'A List' and carry a state-mandated eradication order. "Watch list" species are invasive species that are not currently known to occur in the monument, but are present either in and/or adjacent to Moffat or Uintah counties. Also included in the list are non-native species that are found in DINO but are not recognized as being invasive in nature and therefore are not listed by either Colorado or Utah.

Table 5 – Non-native and Invasive Plants of Colorado and Utah

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Absinth wormwood (*Artemisia absinthium*)		CO		
African mustard *(Malcomia africana)*	**yes**			
African rue (Peganum harmala)		CO		
Annual wheatgrass *(Eremopyrum triticeum)*	**yes**			
Asperagus *(Asperagus officinalis)*	**yes**			
Baby's breath (*Gypsophilia paniculata)*		CO	●	
Bassia (*Bassia hyssopifolia)*	**yes**			
Bermudagrass (*Cynodon dactylon*)		UT		
Black henbane (*Hyoscyamus niger*)	**yes**	CO		**yes**
Black medic *(Medicago lupulina)*	**yes**			
Black nightshade (*Solanum nigrum*)		CO		
Blue mustard (*Chorispora tenella*)	**yes**	CO		
Bouncingbet (*Saponaria officinalis*)	**yes**	CO		
Broad-leaf plantain *(Plantago major)*	**yes**			
Bulbous bluegrass *(Poa bulbosa)*	**yes**			
Bull cottonthistle (*Onopordum tauricum*)		CO		
Bull thistle (*Cirsium vulgare*)	**yes**	CO		**yes**
Bur buttercup *(Ranunculus testiculatus)*	**yes**			
Camelthorn (Alhagi pseudalhagi)		CO		
Canada bluegrass *(Poa compressa)*	**yes**			

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Canada thistle (*Cirsium arvense*)	**yes**	CO, UT		**yes**
Catnip *(Nepeta cataria)*	**yes**			
Cheatgrass (*Bromus tectorum)*	**yes**	CO		**yes**
Chicory (*Cichorium intybus*)	**yes**	CO		
Chinese clematis (*Clematis orientalis*)		CO		
Clasping peppergrass *(Lepidium perfoliatum)*	**yes**			
Coast tarweed (*Madia sativa*)		CO		
Common burdock (*Arctium minus*)	**yes**	CO		**yes**
Common crupina (Crupina vulgaris)		CO		
Common dandelion (*Taraxacum officinale)*	**yes**			
Common groundsel (*Senecio vulgaris*)		CO		
Common mullein (*Verbascum thapsus*)	**yes**	CO		
Common St. Johnswort (*Hypericum perforatum*)		CO		
Common tansy (*Tanacetum vulgare*)		CO		
Common teasel (*Dipsacus sylvestris*)		CO	●	
Crested wheatgrass *(Agropyron cristatum)*	**yes**			
Curly dock (*Rumex crispus)*	**yes**			
Cut-leaf water parsnip *(Berula erecta)*	**yes**			
Cypress spurge (Euphorbia cyparissias)		CO		
Dalmatian toadflax – broadleaf (*Linaria dalmatica*)	**yes**	CO		**yes**
Dalmatian toadflax – narrowleaf (*Linaria genistifolia*)	**yes**	CO		**yes**
Dame's rocket (*Hesperis matronalis*)		CO	●	
Desert alyssum (*Alyssum desertorum*)	**yes**			
Diffuse knapweed (*Centaurea diffusa*)	**yes**	CO, UT		**yes**
Dyers woad (Isatis tinctoria)		CO, UT	●	
Eurasian watermilfoil (*Myriophyllum spicatum*)		CO		
False flax *(Camelina microcarpa)*	**yes**			
Field bindweed (*Convolulus arvensis*)	**yes**	CO, UT		
Flixweed (*Descurainia sophia*)	**yes**	CO		
Giant salvinia (Salvinia molesta)		CO		
Green foxtail (*Setaria viridis*)		CO		
Hairy nightshade (*Solanum sarrachoides*)		CO		
Hairy whitetop *(Cardaria pubscens)*	**yes**			
Halogeton (*Halogeton glomeratus*)	**yes**	CO		
Hoary cress (*Cardaria draba*)	**yes**	CO, UT		**yes**
Houndstongue (*Cynoglossum officianale*)	**yes**	CO		**yes**

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Hydrilla (Hydrilla hydrilla)		CO		
Jagged chickweed *(Holosteum umbellatum)*	**yes**			
Japanese brome *(Bromus japonicus)*	**yes**			
Johnsongrass (*Sorghum halepense*)		CO, UT		
Jointed goatgrass (*Aegilops cylindrica*)	**yes**	CO		**yes**
Kentucky bluegrass (*Poa pratensis*)	**yes**			
Kochia (*Kochia scoparia*)	**yes**	CO		
Leafy spurge (*Euphorbia esula*)	**yes**	CO, UT		**yes**
Mayweed chamomile (*Anthemis cotula*)		CO		
Meadow fescue *(Festuca pratensis)*	**yes**			
Meadow foxtail (*Alopecrus pratensis*)	**yes**			
Meadow knapweed (Centaurea pratensis)		CO	●	
Meadow / perennial sowthistle *(Sonchus uliginosus)*	**yes**			**yes**
Mediterranean sage (Salvia aethiopis)		CO		
Medusahead rye (Taeniatherum caput-medusae)		CO,UT		
Moth mullein (*Verbascum blattaria*)		CO		
Musk thistle (*Carduus nutans*)	**yes**	CO, UT		**yes**
Myrtle spurge (Euphorbia mysinites)		CO		
Oakleaf goosefoot *(Chenopodium glaucum)*	**yes**			
Orange hawkweed (*Hieracium aurantiacum*)		CO		
Orchard grass (*Dactylis glomerata*)	**yes**			
Oxeye daisy (*Chrysanthemum leucanthemum*)		CO	●	
Perennial pepperweed (*Lepidium latifolium*)	**yes**	CO, UT		**yes**
Perennial sorghum *(Sorghum halepense L. & Sorghum almum)*		UT		
Plumeless thistle (*Carduus acanthoides*)		CO	●	
Poison hemlock (*Conium maculatum*)		CO		
Prickly lettuce *(Lactuca serriola)*	**yes**			
Prostrate knotweed *(Polygonum aviculare)*	**yes**			
Puncturevine (*Tribulus terrestris*)		CO		
Purple loosestrife (Lythrum salicaria)		CO, UT	●	
Quackgrass (*Agropyron repens*)	**yes**	CO, UT		**yes**
Rabbitfoot grass *(Polypogon monspeliensis)*	**yes**			

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Red fescue *(Festuca rubra)*	**yes**			
Redstem filaree (*Erodium cicutarium*)		CO		
Redtop (*Agrostis stolonifera*)	**yes**			
Rush skeletonweed (Chondrilla juncea)		CO		
Russian knapweed (*Centaurea repens*)	**yes**	CO, UT		**yes**
Russian olive *(Elaeagnus angustifolia)*	**yes**	CO, listed as noxious by Uintah County, UT		**yes**
Russian thistle (*Salsola collina*)		CO		
Russian thistle-prickly (*Salsola iberica*)	**yes**	CO		
Saltcedar, tamarisk (*Tamarix ramosissima x parviflora*)	**yes**	CO, proposed for listing in UT and listed as noxious by Uintah County, UT		**yes**
Saltmarsh sandspurry *(Spergularia marina)*	**yes**			
Scentless chamomile (*Matricaria perforata*)		CO		
Scotch thistle (*Onopordum acanthium*)	**yes**	CO, UT		**yes**
Sericea lespedeza (Lespedeza cuneata)		CO		
Shepherd's purse *(Capsella bursa-pastoris*)	**yes**	CO		
Siberian elm *(Ulmus pumila)*	**yes**			**yes**
Slenderweed *(Hutchinsia procumbens)*	**yes**			
Smooth brome (*Bromus inermis*)	**yes**			
Spotted knapweed (*Centaurea maculosa*)	**yes**	CO, UT		**yes**
Spurred anoda (*Anoda cristata*)		CO		
Squarrose knapweed (*Centaurea virgata*)		CO, UT	●	
Sulfur cinquefoil (*Potentilla recta*)		CO		
Swainsonpea (*Sphaerophysa salsula*)		CO		
Tall fescue *(Festuca arundinacea)*	**yes**			
Tansy ragwort (Senecio jacobaea)		CO		
Tumble mustard *(Sisymbrium altissimum)*	**yes**			
Velvetleaf (*Abutilon theophrasti*)		CO		
Venice mallow (*Hibiscus trionum*)		CO		
Water plantain (*Alisma plantago-aquatica*)	**yes**			
Water speedwell *(Veronica anagallis-*	**yes**			

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
aquatica)				
Watercress *(Nasturtium officinale)*	**yes**			
White clover *(Trifolium repens)*	**yes**			
White sweetclover (*Melilotus alba*)	**yes**			
Wild caraway (*Carum carvi*)		CO		
Wild mustard (*Brassica kaber*)		CO		
Wild oats (*Avena fatua*)		CO		
Wild proso millet (*Panicum miliaceum*)		CO		
Willow weed *(Polygonum lapathifolium)*	**yes**			
Yellow foxtail (*Setaria glauca*)		CO		
Yellow nutsedge (*Cyperus esculentus*)		CO		
Yellow salsify *(Tragopogon dubious)*	**yes**			
Yellow starthistle (Centaurea solstitialis)		CO, UT	●	
Yellow sweetclover (*Melilotus officianalis*)	**yes**			**yes**
Yellow toadflax (*Linaria vulgaris*)	**yes**	CO		**yes**

Sources:
State of Colorado Department of Agriculture website:
http://www.ag.state.co.us/DPI/weeds/mapping/NoxiousWeedLists.html

State of Utah Department of Agriculture and Food website:
http://ag.utah.gov/plantind/nox_utah.html

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired conditions- Park vegetation communities would be restored and would maintain long-term ecological diversity and stability.

Source – NPS Management Policies (2001)

Impacts of Alternative I: Continuation of Current Management Practices – Use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

<u>Mechanical Control</u>
Manual and mechanical treatments could cause negligible, temporary damage to non-target species, spread propagules of undesirable species, and smother desirable vegetation caused by the accumulation of cut material. Soil microbiota and mycorrhizal fungi could be disturbed by

foot in sensitive areas and by equipment traffic and use, causing erosion from loss of vegetative cover or compaction from the use of heavy equipment.

Cultural Control

The introduction of undesirable species through contaminated equipment as a result of revegetation and restoration activities could adversely impact desirable vegetation. The use of seed drills can result in vegetation establishment in distinct rows, and also can cause soil compaction. Seedbed preparation, such as decompaction, harrowing, or raking can have adverse effects on established desirable vegetation, by damaging aboveground plant material. Decompaction can negatively affect soils by damaging mycorrhizal fungi and other soil microbiota and create an erosion hazard. Harrowing can cause soil compaction and minor soil disturbance, since it is usually done with a vehicle. There is also the risk that revegetation will be unsuccessful, leaving large areas of bare ground susceptible to erosion and weed invasion.

If improperly managed, livestock grazing for weed management can be, at best, ineffective and, at worst, detrimental to desirable vegetation and soils (Ohmart 1996). Livestock may feed on desirable species by either moving out of infested areas, by preferentially grazing desirable species over target species or by grazing at a time when differences in phenology do not protect desirable species from being impacted (Bullock et al. 1994). Undesirable species could be introduced in livestock feces, fur, or in supplemental forage brought to the site (DeClerck-Floate 1997). Impacts to soils may include disturbance, compaction, and destruction of cryptobiotic crusts and danger of erosion caused by loss of vegetative cover.

Prescribed fire may damage above ground desirable plant material and/or sub-surface microbiota or escape from the intended burn area into plant communities that will not benefit from burning. These include non-fire-adapted communities or communities which are infested, but not dominated, by disturbance-adapted weeds or their propagules. In communities composed of both desirable species and weed species, the disturbance caused by fire may favor the weed species and negatively impact desirable species. Fire also releases nutrients into the soil, which may favor weed species (McLendon and Redente 1992, Redente et al. 1992). Fires that stimulate forage production may attract both native and domestic grazers. If the burned area is not large enough to accommodate grazers an overall degradation in the plant community could occur. Extremely hot fires, caused by excessive fuel build-up, can result in soil sterilization and destruction of cryptobiotic crusts by precluding crustal species' recolonization or succession. Frequent fires can do the same by preventing recovery of lichens and mosses, leaving only a few species of cyanobacteria (Whisenant 1990; Eldridge and Bradstock 1994). Other impacts to vegetation and soils include the damage from the construction of firebreaks, soil compaction caused by heavy equipment, and the risk of erosion caused by the loss of vegetative cover and soil crusts.

Chemical Control

Unintentional off-target spray or spills may damage soil microbiota and desirable vegetation. There is also the potential for soil disturbance and compaction caused by chemical application equipment and the risk of erosion caused by loss of vegetative cover. However, the potential for accidental over spray and spills is low since equipment appropriately scaled to the job will be used and all spills would be cleaned up in accordance with the Pesticide Handling and Response Plan (Appendix I)

Many adjuvants used with/in herbicides include either nitrogen or sulphur-based fertilizers. The exact effect of these fertilizers on native vegetation is unknown, but it is suspected that since many weeds are competitive in high resource environments, it would give them an advantage and be detrimental to native vegetation (McLendon and Redente 1992, Redente et al. 1992). Adjuvants could also have a detrimental effect on soil microbiota.

Summary of Alternative I
Continuation of current management practices under Alternative I would be negligible, direct, site-specific, and short-term since mitigation measures would minimize potential impacts to soils and native or desirable vegetation. Continuing to use mechanical, cultural, chemical, and some prevention techniques for invasive plant management would not fully achieve the desired condition of maintaining, preserving, and protecting soil and native vegetation resources. These techniques are expected to have an overall long-term slightly beneficial effect for restoring some native plant communities, which would also reduce the potential for soil erosion in disturbed areas. Success in identifying and treating new infestations, however, would be minimal given current prevention and early detection techniques. Therefore, the overall impacts of current management practices (Alternative 1) would be direct, beneficial, site-specific, short- and long-term, and negligible to minor.

Cumulative Effects for Alternative I
Previous impacts to soils and native vegetation in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant management work, and from past and present human disturbances such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and monument and county development activities such road building and maintenance. These disturbances varied considerably as to type, intensity, and duration before and after the monument was established and continue still today.

Invasive species are regularly establishing and expanding in DINO. Introduction of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors helps to prevent establishment of new infestations. Any overgrazing by neighbors creates disturbed areas adjacent the park, which also contributes to the reestablishment of invasive plants. Wildland fire could create large disturbed areas and contributed to the establishment of new invasive plant infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Under Alternative I, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. Alternative I would likely have negligible, beneficial effects on reducing the introduction of new species into the park without proactive cooperation with regional neighbors for containment or control and use of better BMPs. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to soils and vegetation, this alternative would have direct, beneficial, site-specific, short- and long-term, and negligible to minor impacts on native plant species and soils.

Impairment
Because there would be no major adverse impacts to soils or native vegetation whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques to soils and vegetation are the same as described for Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
Any biological agent released in a park would be approved by APHIS and would have no demonstrated affinity for native plant species. Because biological control agents are specific to a species of invasive plants, there would be negligible adverse impacts to native plant species. No specific measures would be implemented to contain biological control agents. Any biological control agent used would be host-specific so each biological control agent would only attack one plant species (the host or the target invasive plant).

Using a full complement of IPM techniques would help DINO achieve the desired condition to have all native plants maintained before it could be reached under Alternatives I or III. By controlling invasive plants using IPM, the chance for successful restoration of native plant and soil communities is high, thereby benefiting native plant species and the habitat they provide.

Summary of Alternative II
The impacts of biological treatments on vegetation resources would be direct, beneficial, site-specific, moderate, and short- and long-term. Biological controls would have no measurable or perceptible effects on soils resources and would, therefore, be negligible. Thus, overall impacts of an integrated plant management program on soils and vegetation would be directly adverse on target exotic species, but indirectly beneficial, site-specific and monument-wide, short- to long-term, and minor to moderate on native plant species.

Cumulative Effects for Alternative II

Previous impacts to soils and native vegetation in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant management work, and from past and present human disturbances, such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and monument and county development activities, such as road building and maintenance. These disturbances varied considerably as to type, intensity, and duration before and after the monument was established, and they continue still today.

Invasive species are regularly establishing and expanding in DINO. Introductions of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors helps to prevent establishment of new infestations. Any overgrazing by neighbors creates disturbed areas adjacent to the park, which also contributes to the reestablishment of invasive plants. Wildland fire could create large disturbed areas and contribute to the establishment of new invasive plant infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, which would be consistent with this final plan.

Under Alternative II, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument would use a full complement of IMP techniques and, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to soils and vegetation, this alternative would have directly adverse impacts on target exotic species, but indirectly beneficial, site-specific and monument-wide, short- to long-term, and minor to moderate impacts on native plant species and soils.

Impairment

Because there would be no major adverse impacts to soils or native vegetation whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and expanded prevention techniques to soils and vegetation are the same as described Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Under this alternative, the monument would implement an invasive plant management program that would not include the use of chemical or biological control techniques because their use on some public lands has been controversial in recent years. Risks of adverse impacts by herbicide use to native vegetation and soils by leaching, inadvertent contact, and accidental spills are eliminated under this alternative. Some of the invasive species present in DINO can be managed using mechanical and cultural techniques; however, for those that cannot, it is anticipated that they will continue to spread.

Any risks to native vegetation by biological control agents are eliminated under this alternative as well. This alternative would ensure that there was no risk of a biocontrol agent switching hosts to a nontarget species. However, there are some species that will likely never be controlled or even reduced without the use of available biocontrols because their ranges are so extensive (e.g. tamarisk). Under this alternative, control would rely solely on mechanical and cultural controls, which would result in an increase in species that are not successfully treated with these methods.

Summary of Alternative III

Use of mechanical, cultural, and expanded prevention techniques only are expected to have an overall long-term adverse indirect effect on existing soil and native plant communities and for potential restoration success. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations. Therefore overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to soil and native vegetation resources would be indirectly adverse, site-specific and monument-wide, long-term, and minor to moderate.

Cumulative Effects for Alternative III

Previous impacts to soils and native vegetation in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant management work, and from past and present human disturbances such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and monument and county development activities such road building and maintenance. These disturbances varied considerably as to type, intensity, and duration before and after the monument was established and continue still today.

Invasive species are regularly establishing and expanding in DINO. Introductions of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors helps to prevent establishment of new infestations. Any overgrazing by neighbors creates disturbed areas adjacent the park, which also contributes to the reestablishment of invasive plants. Wildland fire could create large disturbed areas and contributed to the establishment of new invasive plant infestations. Monument staff anticipate developing a livestock management plan and Wilderness stewardship plan over the next several years, which would be consistent with this final plan.

Under Alternative III, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. The least amount of acres would be treated under Alternative III and while new species introductions may be identified early, the techniques to most efficiently and effectively control or eradicate them may not be available. When combined with other past, present, and future actions that would result in impacts to soils and vegetation, Alternative III would have indirectly adverse, site-specific and monument-wide, long-term, minor to moderate impacts.

Impairment

Because there would be no major adverse impacts to soils or native vegetation whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Wetlands and Floodplains

Affected Environment

The focus of Dinosaur National Monument for many visitors is the two river canyons and their confluence, located at the center of the monument. The Green River enters DINO at its northern boundary in Browns Park and flows southward through the Canyon of Lodore. The Yampa River enters the eastern portion of the monument at Deerlodge Park and flows through deeply entrenched meanders until it joins the Green River at Echo Park. The augmented flow of the Green River then enters Whirlpool Canyon, meanders through open country of Island and Rainbow Parks, and moves swiftly through Split Mountain Gorge, leaving the monument at its southwestern boundary.

The Green River has been regulated since November 1962 by Flaming Gorge Dam, located 47 miles upstream of the monument boundary. Impoundment has severely altered the natural regime of the river below the dam. Regulated releases from Flaming Gorge Reservoir have reduced the magnitude of high water peaks, increased early spring and late summer flows, and created erratic diurnal fluctuations. In addition to modifying the flow of the river, impoundment has lowered water temperatures, changed the natural ion balance, decreased turbidity, altered natural sediment deposition and scouring processes, and modified riparian communities.

The Yampa River is the only remaining free-flowing tributary in the Colorado River systems, although dams have been proposed at several locations upstream from the monument in the past. The Yampa is the major drainage of northwestern Colorado. High flow, resulting from spring run-off, generally lasts only a few weeks in late May and early June. During the remainder of the year the 46-mile segment from Deerlodge to Echo Park is essentially unnavigable (USDI NPS 1979).

As is true in the West, wetland and riparian areas contain some of the greatest diversity of habitat for plants and animals in the monument. Riparian and other mesic vegetation communities are found along these perennial and some ephemeral drainages, at spring locations, and in seep and hanging garden locations. Dominant vegetation found in these communities includes natives such as cottonwood, box elder, sandbar willow, river birch, Nebraska sedge, muhly grass, saltgrass, and Baltic rush. Invasive species, such as tamarisk and Russian olive, are also present in most riparian corridors and threaten to outcompete native riparian vegetation. Rare wetland and riparian plants species occur or potentially occur in the monument including the alcove bog orchid, Ute ladies'-tresses, Ownby thistle, and helleborne orchid. Grazing pressure and invasive species have been identified as significant threats to these important communities in the monument. Rare mesic habitats such as hanging gardens form around springs and moist cracks in the canyon walls of the Colorado Plateau. Many of these mesic communities also qualify as wetlands and are subject to protection according to NPS policy and the Clean Water Act.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired conditions: Surface and ground waters perpetuate as integral components of park aquatic and terrestrial systems; natural and beneficial floodplain and wetland values are preserved, enhanced, or restored; soil resources would be maintained, preserved, and protected as integral components of natural systems.

Source: Clean Water Act, Rivers and Harbors Act, E.O. 11514, 12088, 11988, and 11990, NPS Organic Act, NPS Management Policies (2001)

Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

Mechanical Control

Ground disturbing activities, such as pulling or sawing, may cause disturbance to surrounding individual native plants. Treatments that have greater impacts, such as tilling, would not be used in wetland or riparian areas. Infrequent impacts to individual plants generally have negligible to minor effects on plant populations, plant communities, or ecological processes. The impacts of mechanical treatments on wetland and floodplains would therefore be directly adverse, site-specific, short-term, and negligible to minor.

Cultural Control

Restoration activities, such as reseeding, could have beneficial effects of promoting the reestablishment of native wetland and riparian vegetation. Effects to wetlands and floodplains may be detectable. Impacts would be site-specific and effects to individual plants would be long-term.

Prescribed grazing would be very limited and site specific in sensitive riparian and wetland areas and would be timed appropriately to impact target species yet avoid as much damage as possible to desirable vegetation.

The effect of fire on plants is species-specific. Fire may either increase or reduce germination and vigor of plants. In wetlands and floodplains, fire would primarily be used to suppress or remove larger stands of undesirable vegetation or dead thatch. Prescribed fire may have adverse impacts on some individual plants, but would affect a relatively small portion of the overall population. Depending on the management objective, wetland or floodplain functions could be increased. Infrequent impacts to individual plants generally do not impact plant populations, plant communities, or ecological processes. Overall the impacts of fire on wetlands and floodplains would therefore be directly adverse and beneficial, site-specific, short-term, and minor. The overall impacts of cultural treatments on wetlands and floodplains would be indirectly beneficial and directly adverse, site-specific, short and long-term, and negligible to minor.

Chemical Control

Desirable plants subjected to pesticide drift could experience no effect, reduced vigor, or death depending on the sensitivity of the plant species to the specific pesticide and the dose to which the plant was subjected. Infrequent impacts to individual plants generally do not impact plant populations, plant communities, or ecological processes. Any off-road vehicles used in control treatments would be routed to avoid wetlands and riparian areas. The impacts of chemical treatments on wetlands and floodplains would therefore be directly adverse, site-specific, short-term, and negligible to minor.

Summary of Alternative I

By controlling invasive plants (particularly tamarisk and Russian olive) wetland and floodplain communities and function would be improved, thus benefiting native plant species and the habitat they provide. Effects to wetlands and floodplains would be detectable in the small areas that are treated with the techniques available. Adverse impacts would be site-specific and effects to individual plants would be short-term. USACE 404 permits would not be required for any proposed treatments under this alternative because these activities would not involve dredging or filling of U.S. waters. Under the continuation of the current management practices, the overall effects on wetlands and floodplains would be directly adverse and indirectly beneficial, site-specific, short -term, and negligible to minor.

Cumulative Effects for Alternative I

Previous impacts to wetlands and floodplains in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant management work, and from past and present human disturbances, such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and monument and county development activities, such as road building and maintenance. In addition, the construction and operation practices (past and current) of Flaming Gorge Dam is suspected of adversely impacting natural riparian processes and functions, a result of which is the persistence and expansion of tamarisk. These disturbances vary considerably as to type, intensity, and duration before and after the monument was established and continues today.

Invasive species are regularly establishing and expanding in DINO. Introductions of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors helps to prevent establishment of new infestations.

Under Alternative I, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. Alternative I will likely have negligible beneficial effects on reducing the introduction of new riparian species into the park without proactive cooperation with regional neighbors for containment or control and use of better BMPs. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wetlands and floodplains, this alternative would have direct adverse impacts on target invasive species, but indirectly beneficial, site-specific and monument-wide, short- to long-term, and minor to moderate impacts on wetlands and floodplains.

Impairment
Because there would be no major adverse impacts to wetlands and floodplains whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques on wildlife are the same as Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
Any biological control agent released in a park would be approved by APHIS and would have no demonstrated affinity for native wetland and floodplain plant species. Because biological control agents are specific to a species of invasive plant, there would be negligible adverse impacts to native plant species. No specific measures would be implemented to contain biological control agents. However, any biological control agent used would be host-specific so each biological control agent would only attack one plant species (the host, or the target invasive plant). No USACE 404 permit would be required for any activities associated with biological control treatments. The impacts of biological treatments to wetland and floodplains would have indirect beneficial effects and be site-specific to monument-wide, long-term, and moderate.

Summary of Alternative II
Using a full complement of IPM techniques would help DINO achieve the desired condition to have all native plants maintained before it could be reached under Alternatives I or III. By controlling invasive plants using IPM, the chance for successful restoration of wetlands and floodplains is high, thereby benefiting native plant species and the habitat they provide. Effects to wetlands and floodplains would be detectable and readily apparent. USACE permits would not be required for any proposed IPM treatments. Overall beneficial effects to wetlands and floodplains would be greater under this alternative because the tools available have the potential to address the scale of management necessary in the monument to affect positive change, particularly in floodplain health and function. The minor short-term adverse impacts would be outweighed by the long-term benefits of habitat restoration. Thus, overall impacts of an integrated plant management program on wetlands and floodplains would be indirectly beneficial, site-specific and monument-wide, short- to long-term, and minor to moderate on native plant species.

Cumulative Effects of Alternative II
Previous impacts to wetlands and floodplains in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant

management work, and from past and present human disturbances, such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and monument and county development activities, such as road building and maintenance. In addition, the construction and operation practices (past and current) of Flaming Gorge Dam is suspected of adversely impacting natural riparian processes and functions, a result of which is the persistence and expansion of tamarisk. These disturbances vary considerably as to type, intensity, and duration before and after the monument was established and continues today.

Invasive species are regularly establishing and expanding in DINO. Introductions of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors helps to prevent establishment of new infestations. Any overgrazing by neighbors creates disturbed areas adjacent to the park, which also contributes to the reestablishment of invasive plants. Wildland fire could create large disturbed areas and contribute to the establishment of new invasive plant infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, which would be consistent with this final plan.

Under Alternative II, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument would use a full complement of IMP techniques and, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. Alternative II would allow resource managers to be more responsive to treating invasive plants both outside and within the park by promoting additional efforts to educate and work with adjacent and regional landowners on the benefits of and techniques for invasive plant management. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wetlands and floodplains, this alternative would have directly adverse impacts on target invasive species, but indirectly beneficial, site-specific and monument-wide, short- to long-term, and minor to moderate impacts on wetlands and floodplains.

Impairment

Because there would be no major adverse impacts to wetlands and floodplains whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical and cultural techniques to wetlands and floodplains are the same as described Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Under this alternative, the monument would implement an invasive plant management program that would not include the use of chemical or biological control techniques because their use on some public lands has been controversial in recent years. Risks of adverse impacts by herbicide use to wetlands and floodplains by inadvertent contact and accidental spills are eliminated under this alternative. It is anticipated that some of the invasive species present in DINO can be managed using mechanical and cultural techniques; however, for those that cannot, it is anticipated that they will continue to spread.

Any impacts to wetlands and floodplains by biological control agents are eliminated under this alternative as well. This alternative would ensure that there was no risk of a biocontrol agent switching hosts to a nontarget species. However, there are some species that will likely never be controlled or even reduced without the use of available biocontrols because their ranges are so extensive (e.g. saltcedar). Under this alternative, control would rely solely on mechanical and cultural controls, which would result in an increase in species that are not successfully treated with these methods.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management would indirectly affect the desired condition of maintaining, preserving, and protecting wetland and floodplain value and function. Use of these techniques only are expected to have an overall long-term adverse indirect effect on wetland and floodplain communities and for potential of restoration success. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
The overall impacts of Alternative III that uses only mechanical, cultural, and expanded prevention techniques for invasive plant management to wetland and floodplain resources would be indirectly adverse, monument-wide, long-term, and moderate.

Cumulative Effects of Alternative III
Previous impacts to wetlands and floodplains in most areas proposed for invasive species management are due to the presence of invasive plants species, past and present invasive plant management work, and from past and present human disturbances such as recreation, livestock grazing and haying, water diversion and irrigation, homesteads, and park and county development activities such road building and maintenance. In addition, the construction and operation practices (past and current) of the Flaming Gorge Dam is suspected of adversely impacting natural riparian processes and function, a result of which is the persistence and expansion of tamarisk. These disturbances vary considerably as to type, intensity, and duration before and after the monument was established and continues still today.

Invasive species are regularly establishing and expanding in DINO. Introduction of new species is estimated at a rate of two per year. Annual spring flooding washes invasive species plant material into the monument from the upper Green and Yampa River watersheds. Any invasive plant control by regional neighbors along floodplains helps to prevent establishment of new infestations. The monument staff anticipates developing a livestock management plan and a

Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Under Alternative III, DINO would continue to treat existing and new invasive plant infestations. Invasive plant management within the monument under all alternatives, combined with any invasive plant management by park neighbors, would have a cumulative beneficial effect of reducing invasive plant sources. This would reduce the potential for spread of invasive plants. The least amount of acres would be treated for invasives under Alternative III and while new species introductions may be identified early, the techniques to most efficiently and effectively control or eradicate them may not be available. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wetlands and floodplains, this alternative would have direct, adverse site-specific impacts on target invasive species, and indirectly beneficial, site-specific short-term minor impacts on wetlands and floodplains.

Impairment

Because there would be no major adverse impacts to wetlands and floodplains whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Wildlife

Affected Environment

Dinosaur National Monument is home to a many wildlife species. Approximately 280 species of birds, 66 species of mammals, 33 species of fish, 6 species of amphibians, and 18 species of reptiles have been documented in the monument (Appendix J). This diversity in wildlife varies by season, elevation, and types of habitats present.

Birds in the monument include year-round residents, seasonal migrants, breeders, and vagrants or occasional visitors. Common bird species include the Black-throated Gray Warbler, Spotted Towhee, Lazuli Bunting, Chipping Sparrow, Yellow Warbler, and American Robin (Giroir 2003). In addition, 26 species present in the monument are identified as "high priority" for conservation needs in the Colorado Plateau, as listed by the Colorado Partners in Flight Land Bird Conservation Plan (Beidleman 2000). Five non-native birds have been observed in the monument – chukar, ring-necked pheasant, California quail, European starling, and house sparrow (Giroir 2003).

Elk, mule deer, moose, pronghorn antelope, and Rocky Mountain bighorn sheep are the large ungulates found within the monument. A seemingly stable population of mountain lions inhabits the monument, though estimates of their numbers have not been studied. Feral horses, although not considered native wildlife, were once abundant in the monument and adjacent BLM lands in the 1960s and 1970s. Nearly 700 animals were removed from the area between 1977-1979 and placed in BLM's Adopt-a Horse program. Currently, no feral horses are known to roam within the monument.

DINO is also home to 16 of the known 20 species of bats found in both Utah and Colorado (U.S. Bats by State). High bat species diversity is a reflection of the habitat diversity (water, roosting sites, and abundant prey) found in the monument.

Native and introduced fish in the Green and Yampa Rivers within DINO have received intense research, inventory, and monitoring interest since before Flaming Gorge Dam construction and operations began in 1962. Twenty-two introduced species and 11 native and/or endemic species have been documented in the monument since 1960. Many of the non-native species were introduced prior to 1900. Four of the six species of endemic fish are listed as endangered or are considered rare and are candidates for federal listing. DINO provides some of the last known spawning and nursery habitat for several of these big river species, largely because of the Yampa River's near-natural annual flows. Large, cooperative restoration and recovery efforts, such as the Upper Colorado River Endangered Fish Recovery Program, are working to identify and mitigate threats to the continued existence of endemic fish in Upper Colorado River watersheds.

Reintroduced Wildlife

Several species have been reintroduced to the monument in the last 50 years. Pronghorn antelope were released in 1983, after being extirpated from DINO during the early 1900s (NPS 1995). Bighorn sheep, now commonly observed along the river bottoms and canyon walls of the Green and Yampa Rivers, were extirpated from DINO by the mid-1940s due to competition with domestic livestock and diseases contracted from domestic sheep. Releases occurred in 1952, 1984, and 2000 to reestablish bighorns throughout their former range in the monument. Based on recent aerial and river corridor surveys, Colorado Division of Wildlife estimates between 100-150 bighorn sheep inhabit the monument today (Finley 2004).

Bonytail chub, considered the rarest of the Colorado River Basin native fish, was reintroduced into the Green River near Island Park in 1988 and 1989, and then again into both the Green and Yampa Rivers in 2000 and 2001 as part of re-establishment in historic habitats.

Historically found in most major river systems throughout Colorado, river otters were extirpated due to trapping. In 1989 and 1990, the Colorado Division of Wildlife (CDOW) released 20 otters into the Green River in an attempt to reestablish an otter population between Flaming Gorge Dam and the confluence with the Colorado River. In 1991 and 1992, the state of UT released 20 otters into the Green River near Island Park (NPS 1995). Today, otters have been observed throughout the Yampa River within monument boundaries and in the Green River through Lodore Canyon.

The peregrine falcon population in Dinosaur used to represent the northernmost remnant of wild peregrines in the Rocky Mountain area. Although not entirely extirpated in Colorado, in 1977 two of the four known remaining pairs of peregrine falcons in Colorado were in DINO. Aeries located along the sheer cliffs of the Green and Yampa rivers were considered critical to the recovery efforts. Since then, the monument has participated in the full range of recovery program activities, including hacking and chick fostering. 2004 marked the 27th consecutive and final year of an intensive peregrine falcon monitoring program. To date, 21 historical and active breeding territories in the Dinosaur area have been identified and surveyed, 17 of those within monument boundaries (USDI NPS 2004).

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired conditions: Most wildlife species present prior to European settlement are still present in Dinosaur National Monument today. Preserve and restore the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur.

Source: NPS Organic Act; NPS Management Polices (2001)

Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

<u>Mechanical Control</u>

Short-term displacement of wildlife may occur in the vicinity of treatments. Mechanical treatments may require the presence of many people and/or multiple treatments, possibly within a few months, causing repeated displacement of any wildlife in the vicinity. This would cause negligible short-term, site-specific, adverse impacts in the form of unnecessary energy expenditure. Overall effects would be slight and of little consequence to wildlife populations. The impacts of intrusion into parks on terrestrial wildlife would therefore be infrequently directly adverse, site-specific, short-term, and negligible.

Manual or mechanical treatments could have site-specific adverse impacts on ground-nesting birds or burrowing animals. Mitigation measures would keep these effects site-specific and of little consequence to the species' population. The impacts of manual or mechanical treatments on terrestrial wildlife would therefore be infrequently direct and adverse, site-specific, short-term, and negligible.

Cultural Control

Restoration activities may disturb wildlife due to the presence of humans and/or equipment, especially if the sites need to be maintained or the treatments need to be repeated. Also, wildlife may need to be excluded from some sites to allow for vegetation to establish (Roundy 1996). Revegetation can produce unintended results due to limited plant material availability or failure to develop a site-appropriate seed mix. Problems can also derive from disturbance created by seedbed preparation followed by failure of the restoration effort. Low plant biodiversity or unvegetated soil provides reduced benefit to wildlife. However, mitigation measures would keep these overall effects slight and of little consequence to wildlife populations, therefore impacts would be infrequent, directly adverse, site-specific, short-term, and negligible.

Use of domestic livestock for prescribed grazing could result in accidental transmission of diseases to closely related species. There is also the risk that the presence of livestock could cause disturbance to wildlife, especially during critical times of the year, such as calving or nesting. Indirect risks from livestock use include competition for resources or damage to habitat and other vegetation desirable to wildlife. Mitigation measures would keep these effects site-specific and of little to no consequence to the species' population.

Fire may have detrimental effects on an existing desirable plant community, which may in turn negatively affect wildlife. This is especially true for wildlife that are dependant on late-seral vegetation that is not fire adapted (e.g. sagebrush obligate birds such as sage grouse, sage thrasher, and sage sparrow) (Riggs et al. 1996). Fire also may cause direct mortality to wildlife (particularly less mobile species such as small mammals, reptiles, amphibians, and invertebrates); however, not more than from naturally occurring fires and would not lead to population-level effects. Because the intensity, duration, and timing of prescribed fires would be controlled, effects to some wildlife would be detectable but would be small and would not lead to population-level effects. Wildlife may also be indirectly impacted by fire through reduction of potential nesting, resting, and foraging habitat, and increased predation. Fire may also cause mobile animals, such as ungulates, to concentrate in specific areas immediately after the burn to search for food or cover. The impacts of prescribed fire on wildlife would therefore be directly and indirectly adverse, site-specific, short-term, and minor.

Foaming agents used in fire suppression and containment activities are slightly toxic to fish, as they reduce the surface tension of water and interfere with their ability to uptake oxygen from water. The soapy, surfactant qualities of foams can be an irritant to some animals as well, causing skin and eye irritation (Fire-Trol Canada Company 2004). Mitigation measures would keep these effects site-specific and of little to no consequence to the species' population. The impacts of cultural treatments on wildlife overall would be directly and indirectly adverse, site-specific, short-term, and negligible to minor.

Chemical Control

Chemical applications may harm wildlife directly through contamination of food, water sources, habitat alteration, or direct contact. It is unlikely that terrestrial wildlife species would receive direct exposure to pesticides during application because they would likely leave the area or would return to burrows during periods of increased human activity. However, insects and small mammals may be directly exposed to pesticides on rare occasions. Pesticides will be applied in accordance with label specifications to mitigate damage to habitat, and because any nests or burrows encountered would be avoided, there is low potential for exposure to acute levels of pesticides. It is also unlikely that wildlife would be overexposed over time if the pesticides are used according to label specifications and mitigation measures.

It is unlikely that aquatic wildlife species would receive direct exposure to herbicides during application, and it is also unlikely that they would be overexposed if the herbicides are used according to label specifications and mitigation measures. Pesticides registered for use in or near water (such as glyphosate) have low toxicity and would not pose a risk to aquatic communities or other standing water environments and would not likely be detectable. The use of herbicides would not be expected to have any long-term adverse impacts on native species, their habitats, or natural processes sustaining them.

It is also possible that adjuvants added to improve the efficacy of herbicides could pose health threats to wildlife. Resource managers and Regional and National IPM Coordinators would strive to stay up-to-date on available toxicity research and would use this information to refine mitigation measures for application of herbicides in wildlife concentration areas. The impacts of chemical treatments on wildlife would therefore be infrequently direct and adverse, site-specific, short-term, and minor.

Controlling invasive plants and promoting healthy native plant communities would restore and improve quality wildlife habitat. The use of the techniques considered under this alternative would help resource managers achieve the desired condition to have, as parts of the natural ecosystems of parks, all native animals maintained. Overall minor to moderate beneficial effects to wildlife habitat is expected to occur. These beneficial effects would be detectable in some areas over the long-term, and may benefit wildlife populations using these areas. However, management of particular invasive species would not be as successful as possible because of the limited use of techniques. The impacts of current management practices overall on wildlife would therefore be directly adverse and indirectly beneficial, site-specific, short- term, and negligible to minor.

Summary of Alternative I
Under the continuation of the current management practices, use of mechanical, cultural, and chemical and limited prevention techniques, the impacts would be infrequently directly and adverse on target plant species, but site-specific, short-term, beneficial, and negligible to minor impacts to wildlife.

Cumulative Effects for Alternative I
Mining, ranching, and farming operations could affect regional wildlife diversity and abundance, which likely affects wildlife found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Alternative I would improve overall wildlife habitat quality within the monument. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. Management activities within the park would likely have negligible beneficial cumulative effects on areas located outside the park that are impacted by mining and agricultural activities. If these activities further degrade wildlife habitat quality outside of DINO, invasive plant management activities within DINO may have an indirect effect. These effects could include increasing wildlife use of habitat within DINO as habitat quality improves relative to the quality of habitat available on surrounding lands. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wildlife, this alternative would have directly adverse impacts on target invasive species, but indirectly beneficial, site-specific, short-term, and negligible to minor impacts on wildlife.

Impairment
Because there would be no major adverse impacts to wildlife whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques on wildlife are the same as Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
Introductions of biocontrol agents may have unintentional effects on the wildlife community by introducing a new food source. The effect may be positive or negative, depending on what species utilize the new food source and how closely co-evolved various members of the affected ecosystem are (e.g., birds, bats, insects, etc.). If generalists respond positively to the new food source it may increase competition to other species, causing an overall decline in specialist populations. There is also the potential risk of reducing a weed species (such as tamarisk) that is currently used as a food source or for nesting/ foraging by wildlife. However, as native species replace invasive species and plant communities are restored, it is expected that specialized wildlife would prefer the more native communities. The impacts of biological treatments on wildlife would therefore be indirectly beneficial, site-specific to monument-wide, long-term and minor to moderate.

Summary of Alternative II
Using the full range of IPM techniques available to manage invasive plants gives resource managers the best chance of restoring native plant communities and their function to the benefit of all wildlife. Beneficial effects to wildlife habitat would be detectable and readily apparent. Overall beneficial effects wildlife would be greater under this alternative because the tools available have the potential to address the scale of management necessary in the monument to affect positive change in desired habitat. The minor, short-term, adverse impacts would be outweighed by the long-term benefits of habitat maintenance and restoration. The overall impacts of integrated plant management on wildlife would therefore be directly beneficial, monument-wide, long-term, and moderate.

Cumulative Effects for Alternative II
Mining, ranching, and farming operations could affect regional wildlife diversity and abundance, which likely affects wildlife found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Alternative II would best improve overall wildlife habitat quality within the monument because of the full range of management tools. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wildlife, this alternative would have directly beneficial, monument-wide, long-term, and moderate impacts.

Impairment
Because there would be no major adverse impacts to wetlands and floodplains whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3)

identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention / early detection) to manage invasive plants.

The impacts of using mechanical and cultural techniques to wildlife are the same as described Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Eliminating chemical controls from use would eliminate the risk of exposure of wildlife to herbicides. Also, potential impacts to wildlife from the introduction of biocontrols would be eliminated. However, the result would be complete reliance solely on mechanical and cultural treatments for weed management. The potential impacts from these control techniques may be incompatible with many aspects of wildlife management. In particular, the repetition required for the success of many mechanical treatments may cause unacceptable levels of disturbance to wildlife. Additionally there are likely some target species that are unable to be controlled with only mechanical or cultural techniques and would be allowed to persist in the environment, causing further degradation of wildlife habitat.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management could indirectly affect the desired condition to have all native wildlife and their habitats maintained as part of the monument's natural ecosystem and use of only these techniques are expected to have an overall long-term moderate adverse effect. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
Overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to wildlife would be indirectly adverse, monument-wide, long-term, and moderate.

Cumulative Effects for Alternative III
Mining, ranching, and farming operations could affect regional wildlife diversity and abundance, which likely affects wildlife found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wildlife, this alternative would have directly adverse, monument-wide, long-term, and moderate impacts.

Impairment
Because there would be no major adverse impacts to wildlife whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Threatened and Endangered Species

Affected Environment

The Endangered Species Act requires the NPS to identify and manage federally listed threatened or endangered species. As required under NEPA guidelines, a biological assessment and consultation with the USFWS was done for this plan. In the interest of streamlining the consultation process, Colorado agreed to be the lead state office in September 2004 for informal consultation, acting and reviewing for adverse impacts to listed species listed by Utah USFWS in addition to those species listed for Colorado. A copy of the letter and biological assessment was sent to the Western Slope CO Field office of the USFWS on November 15, 2004 regarding endangered, threatened, and rare species and is included in Appendix E.

Letters were sent to the Utah and Colorado Field Offices of the USFWS in February 2004 (Appendix E) requesting listed species lists for both Moffat and Uintah Counties to identify species that must be protected if found within project sites. Below is the list and the status of those federally listed species for the two counties:

Common Name	Scientific Name	Status	Listed for Moffat County, CO	Listed for Uintah County, UT
Bald eagle	*Haliaeetus leucocephalus*	Listed Threatened	yes	yes
Mexican spotted owl	*Strix occidentalis lucida*	Listed Threatened	yes	yes
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate for Listing	yes	yes
Black-footed ferret	*Mustela nigripes*	Listed Endangered	yes	yes
Canada lynx	*Lynx canadensis*	Listed Threatened	yes	yes
White-tailed prairie dog[1]	*Cynomys leucurus*	Removed from consideration	no	no
Bonytail	*Gila elegans*	Listed Endangered	yes	yes
Colorado pikeminnow	*Ptychocheilus lucius*	Listed Endangered	yes	yes
Humpback chub	*Gila cypha*	Listed Endangered	yes	yes
Razorback sucker	*Xyrauchen texanus*	Listed Endangered	yes	yes
Boreal toad	*Bufo boreas*	Candidate for Listing	yes	yes
Ute ladies'-tresses	*Spiranthes diluvialis*	Listed Threatened	yes	yes
Clay Reed-mustard	*Schoenocrambe argillacea*	Listed Threatened	no	yes
Graham Beardtongue	*Penstemon grahamii*	Candidate for Listing	no	yes

Common Name	Scientific Name	Status	Listed for Moffat County, CO	Listed for Uintah County, UT
Horseshoe milkvetch	*Astragalus equisolensis*	Candidate for Listing	no	yes
Shrubby Reed-mustard	*Schoenocrambe suffrutescens*	Listed Endangered	no	yes
Uinta Basin Hookless Cactus	*Sclerocactus glaucus*	Listed Threatened	no	yes
White River Beardtongue	*Penstamon scariosus var. albifluvis*	Candidate for Listing	no	yes

[1] The status of White-tailed prairie dog was "Petitioned for Listing" when the research and analysis for this document began in January 2004. However the species was removed from consideration on November 9, 2004 because FWS ruled that there was insufficient scientific information to warrant studying whether the species should be placed on the endangered species list. DINO has chosen to keep all analysis and implement any relevant conservation measures that were completed for the species before its change in status because it provides critical habitat for the endangered Black-footed ferret, therefore making it a species of management concern to monument staff.

Federally listed Threatened & Endangered Species

Of the species identified for both Moffat and Uintah Counties, monument records show that the bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), bonytail chub (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), and Ute ladies'-tresses (*Spiranthes diluvialus*) do currently occur in the monument. Recent surveys in 2001 & 2002 revealed no yellow-billed cuckoo (*Coccyzus americanus*) presence, and no black-footed ferrets (*Mustela nigripes*) have been recorded within the monument. Suitable habitat for both these species does exist in the monument, however, and confirmed observations of both species have been recorded within conceivable reach of the monument within the last two years.

Although potentially present in other parts of Moffat and Uintah County, monument records indicate that the boreal toad (*Bufo boreas*) and Canada lynx (*Lynx canadensis*) do not occur in the monument because DINO does not contain their required/preferred habitat type (dense spruce/fir stand above 9,000 ft. for lynx [Fitzgerald et. al. 1994]; marshes, wet meadows, and the margins of streams between 8,500 and 11,000 ft. for boreal toads [Hammerson 1986]). In addition, all of the following plants on the Uintah County list may occur in Uintah County, but do not occur in the monument: Clay Reed-mustard (*Schoenocrambe argillacea*), Graham Beardtongue (*Pentemon grahamii),* Horseshoe milkvetch (*Astragalus equisolensis),* Shrubby Reed-mustard (*Schoenocrambe suffrutescens),* Uinta Basin Hookless Cactus (*Sclerocactus glaucus),*and White River Beardtongue (*Penstamon scariosus var. albifluvis*). Recent extensive rare plant surveys (Dewey et. al. 2003) in the monument give us confidence that these highly localized plants, while endemic to the Uinta Basin, do not extend into DINO.

State-listed Species of Concern

It is well within the spirit of the Endangered Species Act and DO 77-8 that DINO manage state-listed threatened and endangered species, state special concern species, and any species considered sensitive or rare to prevent future federal listing. Please see Appendix K for a list of plant and animal species of state concern that DINO will manage in ways consistent with those federally listed species protected under the Endangered Species Act.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Federal and state-listed threatened and endangered species and their habitats are sustained. No invasive plant management actions jeopardize the continued existence of listed or candidate species or adversely impact critical habitats.

Source – Endangered Species Act; NPS Organic Act; NPS Management Policies (2001), Director's Order 77-8.

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

In the event that an area infested by one of the target species provides habitat for a listed species, weed management activities will be implemented in such a way that any potential adverse impacts to that species are negligible. If certain times of the year are less likely to cause disturbance than others, then for all treatments this will be implemented. If a critical feature (such as a snag or den) is within the treatment area, then for all treatments it will be maintained. Also, if a target species provides critical habitat for a listed species, such as nesting sites or a food source, then for all treatments it will be controlled in phases, so that native vegetation can be reestablished that will provide equivalent requirements and habitat is maintained.

Mechanical Control

No direct impacts to T&E wildlife or plants are expected because of proposed mitigation measures. Little to no disturbance to T&E wildlife or trampling of T&E plants is expected because mitigation and conservation measures (Appendix E) would be followed, particularly during critical reproductive periods. The impacts of manual and mechanical treatments on T&E species would therefore be direct, site-specific, short-term, and negligible to minor.

Cultural Control

The introduction of undesirable species through contaminated equipment, seed or through improper selection of species for revegetation could impact a listed plant species in areas where active restoration occurs. Equipment used for restoration could damage listed plants. Restoration activities may disturb listed wildlife, especially if sites need to be maintained or the treatments need to be repeated. Mitigation and conservation measures would keep these effects site-specific and of little to no consequence to the species' population. Many T&E species would likely directly benefit from the restoration of native plant communities and wildlife habitat. Restoration activities, such as reseeding, would have the direct beneficial effect of promoting the establishment of native vegetation. Beneficial effects may be detectable in some areas, and would benefit T&E populations using those areas. The impacts of restoration on T&E species of concern would therefore be indirectly beneficial and directly adverse, site-specific, short-term, and minor.

Domestic livestock used for prescribed grazing could eat or trample listed plant species. In addition, domestic livestock could transmit disease to related wildlife or could disturb T&E wildlife, especially during critical times such as nesting or rearing of young. Mitigation and conservation measures would keep these effects site-specific and of little to no consequence to the species' population.

How a listed plant species will respond to fire depends on the plants' characteristics - if a plant is not fire-adapted, it is very likely that a fire will be detrimental to the health of the population. Using prescribed fire also carries the risk of causing wildlife mortality or damage to critical habitat features such as snags or nesting areas. Prescribed fire could destroy important woody riparian vegetation, killing cottonwoods used by bald eagles and yellow-billed cuckoo for nesting and roosting and damaging Mexican spotted owl habitat, and so it would not be used in occupied or potential habitat for these species. Fire will not likely carry in prairie dog towns, and so is not identified as a threat to white-tailed prairie dogs or any black-footed ferrets who might inhabit these colonies. There is no evidence that fire causes harm to endemic Colorado River fish, which are adapted to high turbidity and silt loads that may be caused by erosion of burned upland areas. *S. diluvialis* is resistant to fire in some settings, and so fire could be used prescriptively for control of invasive species in *S. diluvialis* habitat. Prescribed fire would not directly affect T&E species because it would not be used in areas that could affect these species during sensitive periods.

Foaming agents used in prescribed fire suppression and containment activities are slightly toxic to all fish, including listed fish species, as they reduce the surface tension of water and interfere with their ability to uptake oxygen from water. The soapy, surfactant qualities of foams can be an irritant to some listed animals as well, causing skin and eye irritation (Fire-Trol Canada Company 2004). It is unlikely that aquatic T&E species would receive direct exposure to these chemicals during application since mitigation and conservation measures would keep these effects site-specific and of little to no consequence to the species' population. The impacts of cultural treatments on T&E species overall when all mitigation and conservation measures are followed would be directly adverse and indirectly beneficial, site-specific, short and long-term, and negligible to minor.

Chemical Control

Some herbicides may be toxic to wildlife in general, including listed species. This risk is increased if the pesticide does not break down rapidly, giving wildlife a longer window of time to come into contact with the chemical. If a pesticide is used for control of aquatic vegetation, the herbicide may eliminate too much vegetation (including desirable vegetation) too quickly resulting in loss of habitat and food sources. It is unlikely that T&E species would receive direct exposure to pesticides during application, and it is also unlikely that they would be overexposed to pesticides over time when used under label specifications and mitigation and conservation measures. Because no pesticides would be applied within buffer areas during sensitive periods, potential risks to T&E species from pesticide application activities is unlikely. The impacts of chemical treatments on T&E species would therefore be indirect, adverse, site-specific, short-term, and minor.

Summary of Alternative I

Controlling invasive plants and promoting healthy native plant communities would restore and improve quality habitat for all wildlife, including T&E species. The use of the techniques considered under Alternative I would help resource managers achieve the desired condition to have all federal and state listed species and their habitats sustained. Overall minor beneficial effects to wildlife habitat are expected to occur. Any minor and short-term adverse impacts would be outweighed by the long-term benefits of habitat restoration. These beneficial effects would be detectable in some areas over the long-term, and may benefit some listed species using these areas. However, management of particular invasive species would not be as successful as possible without implementation of more proactive prevention techniques. The impacts of current management practices overall on T&E species would therefore be directly adverse and indirectly beneficial, site-specific, short- term, and negligible to minor.

Cumulative Effects for Alternative I

Mining, ranching, and farming operations could affect regional wildlife and plant diversity and abundance, including T&E species found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Alternative I would improve overall wildlife habitat quality within the monument. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. Management activities within the park would likely have negligible beneficial cumulative effects on areas located outside the park that are impacted by mining and agricultural activities. If these activities further degrade wildlife habitat quality outside of DINO, invasive plant management activities within DINO may have an indirect effect. These effects could include increasing wildlife use of habitat within DINO as habitat quality improves relative to the quality of habitat available on surrounding lands. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to T&E species, this alternative would have directly adverse impacts and indirectly beneficial, site-specific, short-term, and negligible to minor impacts.

Impairment

Because there would be no major adverse impacts to threatened and endangered species whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument’s resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques on T&E species are the same as described for Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control

Introductions of biocontrol agents may have unintentional effects on T&E wildlife by introducing a new food source. The effect may be positive or negative, depending on what species utilize the new food source and how closely co-evolved various members of the affected ecosystem are (e.g., birds, bats, insects, etc.). If generalists respond positively to the new food source, it may increase competition to other species, causing an overall decline in specialist populations. There is also the potential risk of reducing a weed species (such as tamarisk) that is currently used as a food source or for nesting/foraging by T&E wildlife. However, as native species replace invasive species and plant communities are restored, it is expected that specialized T&E species would prefer the more native communities. The impacts of biological treatments on T&E wildlife would therefore be indirectly beneficial, site-specific to monument-wide, long-term and minor to moderate.

The biocontrol agent may move from target to non-target species over time. In this event, the damage caused to listed non-target species could be enough to cause further endangerment or even extinction. Because biological control agents considered for use have been tested for host specificity, there would be no known direct impacts to non-target T&E plant species. Over time, biocontrols would have a long-term beneficial effect on T&E species' communities by reducing pressure and competition of invasive species. Therefore the impacts of biological controls on T&E plants would be indirectly beneficial, long-term, and site-specific to monument-wide.

A Biological Assessment (BA) was prepared for this project to evaluate its potential effects on federally listed T&E species (Appendix E). The BA evaluates the potential effects of implementing the proposed action on T&E species that are known to occur, or that have potential to occur, in the plan area. A number of conservation measures have been developed to mitigate potential impacts to T&E species and are fully described in the BA. These measures are considered part of the proposed action. Although candidate species are not afforded any protection under the ESA, efforts will be made to avoid or minimize potential impacts to these species.

Based on the analysis in the BA, one of three possible determinations was chosen for each listed species based on the best available scientific literature, a thorough analysis of the potential effects of the plan, and the professional judgment of the biologists and ecologists who completed the evaluation. The three possible determinations are:

> **"No effect"** – where no effect is expected;
> **"May affect - not likely to adversely affect**" – where effects are expected to be

beneficial, insignificant (immeasurable), or discountable (extremely unlikely); and
"May affect - likely to adversely affect" – where effects are expected to be adverse or detrimental.

USFWS concurred with DINO's determination in June 2005 that proposed actions under this (preferred) alternative may affect, but are not likely to adversely affect T&E species which are found or could potentially be found within the monument's boundaries.

Summary of Alternative II
Using the full range of IPM techniques available to manage invasive plants gives resource managers the best chance of restoring native plant communities and their function to the benefit of all wildlife. Beneficial effects to T&E species habitat would be detectable and readily apparent. Overall beneficial effects to habitat would be greater under this alternative because the tools available have the potential to address the scale of management necessary in the monument to affect positive change in preferred habitat. The minor, short-term, adverse impacts would be outweighed by the long-term benefits of habitat restoration. The impacts of integrated plant management techniques on T&E species would therefore be indirectly beneficial, monument-wide, long-term, and moderate.

Cumulative Effects for Alternative II
Mining, ranching, and farming operations could affect regional T&E species' diversity and abundance, which likely affects the T&E species found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Alternative II would best improve overall T&E species' habitat quality within the monument because of the full range of management tools. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to T&E species, this alternative would have directly beneficial, monument-wide, long-term, and moderate impacts.

Impairment
Because there would be no major adverse impacts to threatened and endangered species whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical and cultural techniques for listed plants and wildlife are the same as described Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

The elimination of chemical and biological controls may reduce some risks to listed species and increase others. Increased reliance on mechanical controls especially may increase disturbance to listed species from the need to repeat treatments and increased soil disturbance from operator foot traffic. Biological controls may provide partial control of target species, the least amount of disruption of habitat to listed wildlife, and the most selective control in communities harboring listed plants. Overall, the elimination of chemical and biological controls is expected to result in the failure to provide adequate control for some target species, particularly and most immediately tamarisk in listed fish habitat (it has already compromised nursery habitat in Echo Park), which will continue to degrade habitat for listed species.

Summary of Alternative III
Using only mechanical, cultural, and expanded prevention techniques for invasive plant management could indirectly affect the desired condition to have all T&E species and their habitats maintained as part of the monument's natural ecosystem. Mitigation and conservation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations. Therefore, overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to T&E species and habitat resources would be indirectly adverse, monument-wide, long-term, and moderate.

Cumulative Effects of Alternative III
Mining, ranching, and farming operations could affect regional T&E species' diversity and abundance, which likely affects the T&E species found inside monument boundaries. Operation of the Flaming Gorge Dam would continue. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Management of invasive species within DINO would reduce sources of invasive plant seeds that could spread to lands adjacent to the park, particularly downstream. Any invasive plant control by regional neighbors would help to prevent establishment of new infestations. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to T&E species, this alternative would have indirectly adverse, monument-wide, long-term, and moderate impacts.

Impairment
Because there would be no major adverse impacts to listed threatened and endangered species whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the

monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Water Quality

Affected Environment

The monument is located within portions of the Green River and Yampa River watershed. The main source of flow in these two rivers is snowmelt from the surrounding mountains, as summer rainstorms do not significantly add to overall flow amounts (Montgomery Watson 2001). The highest flows typically occur in May. Perennial tributaries that flow into the Green River within the monument include Jones Hole Creek, Zenobia Creek, Garden Creek, and Pool Creek. Another perennial stream that flows through the monument is Cub Creek, but it enters the Green River outside the monument boundaries (Sumsion 1976). In addition to the major rivers and tributaries, there are also numerous springs and ephemeral drainages in the area. (Miller 2002).

Yampa River

The Yampa River enters the monument at Deerlodge Park, in the eastern section of the monument. From there, it flows in a generally westward direction for 46 miles through the Yampa Canyon joining the Green River at Echo Park in the monument's center. In the entire Colorado River System, it is the only tributary that is free of major instream impoundments (NPS 1995). The water quality of the Yampa River is good, especially in the upper reaches in the high mountains. Portions of the headwaters have been designated as "Outstanding Waters" for their high quality trout habitat (Montgomery Watson 2001). However, lower elevation water sources have some concerning characteristics, including accelerated sedimentation, elevated pH levels, and naturally occurring salts (Montgomery Watson 2001).

Green River

The Green River originates in the Wind River Mountains of Wyoming and enters the monument in the northern section at Browns Park (Colorado) and flows for 19 miles south through the gorge of the Canyon of Lodore (Sumsion 1976) where it meets the Yampa River in Echo Park. From Echo Park the river leaves the monument 26 miles further downstream through Split Mountain Canyon in the southwest portion at 4,730 feet, the lowest elevational point in the monument. Not much water quality data is available concerning the portion of the Green River that is within monument boundaries. Water quality of surrounding portions is generally good although water flows and sediment levels have been altered by human activities, such as damming and diversion of water for agricultural purposes. The State of Utah maintains a water quality monitoring station within the monument across from the Chew Ranch.

Groundwater and Upland Water Resources

Aquifers within the monument are mainly sandstone and limestone formations that are drained from higher areas (Sumsion 1976). Public water supplies in the area are usually from wells and the groundwater needs little or no treatment to be potable (Foster et al. 2000). Inflow of groundwater to rivers is believed to occur in a few locations within the monument, predominantly in the Weber sandstone and Morgan Formation (Foster et al. 2000).

Upland water resources include all surface waters except the Green and Yampa Rivers. Through the monument, there are many areas with seeps or springs, especially in canyons where water is free to seep out through the rock. The quality of these water sources varies depending upon the type and level of utilization. Some spring locations have been used or developed as permanent water sources for livestock. In 1997 and 1998, 94 springs or seeps were located and sampled within the monument (Foster et al. 2000). At that time 15 of these locations were developed as a stock pond, reservoir, or other method of water collection.

Regulations and Policies
Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Watersheds will be managed as complete hydrologic systems; protection of watershed and stream features will be achieved by avoiding impacts to watershed and riparian vegetation; water resources will be protected from pollution sources or flow disruption from causes originating within or outside park boundaries; Park management activities do not violate federal or state water quality standards.

Source – NPS Organic Act; NPS Management Policies (2001); Clean Water Act; Executive Order 12088: Federal Compliance with Pollution Control Standards (1978); Director's Order 77-1 Wetland Protection.

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

Mechanical Control
Disturbance from mechanical control may increase turbidity caused by sediment runoff from areas of soil disturbance or loss of vegetation cover. This is likely to occur only in areas of extensive invasive species infestations, including Echo Park, Island Park, Rainbow Park, and along the Green River below Split Mountain Canyon. Impacts of mechanical controls are expected to be measurable and indirectly adverse, but short-term and site specific.

Cultural Control
Restoration activities such as reseeding and irrigation would have a beneficial effect of promoting the reestablishment of native vegetation, which could help reduce erosion and sedimentation. Changes in water quality may be measurable and long-term, but would be relatively site-specific.

The use of livestock for prescribed grazing can also damage water quality through deposition of feces and urine (Vallentine 2001). Changes in water quality may be measurable, but would be short-term and site-specific.

Loss of vegetation from prescribed fire could cause minor temporary increases in erosion and sedimentation. Changes in water quality may be measurable but would be short-term and relatively site-specific. Runoff from burned areas could contain soils and ash, which would also have a negligible short-term effect on water quality. The impacts of cultural controls on water resources would therefore be directly adverse and indirectly beneficial, site-specific, long-term, and negligible to minor.

<u>Chemical Control</u>
Chemical controls could lead to reduced water quality through leaching and runoff, depending on soil type, water table characteristics, application technique and distance to water, and herbicide(s) used. To minimize potential environmental effects, herbicides would be selected based on these factors. Resource managers considering application of herbicide in areas with low water tables would assess the risk of leaching using RAVE (Appendix F). Alternative types of treatments, herbicides, or herbicide application rates would be considered for areas with high leaching potential. Using these mitigation measures, the potential for surface and ground water contamination would be unlikely. Pesticide application would therefore not likely cause detectable changes in chemical water quality standards that exceed desired water quality conditions.

The potential for directly spilling pesticides into surface waters is unlikely. Pesticides are transferred in controlled settings, contained in spill-proof containers, and are handled in accordance with label specifications. In the unlikely event that a spill occurs, resource managers would immediately implement standard operating procedures for containing and remediating spills. The impacts of herbicide use on water resources would therefore be directly adverse, site-specific, short-term and negligible to minor.

Summary of Alternative I
Removal of invasive plants that affect riparian areas (such as Russian olive, tamarisk, and perennial pepperweed) would help return some surface waters to natural flows, reduce visual obstructions along river and stream banks, and create additional habitat. Removal of these species using these techniques may help DINO achieve the desired condition to have surface waters and ground waters perpetuated, natural floodplain values restored, and natural values of wetlands preserved. Any minor and short-term adverse impacts would be outweighed by the long-term benefits of improved water quality. However, management of particular invasive species would not be as successful or as widespread as possible because of the limited use of techniques. The impacts of current management practices overall on water quality would, therefore, be indirectly beneficial, site-specific, short-term, and negligible to minor.

Cumulative Effects for Alternative I
Operation of the Flaming Gorge Dam controls water flow and velocity as well as water quality characteristics, such as reduced sedimentation. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Mining operations and agricultural practices, such as pesticide and fertilizer application and tillage, could adversely affect water quality, particularly if inappropriately conducted. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to water quality, this alternative would have indirectly, beneficial, site-specific, short-term and negligible to minor impacts.

Impairment
Because there would be no major adverse impacts to water quality whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques on water quality are the same as described for Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
No direct or indirect adverse impacts are known to occur to water quality. Impacts of biocontrol treatments would therefore be negligible.

Summary of Alternative II
Overall beneficial effects to water quality would be greater under this alternative because the full range of tools available have the potential to address the scale of management necessary in the monument to affect positive change. Any minor short-term adverse impacts would be outweighed by the long-term benefits of improved water quality and associated aquatic resources. The overall effects of integrated plant management techniques under this alternative would be directly adverse and indirectly beneficial, monument-wide, long-term, and negligible to moderate.

Cumulative Effects for Alternative II
Operation of the Flaming Gorge Dam controls water flow and velocity as well as water quality characteristics, such as reduced sedimentation. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Mining operations and agricultural practices, such as pesticide and fertilizer application and tillage, could adversely affect water quality, particularly if inappropriately conducted. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to water quality, Alternative II would have indirectly, beneficial, monument-wide, long-term and negligible to moderate impacts.

Impairment
Because there would be no major adverse impacts to water quality whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and prevention techniques to water quality are the same as described for Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Alternative III would eliminate the risks associated with chemical controls to water quality. The indirect benefits to water quality would likely be outweighed by the inability to control weeds without the use of herbicides and biological control agents when and where possible. The end result would be an increase in invasive species, particularly in wetland and riparian habitats that cannot be effectively controlled by other means.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management could indirectly affect the desired condition to maintain and improve water quality and use of only these techniques are expected to have an overall long-term minor adverse effect to processes that contribute to good water quality. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
Overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to factors affecting water quality resources would be indirectly adverse, monument-wide, long-term, and minor.

Cumulative Effects of Alternative III
Operation of the Flaming Gorge Dam controls water flow and velocity as well as water quality characteristics, such as reduced sedimentation. DINO will continue to provide some of the last known spawning and nursery habitat for several of the endemic fish that are listed as endangered or rare. Mining operations and agricultural practices, such as pesticide and fertilizer application and tillage, could adversely affect water quality, particularly if inappropriately conducted. The monument staff anticipates developing a livestock management plan and a wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to water quality, Alternative III would have indirectly adverse, monument-wide, long-term and minor impacts.

Impairment
Because there would be no major adverse impacts to water quality whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Wilderness

Affected Environment

Although national parks are protected areas, Congress chose to apply the Wilderness Act of 1964 to National Parks to augment protection of these areas in response to a trend within the agency to make parks more accessible and comfortable to visitors through additional development (USDI 2003). The Wilderness Act of 1964 established a National Wilderness Preservation System "to secure for the American people of present and future generations the benefits of an enduring resource of Wilderness." NPS *Management Policies 2001* states that "NPS will manage Wilderness for use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as Wilderness."

A variety of uses, management actions, and even facilities are permitted in Wilderness areas under the Wilderness Act and NPS policies. The Wilderness Act declares that Wilderness areas will be devoted to the "public purposes of recreation, scenic, scientific, educational, conservation, and historical use" and includes the activity of invasive species management as described specifically by "management actions taken to correct past mistakes or impacts of human use, including restoration of extirpated species, controlling invasive alien species, endangered species management, and protection of air and water quality" (USDI 2003).

There is no designated Wilderness in DINO, however 205,672 acres are recommended for Wilderness status (lands that qualify for inclusion within the national Wilderness preservation system) and 5,055 acres are identified as potential Wilderness (lands that are being recommended for immediate Wilderness designation) (USDI 2003). Park Service policy is to manage recommended and potential Wilderness lands as if they were designated Wilderness.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired conditions- Park will mange Wilderness areas for the preservation of Wilderness character and resources in an unimpaired condition as well as for purposes of recreational, scenic, scientific, education, conservation, and historic uses.

Source – The Wilderness Act of 1964, NPS Organic Act, NPS Management Policies (2001), Director's Order 41: Wilderness Preservation and Management.

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

<u>Mechanical, Cultural and Chemical Control</u>

A temporary change in Wilderness character and associated values would occur during invasive plant management activities. Some aspects of control may intrude on the Wilderness experience: mechanized and motorized equipment such as chainsaws, brush cutters, wood chippers, aircraft, would cause a certain level of noise when used within recommended and proposed Wilderness areas, thereby compromising the preservation of natural conditions (including the lack of man-made noises). Also the repeated presence of park personnel, equipment, and domestic livestock could impact visitor solitude. The site-specific, short-term impacts on Wilderness would be noticeable to Wilderness visitors.

The reduction or elimination of invasive plants would ultimately restore the naturalness sought by visitors. There would be a minor beneficial change in Wilderness character and quality that would be measurable and site-specific. The minor, short-term, adverse impacts would be outweighed by the benefits to Wilderness preservation.

Summary of Alternative I

Current management practices would not inhibit and is expected to facilitate the maintenance of the desired condition to have Wilderness areas in an unimpaired condition, except as necessary to meet minimum requirements for the administration of the area. The overall impacts of current management practices on Wilderness would therefore be directly and indirectly adverse and beneficial, site-specific, short-term and minor.

Cumulative Effects for Alternative I

Past land uses, including ranching and agriculture, within recommended and potential Wilderness areas have affected its “pristine” nature, though many are not very evident to the public. Examples of these disturbances include barbed wire fragments and changes in native plant communities. Wilderness designation changes access, tools, and methods that can be used in large areas of the park, which in turn increases the amount of effort or funds required to accomplish projects. Park operations using aircraft, ATVs, or large work crews can degrade the Wilderness experience, even though minimum requirement analyses are used. Oil and gas wells activities outside monument boundaries and the associated traffic in areas adjacent to Wilderness could degrade Wilderness experience, both from sight and sound. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

This alternative would have negligible to minor adverse additive impacts on recommended and proposed Wilderness areas. Minor adverse additive impacts could occur for short periods when invasive plants within the Wilderness area are treated. The minimum tool analysis (Appendix H) would be used to select the treatments that could meet invasive plant management objectives, while minimizing potential impacts. Any direct or indirect adverse impacts are expected to be ameliorated as native vegetation and wildlife communities are restored.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to Wilderness, Alternative I would have directly and indirectly, adverse and beneficial, site-specific, short-term and minor impacts.

Impairment
Because there would be no major adverse impacts to Wilderness whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques in Wilderness areas are the same as described for Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
Biocontrol agents could evolve over the long-term and have a negative impact to native vegetative and wildlife communities, consequently impacting Wilderness character. However, any biological control agent released in a park would be approved by APHIS and would have no demonstrated affinity for native species. Because biological control agents are specific to a species of invasive plant, there would be negligible adverse impacts to native plant species. No specific measures would be implemented to contain biological control agents. Impacts to native or desirable (non-target) plants would be indirect and beneficial. The impacts of biological treatments on preserving Wilderness characteristics would therefore have indirect beneficial effects and be site-specific to monument-wide, long-term, and minor to moderate.

The reduction or elimination of invasive plants would ultimately restore the naturalness sought by visitors. There would be a beneficial change in Wilderness character and quality that would be measurable and site-specific. DINO will disseminate information to the public and staff on various control projects as to how and why particularly loud techniques, such as ATVs and aircraft, are necessary to accomplish project goals. The minor, short-term, adverse impacts would be outweighed by the long-term benefits to Wilderness preservation. IPM would not inhibit and is expected to facilitate and improve the maintenance of the desired condition to have Wilderness areas in an unimpaired condition, except as necessary to meet minimum requirements for the administration of the area.

Summary of Alternative II
The impacts of integrated plant management on recommended and potential Wilderness would therefore be directly adverse and beneficial, monument-wide, long-term and minor to moderate.

Cumulative Effects for Alternative II
Past land uses, including ranching and agriculture, within recommended and potential Wilderness areas have affected its "pristine" nature, though many are not very evident to the public. Examples of these disturbances include barbed wire fragments and changes in native plant communities. Wilderness designation changes access, tools, and methods that can be used

in large areas of the park, which in turn increases the amount of effort or funds required to accomplish projects. Park operations using aircraft, ATVs, or large work crews can degrade the Wilderness experience, even though minimum requirement analyses are used. Oil and gas wells activities outside monument boundaries and the associated traffic in areas adjacent to Wilderness could degrade Wilderness experience, both from sight and sound. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

This alternative would have negligible to minor adverse additive impacts on recommended and proposed Wilderness areas. Minor adverse additive impacts could occur for short periods when invasive plants within the Wilderness area are treated. The minimum tool analysis (Appendix H) would be used to select the treatments that could meet invasive plant management objectives, while minimizing potential impacts. It is anticipated that Wilderness values and character would benefit overall under Alternative II because size, spread, and new introductions of invasive species is expected to decrease when a full range of IPM techniques are implemented. Any direct or indirect adverse impacts are expected to be ameliorated as native vegetation and wildlife communities are restored. IPM would help to rehabilitate native plant communities and wildlife habitat in Wilderness areas. Negligible to minor short-term additive effects would likely occur from IPM because mitigation measures would be implemented.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to Wilderness, impacts of integrated plant management on recommended and potential Wilderness would be directly adverse and beneficial, monument-wide, long-term and minor to moderate.

Impairment

Because there would be no major adverse impacts to Wilderness whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical and cultural techniques in Wilderness areas are the same as described Alternatives I & II. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

The elimination of chemical and biological controls may reduce some risks to Wilderness character preservation and increase others and may be incompatible with many aspects of Wilderness management. In particular, the repetition required for the success of many mechanical treatments may cause unacceptable levels of disturbance to natural and cultural resources as well as to visitors. Additionally there are likely some target species that cannot be controlled with only mechanical or cultural techniques and would therefore persist in the environment, compromising the ecological integrity of areas the Wilderness Act is designed to protect.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management could indirectly affect the desired condition to mange Wilderness areas for the preservation of Wilderness character and resources in an unimpaired condition and use of only these techniques are expected to have an overall long-term moderate adverse effect. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations, especially those larger in size and distribution, that degrade Wilderness quality.

Summary of Alternative III

Overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to Wilderness would be indirectly adverse, monument-wide, long-term, and moderate.

Cumulative Effects of Alternative III

Past land uses, including ranching and agriculture, within recommended and potential Wilderness areas have affected its "pristine" nature, though many are not very evident to the public. Examples of these disturbances include barbed wire fragments and changes in native plant communities. Wilderness designation changes access, tools, and methods that can be used in large areas of the park, which in turn increases the amount of effort or funds required to accomplish projects. Park operations using aircraft, ATVs, or large work crews can degrade the Wilderness experience, even though minimum requirement analyses are used. Oil and gas wells activities outside monument boundaries and the associated traffic in areas adjacent to Wilderness could degrade Wilderness experience, both from sigh and sound. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

This alternative would have negligible to minor adverse additive impacts on recommended and proposed Wilderness areas. Minor adverse additive impacts could occur for short periods when invasive plants within the Wilderness area are treated. The minimum tool analysis (Appendix H) would be used to select the treatments that could meet invasive plant management objectives, while minimizing potential impacts. Any direct or indirect adverse impacts are expected to be ameliorated as native vegetation and wildlife communities are restored.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to Wilderness, using only mechanical, cultural, and expanded prevention techniques for invasive plant management to Wilderness would be indirectly adverse, monument-wide, long-term and moderate.

Impairment

Because there would be no major adverse impacts to Wilderness whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Air Quality

Affected Environment

The National Parks and Monuments of the Colorado Plateau receive millions of visitors each year, attracted by outstanding scenic vistas and ecosystems that approach pristine conditions for the American West. Air quality is fundamentally important; imposing scenery needs to be visible to be appreciated. Vegetation, visibility, water quality, wildlife, historic and pre-historic structures and objects, cultural landscapes, and most other elements of a park environment are sensitive to air pollution and are referred to as air quality-related values.

Dinosaur National Monument and environs have been noted in the past for their wide-ranging vistas and good air quality. The monument is a class II air quality "floor" under the prevention of significant deterioration provisions of the federal 1963 Clean Air Act, as amended, and as a category 1 area by Colorado standards (USDI NPS 1986). Under Class II designation, the area is protected by the Clean Air Act, but is identified for somewhat less stringent protection from air pollution damage than a Class I area, except in specified cases. This means that developments can be permitted in the vicinity of the park unit as long as the levels of particulate matter, sulfur dioxide, and nitrogen dioxide do not exceed the Class II maximum allowable increases.

Meteorological and air quality monitoring stations have recently been installed within the monument. An air quality station was installed in May 2005 near the Quarry that is being monitored by NPS Air Resources Division. Data from this station will eventually be posted to http://www2.nature.nps.gov/air/monitoring/network.cfm#data. There is one meteorological station that is maintained by the Grand Junction NOAA weather service, though the data is not posted on the Internet. There is also a NOAA weather station located near park headquarters.

No confirmed threats to air quality-related values from sources outside the monument have been identified thus far, and very little data even exists for air quality in the region (air quality monitoring has just been initiated in the monument). The only documented impacts of air pollution on air quality-related values in the Colorado Plateau involve visibility reductions. However, longer-term data (1994-2003) collected from Dinosaur National Monument's closest park neighbors that have similar air quality monitoring protocols in place (Rocky Mountain NP, Yellowstone NP, Canyonlands NP, Mesa Verde NP) all show a regional trend of increasing ozone and deposition (data available at http://www2.nature.nps.gov/air/who/npsPerfMeasures.cfm). Increasing regional development and high pollutant concentrations around Salt Lake City are a concern, however, data collected from the monitoring stations in DINO should provide long-term air quality trend data as well as complement existing stations elsewhere on the Colorado Plateau in the future for monument and regional analysis.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – NPS will seek to perpetuate the best possible air quality in parks to preserve natural resources and systems, preserve cultural resources, and sustain visitor enjoyment, human health, and scenic vistas. The Service will assume an aggressive role in promoting and pursuing measures to protect air-quality related values from the adverse impacts of air pollution. Air resource management requirements will be integrated into NPS operations and planning, and all air pollution sources within parks – including prescribed fire management and visitor use activities – will comply with all federal, state, and local air quality regulations and permitting requirements.

Source – Clean Air Act (CAA); Organic Act; NPS Management Policies (2001); NEPA; Director's Order 77 – Natural Resource Protection

The following topic has been identified as having similar impacts to monument resources under all three alternatives considered. Expected impacts to air quality are summarized in the following analysis in an effort to eliminate unnecessary duplication of analysis under each alternative:

Implementation of any of the alternatives considered would at most create a short-term and site-specific reduction in air quality from dust from vehicles and exhaust from equipment (ATVs, tractors) used for mechanical, cultural, and chemical treatments in certain areas. Prescribed fire plans would be developed for each prescribed fire. The site-specific and short-term effects of smoke on local community activities and land users would be considered when planning prescribed fires. Appropriate signing would be posted if smoke would affect roadways or designated visitor areas (visitor centers, campgrounds, river canyons) and the appropriate authorities would be contacted regarding smoke or visibility.

There is some risk that the use of herbicides under Alternatives I and II could volatize, causing short-term impacts to air quality on a localized basis. Most pesticides used have a low volatility. Those pesticides with higher volatility are used at low concentrations. Such events should be rare when herbicides are used in conditions and in a manner consistent with product labeling, as required by law. No measurable adverse impacts to air quality from biological controls or invasive plant prevention strategies are known.

Summary

Invasive plant management activities would not inhibit the maintenance of the desired condition to have air quality standards met or maintained. Any impacts of mechanical, cultural, or chemical techniques are expected to cause negligible to minor, site-specific decrease in air quality conditions and is not likely to impact visibility for, at most, greater than a couple of hours.

Cumulative Effects

Local air quality impacts in DINO are most often caused by visitor and staff vehicle traffic and any fire activity in the area. Nearby power plants and mining activities also contribute to regional air quality, though the degree to which they impact air quality is presently unknown. When added to these existing impacts within or near the monument, most invasive plant management activities are expected to have negligible additive impacts to local or regional air quality. Prescribed fires for invasive plant management may have additive cumulative short-term minor adverse impacts to air quality if fires are conducted during periods of poor regional air quality or during periods of increased fire activity in areas outside the monument.

Impairment

Because there would be no major adverse impacts to air quality whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I, II, or III is selected.

Soundscape

Affected Environment

"Soundscape" is defined as the totality of sounds – both "natural" sounds (the sounds of animals, the wind in the trees, water, etc.) as well as human-caused sounds. Though intangible, the natural soundscape is considered a natural resource of the National Park Service to be protected under the Organic Act.

Over 99% (210,722 of 211,141 acres) of the monument is either recommended or potential Wilderness, where natural quiet is considered an important resource. DINO strives to preserve this resource and the natural sounds associated with physical and biological resources of the monument.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – The Service will preserve, to the greatest extent possible, the natural soundscapes of parks. The Service will restore degraded soundscapes to the natural condition wherever possible, and will take action to prevent or minimize all noise (undesirable human-caused sound) that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values

Source – NPS Management Policies (2001); Director's Order 47: Sound Preservation and Noise Management

The following topic has been identified as having similar impacts to monument resources under all three alternatives considered. Expected impacts to soundscape are summarized in the following analysis in an effort to eliminate unnecessary duplication of analysis under each alternative:

Noise is defined as an unwanted human-caused sound. Some mechanical, cultural, and chemical management techniques, including tree and shrub removal, larger scale restoration projects, and prescribed fire activity can all involve the use of noise-generating equipment such as chainsaws, trucks/ATVs, and occasionally wood chippers and aircraft. Each of these tools, especially wood chippers and helicopters, is quite loud (in excess of 100 decibels) and operators are directed to use hearing protection equipment. Noise would be temporarily and quickly dissipated in the open environments of DINO and would have temporary site-specific negligible to minor adverse impacts for all alternatives. No adverse impacts to soundscape from biological controls or invasive plant prevention strategies are known.

Any use of gas-powered equipment for invasive tree removal in more closed canyon environments will be limited to less than four hours per day, three days/week, and scheduled (to the degree practicable) during low visitor use seasons (late summer through fall) to reduce impacts to park visitors. Further, the use of such equipment would be very infrequent in light of the number of infestation locations present in DINO that require this type of management (from single events of hours to periods of one to two weeks per year per location for one to two years). This is not frequent or repetitive enough to substantively interfere with human activities in the area or with wildlife behavior and projects would be timed to the degree possible to occur before or after expected seasons of high visitor use and periods of critical wildlife behavior (e.g. nesting), as outlined in mitigation measures relevant to all wildlife, including listed species. Nor would such infrequent noise chronically impair the solitude and tranquility (natural soundscape) associated with the monument.

DINO would disseminate information to the public and staff on various control projects as to how and why particularly loud techniques, such as ATVs and aircraft, are necessary to accomplish project goals. Some degradation caused by noise would result from operation of equipment, such as chainsaws, pump motors, and wood chippers but this would be short-term and site-specific and only occur between sunrise and sunset. No technique proposed would inhibit the maintenance of the desired condition to have, to the greatest extent possible, the natural soundscapes of parks protected.

Summary

The impacts of invasive plant management on soundscapes would therefore be temporarily adverse, site-specific, short-term, and minor.

Cumulative Effects

Noise impacts in DINO are most often caused by vehicle traffic and humans (campers, boaters, etc.). Aircraft over-flight noise is occasional and vehicle noise in accessible areas of the park (Harper's Corner Road, the Quarry, Green River and Split Mountain campgrounds, Deerlodge, Echo, Rainbow Parks, and Lodore) can be heard mostly during high visitor use season.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to soundscapes, these alternatives would have negligible to minor, site-specific, short-term impacts.

Impairment

Because there would be no major adverse impacts to soundscape whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I, II, or III is selected.

Historic Structures

Affected Environment

Friars Escalante and Dominguez were the first recorded Euro-Americans to venture into western Colorado. The Escalante-Dominguez expedition explored the land south of the monument, following the White River west into Utah in 1776. They crossed the Green River near the present site of the Quarry entrance in view of Split Mountain. Their goal of establishing a route from New Mexico to the California missions was not achieved and they left few maps and records of the trip (Prokopetz 2004).

The 19th century's westward expansion brought trappers, explorers, cattlemen, and outlaws to the area. John Wesley Powell's exploration of the Green and Colorado rivers in 1869 is probably the best-known adventure involving the monument. He boated the river canyons, explored portions of the monument, studied the land, and named many geographic features in Dinosaur and the West. In addition, the scattered remnants of homesteads, ranches, and trails provide tangible evidence of the hearty people who settled here. Places such as the Chew ranch, Morris ranch, and Outlaw Trail are all remnants from settlement history. This is the only period from which historic structures survive; descendents of some of these pioneers are still living and ranching in the area today. NPS personnel have also developed a list of over 54 historic structures, such as ranches, outbuildings, cemeteries, and period Ute structures within the monument.

River running on the Green and Yampa rivers has long been a tradition. First used by explorers and trappers, like W.H. Ashley who floated the canyons by bullboat in 1825, the rivers were later boated by Julien, Powell, Galloway, and Dellenbaugh. In the early 20th century, recreational river running began. The Hatch family started their famed river running business in the monument in 1929 (USDI 1986).

The conservation movement has been important in the history of the monument. In the early 1950s Echo Park and Split Mountain were proposed as dam sites. Opposition to the dams was led by the Sierra Club and Lower Colorado Basin interest groups. The final legislative defeat of the proposals in 1955 was an important victory for conservation interests and marked a turning point in preservation and development of Dinosaur National Monument. It also heralded changes in water resource use in the Colorado Basin (USDI 1986).

In a couple of cases within the monument the presence of non-native species today are the result of intentional introductions – especially around historic structures and homesteads. Several species were introduced for ornamental purposes, such as Russian olive at the Morris Ranch, bank stabilization (tamarisk), or livestock forage (brome). Despite being intentionally planted in what is now considered a cultural landscape, non-native species that are now identified as invasive by the states (CO and/or UT) and/or the counties (Moffat & Uintah) will be removed because of the threat they present to multiple resources.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Historic properties are identified and inventoried and their significance and integrity are evaluated under National Register criteria. The qualities that contribute to the eligibility for listing or listing of historic properties on the NRHP are protected in accordance with the Secretary of the Interior's Standards.

Source – National Historic Preservation Act; Executive Order 11593; Archeological and Historic Preservation Act; Archeological Resources Protection Act; the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation; Programmatic Memorandum of Agreement Among the NPS, Advisory Council on Historic Preservation, and the National Council of State Historic Preservation Officers (1995); NPS Organic Act; NPS Management Policies (2001).

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

Mechanical Control

Ground-disturbing activities, such as plowing/discing, digging, could damage historic structures and artifacts such as foundations or fences. These types of activities would be performed in areas suspected or known to contain resources of historic value only after consultation with the staff archeologist, and SHPO if necessary. The adverse impacts of mechanical treatments to cultural resources would therefore be negligible to minor, site-specific, and short-term.

Cultural Control

Ground disturbing restoration or revegetation activities such as cultivation, raking, digging, and vehicle (tractor, ATV) and foot traffic could potentially damage previously undiscovered structures or artifacts. Hoof action and rubbing/scratching of grazing animals can cause direct damage to structures and cause accelerated erosion around structures and foundations. Prescribed fire and associated equipment could accidentally damage or destroy the structure if the fire moves outside of prescription. Indirect impacts include the possibility of smoke damage to structures. In addition, foot and vehicle traffic caused by prescribed fire containment or suppression activities could damage artifacts by displacing surface materials that protect them. Hand line construction activities could expose buried materials that lead to erosion or theft. Use of foam fire suppressants may strip finishes or surfaces from structures (Fire-Trol Canada Company 2003). However, no catastrophic impacts to historic structures are expected since the prescribed use of fire would avoid these structures. These types of activities would be planned and performed in areas suspected or known to contain resources of historic value only after consultation with the staff archeologist, and SHPO if necessary. The impacts of cultural controls to historic structures would therefore be negligible to minor, site-specific, and short to long-term.

Chemical Control
The potential short and long-term effects of herbicides on historic structures made of various materials, such as wood and stone, are not well understood. No herbicides will be applied directly to historic structures, making effects to these sites negligible.

Use of current management practices would not alter or diminish the overall character or features of any National Register eligible or listed historic structures. This alternative is not expected to be the most effective at adequately managing range expansions of existing aggressive species nor is it expected to adequately prevent new species introductions, that could result in long-term minor impacts through destabilization and degradation of context of historic structures.

Summary of Alternative I
With the guidance of park staff and SHPO, impacts of current management practices on the historical nature of the built environment would therefore be negligible to minor, site-specific, and short to long-term.

Cumulative Effects for Alternative I
Some land uses, even prior to monument establishment, such as ranching and farming, may have disturbed or damaged some sites' structures. Road and trail maintenance and construction, though there are few in the monument, could adversely affect unknown resources and structures. Compliance with the NHPA, however, is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage and wildland fire could cause direct loss of historic structures. Restoration/rehabilitation of historic structures, such as Josie's cabin, would help to protect historic structures from deterioration. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on historic structures. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known historic structures without first consulting staff. Currently unknown or undocumented structures could be affected by treatments, but in the event such structures are discovered, treatments would stop until staff or SHPO can evaluate these resources.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to historic structures, Alternative I would have negligible to minor, site-specific, and short- to long-term impacts.

Impairment
Because there would be no major adverse impacts to historic structures whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative 1 is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical IPM techniques on historic structures are the same as described in Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
There are no known direct impacts from biological control to historic structures. Impacts of biological control agents to these structures would therefore be negligible.

Summary of Alternative II
IPM would not inhibit the maintenance of the desired condition to have historical structures protected in an undisturbed condition. In general, disturbance to structures would be negligible to minor and site-specific within a relatively small area. Control of invasive plants in these areas is expected to improve or restore the context for which these structures were listed. Removal of invasive species in general using the full rage of IPM techniques is expected to have long term minor benefits for the protection, stabilization, and context of historic sites by enhancing pre-European native plant and soil communities. As native plant communities are restored, and impacts to historic structures would be ameliorated. Mitigation measures would be implemented to minimize the potential for accidental impacts to unknown resources. The overall impacts of integrated plant management on historic structures would therefore be beneficial, minor, site-specific, and short to long-term.

Cumulative Effects of Alternative II
Some land uses, even prior to monument establishment, such as ranching and farming, may have disturbed or damaged some sites' structures. Road and trail maintenance and construction, though there are few in the monument, could adversely affect unknown resources and structures. Compliance with the NHPA, however, is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage and wildland fire could cause direct loss of historic structures. Restoration/rehabilitation of historic structures, such as Josie's cabin, would help to protect historic structures from deterioration. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on historic structures. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known historic structures without first consulting staff. Currently unknown or undocumented structures could be affected by treatments, but in the event such structures are discovered, treatments would stop until staff or SHPO can evaluate these resources. It is expected that under Alternative II managers will have more flexibility in treating the most acres and most invasive species than under Alternatives I or III and will be most effective and efficient in treating species that may threaten context and structural integrity of historic structures in the monument.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to historic structures, Alternative II would have minor beneficial, site-specific, and short- to long- term impacts.

Impairment
Because there would be no major adverse impacts to historic structures whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and prevention IPM techniques to historic resources are the same as described in Alternative II. Alternative III would eliminate the risk of damage caused by chemical application to historic structures. There is no anticipated risk of damage to historic structures by use of biocontrol agents.

However, the effectiveness of invasive species control is likely to be significantly reduced in situation where a combination of techniques that includes the use of biocontrol and/or chemical control is shown to be most effective and efficient. The likelihood of damage to historic structures caused by repeated entry of a mower or weed whip operator exceeds that of the one to few entries of a mower or weed whip operator and an ATV or backpack sprayer operator to control the target infestation(s). Also, there is a risk of further loss of soil quality and quantity that may help to protect historic structures the longer the infestation(s) exists.

Similar results could occur if biocontrol agents are prohibited from use in the monument. Proper and effective use of biocontrol calls for use in combination with other techniques on infestations that are so widespread that the use of other techniques used alone or in combination are not sufficient to arrest the spread of the infestation and/or species. The use of biocontrol can help to prevent or reduce further degradation by widespread invasive species of vegetation and soil environments that protect historic structures from the accelerated erosion that occurs with the persistence and dominance of invasive species.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management may affect the desired condition of maintaining and preserving historic structures. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
Overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to historic structures would be indirectly adverse, site-specific, long-term, and moderate.

Cumulative Effects of Alternative III

Some land uses, even prior to monument establishment, such as ranching and farming may have disturbed or damaged some sites structures. Road and trail maintenance and construction, though there are few in the monument, could adversely affect unknown resources and structures. However, compliance with the NHPA is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage and wildland fire could cause direct loss of historic structures. Restoration/rehabilitation of historic structures, such as Josie's cabin, would help to protect historic structures from deterioration. Monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on historic structures. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known historic structures without first consulting staff. Currently unknown or undocumented structures could be affected by treatments, however, in the event such structures are discovered, treatments would stop until staff or SHPO can evaluate these resources. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to historic structures, Alternative III with the use of only mechanical, cultural, and expanded prevention techniques, would have directly adverse, site-specific, long-term and moderate impacts.

Impairment

Because there would be no major adverse impacts to historic structures whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Cultural Landscapes

Affected Environment

Cultural landscapes in the monument include the Josie Morris, Ruple, and Chew Pool Creek Ranches (Propkopetz 2004). Each site is approximately 160 acres in size. These areas were nominated for the National Register in 1988 because the intact landscapes, with their original structures and farm/ranch layouts, represent some of the earliest homesteading in the Uintah Basin. The sites were officially listed in 2003 as cultural landscapes in the monument's inventory.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Cultural landscapes are identified and inventoried and their significance and integrity are evaluated under National Register criteria. The qualities that contribute to the eligibility for listing or listing of cultural landscape sites on the NRHP are protected in accordance with the Secretary of the Interior's Standards.

Source – National Historic Preservation Act; Executive Order 11593; Archeological and Historic Preservation Act; Archeological Resources Protection Act; the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation; Programmatic Memorandum of Agreement Among the NPS, Advisory Council on Historic Preservation, and the National Council of State Historic Preservation Officers (1995); NPS Organic Act; NPS Management Policies (2001).

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

<u>Mechanical, Cultural, and Chemical Control</u>

Some patterns or features of the cultural landscape may be altered, but the overall integrity of the landscape would not be diminished. Removal of invasive plants may cause a temporary change in current landscape patterns until native vegetation becomes reestablished and may cause negligible, short-term, temporary disturbance to the cultural landscape. Species that were originally planted for ornamental or agricultural purposes that are now designated by the state or federal government as invasive, such as Russian olive around the Josie Morris Ranch, will be removed only after consultation with the SHPO. Otherwise, control of invasive plants would have a long-term beneficial effect of restoring the context of the cultural landscape. The impacts of invasive plant management on cultural landscapes would therefore be adverse and beneficial, site-specific, short-and long-term and negligible to minor.

Summary of Alternative I
Use of current management practices would not alter or diminish the overall integrity of cultural landscapes and would not affect the qualities under which they were listed as eligible in the National Register. This alternative is not expected to be the most effective or efficient at adequately managing range expansions of existing aggressive species that threaten these landscapes, nor is it expected to adequately prevent new species introductions, that could result in long-term degradation of landscape character. With the guidance of park staff and SHPO, impacts of current management practices on the cultural landscapes would therefore be beneficial, minor, site-specific, and long-term.

Cumulative Effects of Alternative I
Some land uses, such as ranching and farming, may have disturbed or damaged some sites' features of cultural landscapes. Visitor use could cause more damage through accidental invasive species introductions and wildland fire could cause direct loss of cultural landscape features. Restoration of impacted landscapes would aid in preserving the context and vegetation community features of cultural landscapes. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on cultural landscapes. Under all alternatives, DINO would control plants originally planted for ornamental or agricultural purposes that are now deemed invasive only with the permission of the SHPO.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to cultural landscapes, Alternative I would have negligible to minor, site-specific, and short- to long- term impacts.

Impairment
Because there would be no major adverse impacts to cultural landscapes whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical techniques on cultural landscapes are the same as described in Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
There are no known direct impacts from biological control to cultural resources. Impacts of biological control agents to cultural landscapes would therefore be negligible.

Summary of Alternative II
IPM would not inhibit the maintenance of the desired condition to protect the qualities that contribute to the eligibility for listing or listing of cultural landscape sites on the NRHP. In general, disturbance to landscapes would be negligible and site-specific within a relatively small area. Control of invasive plants in these areas is expected to improve or restore the context for which these landscapes were listed. Removal of invasive species in general using the full rage of IPM techniques is expected to have long term minor to moderate benefits for the protection, stabilization, and context of cultural landscapes by enhancing these modified plant and soil communities. As modified/native plant communities are restored impacts of control would be ameliorated. The overall impacts of integrated plant management on cultural landscapes would therefore be beneficial, minor to moderate, site-specific, and long-term.

Cumulative Effects of Alternative II
Some land uses, such as ranching and farming, may have disturbed or damaged some sites' features of cultural landscapes. Visitor use could cause more damage through accidental invasive species introductions and wildland fire could cause direct loss of cultural landscape features. Restoration of impacted landscapes would aid in preserving the context and vegetation community features of cultural landscapes. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on cultural landscapes. Under all alternatives, DINO would control plants originally planted for ornamental or agricultural purposes that are now deemed invasive only with the permission of the SHPO. It is expected that under Alternative II managers will have more flexibility in treating the most acres and most invasive species than under Alternatives I or III and will be most effective and efficient in treating species that may threaten context and integrity of cultural landscapes in the monument.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to cultural landscapes, Alternative II would have minor to moderate, site-specific, and long-term impacts.

Impairment
Because there would be no major adverse impacts to cultural landscapes whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and prevention IPM techniques to cultural landscapes are the same as described in Alternative II. Alternative III would eliminate the risk of damage caused by chemical application to other plants of cultural landscape value. There is no anticipated risk of damage to cultural landscapes by use of biocontrol agents.

However, the effectiveness of control in landscapes where invasive species threaten cultural context is likely to be significantly reduced in situations where a combination of techniques that includes the use of biocontrol and/or chemical control is shown to be most effective and efficient. Further loss of soil quality and quantity caused by invasive species may accelerate loss of vegetation of value.

Similar results could occur if biocontrol agents are banned from use in the monument. Proper and effective use of biocontrol calls for use in combination with other techniques on infestation that are so widespread that the use of other techniques used alone or in combination are not sufficient to arrest the spread of the infestation and/or species. The use of biocontrol can help to prevent or reduce further degradation of landscapes impacted by invasive species.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management may affect the desired condition of maintaining and preserving cultural landscapes. Mitigation measures would eliminate any adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
The overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to cultural landscapes would be indirectly adverse, site-specific, long-term, and minor to moderate.

Cumulative Effects of Alternative III
Some land uses such as ranching and farming may have disturbed some features of cultural landscapes. Visitor use could cause more damage through accidental invasive species introductions and wildland fire could cause direct loss of cultural landscape features. Restoration of impacted landscapes would aid in preserving the context and vegetation community features of cultural landscapes. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on cultural landscapes. Under all alternatives, DINO would control plants originally planted for ornamental or agricultural purposes that are now deemed invasive only with the permission of the SHPO.

Impairment

Because there would be no major adverse impacts to cultural landscapes whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected

Archeological Resources

Affected Environment

Archeological inventories and investigations within the monument since the 1930s have revealed over 680 prehistoric and historic sites, even though only an estimated 10% of the monument has received intensive survey (Prokopetz 2004). The archeological sites in the monument span a time period from 9,000 years ago until Euro-American contact in the Uinta Basin. Most known archeological sites in the Monument are from the Fremont period.

The most extensive occupation of the area was by the Fremont culture. These people most likely represent a northern extension of the Pueblo-like cultures from the Southwest. The general Fremont occupation in Utah began around A.D. 950 and ended about A.D. 1300. These people eventually settled along the fertile river bottoms and used places like Jones Hole and Echo Park for growing crops. Fremont culture at the monument is best known from a series of open village sites in the Cub Creek areas. Important sites are also known in the Castle Park area, which is the easternmost documented extent of Fremont culture (Prokopetz 2004). The majority of the pictographs and petroglyphs in the monument are attributed to the Fremont people. The “Vernal” style of Fremont rock art (distinctive human, animal, and geometric forms) characterizes the panels at the monument. The rock art at McKee springs is perhaps the best executed in the Intermontane region (USDI 1986).

Following the Fremont occupation, the area experienced seasonal occupation by the Shoshone and the Utes (Husband 1984; Reed and Metcalf 1999). The historical record indicates at least three groups occupied the area when Euro-Americans arrived in the late eighteenth century. Escalante notes in his 1876 journals that Utes and Yamparicka Comanches lived in the area and that the area north of the Green River belonged to the Yamparickas. Early trapper diaries indicate that the Shoshone, particularly the Dove Eater Band, also contested for the area. The White River and Uinta Bands of the Ute also wintered in Browns Park, moving onto the eastern plains during the summer. The Utes had established themselves in the general region by AD 1700 and practiced a continual lifestyle of hunting/gathering, which had begun in the Archaic era (Miller 2002).

Various Ute bands to the south, more specifically along the northern New Mexico frontier, had contact with the Spanish explorers and settlers. When the Spanish retreated south after the Pueblo revolt of AD 1680, the Utes returned to their homeland in the north, taking a large number of the Spanish horses with them. The Utes were critical to the spread of horses throughout the Rocky Mountain region. Supplying horses to the Comanche and the Shoshone, who lived north of the Yampa River, the Ute were able to join them in driving out the Apache, who occupied the Colorado plains until about AD 1700. By AD 1750, most of the Apache had moved south (Cassells 1997). In AD 1881, the Utes that once resided in the area were removed, with the majority of the population being settled on the Uinta Ouray Reservation in northeastern Utah (Miller 2002).

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – A condition where archeological sites are protected in an undisturbed condition unless it is determined through formal processes that disturbance or natural deterioration is unavoidable.

Source – National Historic Preservation Act; Executive Order 11593; Archeological and Historic Preservation Act; Archeological Resources Protection Act; the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation; Programmatic Memorandum of Agreement Among the NPS, Advisory Council on Historic Preservation, and the National Council of State Historic Preservation Officers (1995); NPS Organic Act; NPS Management Policies (2001).

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

<u>Mechanical Control</u>

Ground-disturbing activities, such as plowing/discing, digging, could damage sensitive and fragile archeological sites, particularly unknown sites. These types of activities would be performed in areas suspected or known to contain resources of historic value only after consultation with the staff archeologist, and SHPO if necessary. The impacts of manual and mechanical treatments to archeological resources would therefore be negligible to minor, site-specific, and short-term.

<u>Cultural Control</u>

Ground disturbing restoration or revegetation activities such as cultivation, raking, digging, and vehicle (tractor, ATV) and foot traffic could potentially damage previously undiscovered artifacts. Hoof action and rubbing/scratching of grazing animals and/or the erection of fences or containment pens can potentially damage resources close to or above soil and rock surfaces and also accelerate erosion around artifacts.

Fire in artifact-rich areas that also contain fuel materials could potentially cause damage to those resources. Severe fires – those that burn in heavy fuel loads and exhibit long residence time and a substantial downward heat pulse – may damage buried organic and inorganic materials. For reference, in heavy continuous fuels, temperatures at the soil surface may be sufficient to damage stone or ceramic resources by scorching, fracturing, charring, and spalling. Organic matter may be distilled or destroyed at temperatures of 200-300° C. Temperatures of 500-600° C will begin to affect stone materials. Temperatures diminish rapidly with soil depth; when surface temperatures are 500° C, the temperatures at a depth of 5 cm would be only about 200°C. With light to moderate severity fires residence time is usually short and the downward heat pulse is low (Petersburg 2004). Ryan (2002) notes that soil heating is commonly shallow even when surface fires are intense and that fires of moderate severity may consume surface fuel layers and cause charring of the top centimeter of the mineral soil.

A study conducted in Badlands National Park in 2001-2002 found that temperatures and residence times of most prescribed burns are not sufficient enough to cause catastrophic damage (Buenger 2002) to prehistoric resources. Impacts of the fire – mostly black or light brown carbonaceous residues – do not impact the scientific value of the objects. Subsurface temperatures were also found to have negligible impacts to buried objects. Fuel loading and duff accumulations in vegetation communities at DINO are generally light; unpublished monitoring data collected in the monument indicates that soil heating in sagebrush fires seldom recorded temperatures on bare soil surfaces in excess of 50-55˚ C (Petersburg 2004). These impacts would have occurred naturally many times on the landscape over archeological resources in their original deposition and are predicted to be within the normal expected range of fire effects.

In addition, foot and vehicle traffic caused by prescribed fire containment or suppression activities could damage artifacts by displacing surface materials that protect them. Hand line construction activities could expose buried materials that lead to erosion or theft. Use of foam fire suppressants may strip finishes or surfaces from structures (Fire-Trol Canada Company 2003).

No catastrophic impacts to archeological resources are expected as these activities would be planned and performed in areas suspected or known to contain resources of archeological value only after consultation with the staff archeologist and SHPO, if necessary. The adverse impacts of cultural controls to archeological resources would therefore be negligible to minor, site-specific, and short to long-term.

<u>Chemical Control</u>
Foot and vehicle traffic (such as a tractor or ATV) during chemical application could potentially damage fragile archeological artifacts. The potential short and long-term effects of herbicides on archeological features made of various materials, such as wood, stone, and clay, are not well understood and so no herbicides will be applied directly to artifacts. These types of activities would be performed in areas suspected or known to contain resources of archeological value only after consultation with the staff archeologist, and SHPO if necessary. The adverse impacts of mechanical treatments to archeological resources would therefore be negligible to minor, site-specific, and short-term.

Summary of Alternative I
Use of current management practices under this alternative would not alter or diminish the overall integrity of the archeological sites or resources. This alternative is not expected to be the most effective at adequately managing range expansions of existing aggressive species nor is it expected to adequately prevent new species introductions, that could result in long-term minor impacts through destabilization of artifacts and degradation of context of archeological sites. With the guidance of park staff and SHPO, overall impacts of current management practices on the archeological resources would therefore be beneficial, minor, site-specific, and short-term.

Cumulative Effects of Alternative I
Past land practices (prior to monument establishment), such as ranching and farming, probably disturbed, damaged, or destroyed some archeological sites and artifacts. Road and trail maintenance and construction could adversely affect archeological resources. Compliance with

NHPA, however, is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage to archeological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could cause direct loss of archeological resources and could uncover lithic scatters and some artifacts that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on archeological resources. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known archeological resources without first consulting staff. Currently unknown or undocumented sites could be affected by treatments, but in the event such sites are discovered, treatments would stop until staff or SHPO can evaluate these resources.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to archeological resources, Alternative I would have negligible to minor, site-specific, and short-term impacts.

Impairment

Because there would be no major adverse impacts to archeological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical IPM techniques on archeological resources are the same as described in Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

<u>Biological Control</u>

There are no known direct impacts from biological control to archeological resources. Impacts of biological control agents to archeological resources would therefore be negligible.

Summary of Alternative II

IPM would not inhibit the maintenance of the desired condition to have archeological sites protected in an undisturbed condition. In general, disturbance to artifacts and sites would be negligible to minor and site-specific within a relatively small area. Control of invasive plants in these areas is expected to improve or restore the context in which these resources exist as well as arrest further or potential destabilization of soils that protect artifacts. Removal of invasive species in general using the full range of IPM techniques is expected to have long-term minor benefits for the protection, stabilization, and context of archeological sites by enhancing pre-European plant and soil communities. As native plant communities are restored, and impacts to archeological resources would be ameliorated. Mitigation measures would be implemented to minimize the potential for accidental impacts to unknown resources. The overall impacts of integrated plant management on archeological resources would therefore be beneficial, negligible to minor, site-specific, and long-term.

Cumulative Effects of Alternative II

Past land practices (prior to monument establishment), such as ranching and farming, probably disturbed, damaged, or destroyed some archeological sites and artifacts. Road and trail maintenance and construction could adversely affect archeological resources. Compliance with NHPA, however, is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage to archeological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could cause direct loss of archeological resources and could uncover lithic scatters and some artifacts that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on archeological resources. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known archeological resources without first consulting staff. Currently unknown or undocumented sites could be affected by treatments, but in the event such sites are discovered, treatments would stop until staff or SHPO can evaluate these resources. It is expected that under Alternative II managers will have the most flexibility in treating the most acres and most invasive species than under Alternatives I or III and will be the most effective and efficient in treating species that may threaten context and integrity of archeological resources in the monument.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to archeological resources, Alternative II would have beneficial, negligible to minor, site-specific and long-term impacts.

Impairment

Because there would be no major adverse impacts to archeological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument’s resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention/early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and prevention IPM techniques to archeological resources are the same as described in Alternative II. Alternative III would eliminate the risk of damage caused by chemical application to archeological resources by foot and vehicle. There is no anticipated risk of damage to archeological resources by use of biocontrol agents.

However, the effectiveness of invasive species control is likely to be significantly reduced in situation where a combination of techniques that includes the use of biocontrol and/or chemical control is shown to be most effective and efficient. The likelihood of damage to archeological resources caused by repeated entry of a mower or weed whip operator exceeds that of the one to few entries of a mower or weed whip operator and an ATV or backpack sprayer operator to control the target infestation(s). Also, there is a risk of further loss of soil quality and quantity that may help to protect artifacts the longer the infestation(s) exists.

Similar results could occur if biocontrol agents are banned from use in the monument. Proper and effective use of biocontrol calls for use in combination with other techniques on infestation that are so widespread that the use of other techniques used alone or in combination are not sufficient to arrest the spread of the infestation and/or species. The use of biocontrol can help to prevent or reduce further degradation by widespread invasive species of vegetation and soil environments that protect archeological resources from the accelerated erosion that occurs with the persistence and dominance of invasive species.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management may affect the desired condition of maintaining and preserving archeological resources in an undisturbed condition. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
The overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to archeological resources would be indirectly adverse, site-specific, long-term, and minor to moderate.

Cumulative Effects of Alternative III
Past land practices (prior to monument establishment) such as ranching and farming probably disturbed, damaged, or destroyed some archeological sites and artifacts. Road and trail maintenance and construction could adversely affect archeological resources. However, compliance with the NHPA is required for all of these projects to evaluate and mitigate potential impacts. Visitor use could cause loss or damage to archeological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could cause direct loss of archeological resources and could uncover lithic scatters and some artifacts that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on archeological resources. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known archeological resources without first consulting staff. Currently unknown or undocumented resources could be affected by treatments, however, in the event such structures are discovered, treatments would stop until staff or SHPO can evaluate these sites.

Impairment
Because there would be no major adverse impacts to archeological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Paleontological Resources

Affected Environment

Although dinosaurs are perhaps the most scientifically important resource in the park, a full range of fossils cover the entire park (Chure 2004). These resources exist as quarry face specimens (uncovered but left in situ), non-quarry fossils that are outside the main quarry area (such as the river canyons, which are primarily marine Paleozoic formations and contain marine invertebrate fossils), and the removed bones of the monument's fossil collection.

Since its discovery in 1909 by Earl Douglass, the quarry deposit has been of worldwide importance. It is the greatest quarry of Jurassic dinosaurs in the world; thousands of individual fossil bones have been found and are housed in museum collections around the world. The quarry is famed for its large number of individuals, species, complete skeletons, skulls, and several rare juvenile dinosaurs. The excellent state of preservation has resulted in specimens of great scientific value that have contributed to our understanding of dinosaur anatomy, ecology, and community structure. The quarry gives visitors a unique opportunity to view firsthand the frequent discovery and daily study of dinosaur fossils and is the principal visitor experience at Dinosaur National Monument.

Although large numbers of fossils were removed from the quarry between 1909 and 1924, nearly all bones uncovered since 1953 have been left in situ on the quarry face. The quarry has been intensively studied by many paleontologists and continues to be a source for scholarly research and publication. Because the bones are in situ, the fossil/sediment relationships remain undisturbed, offering a research opportunity and potential that cannot be matched by museum collections. Preliminary work has also shown that significant fossils exist elsewhere in the monument (USDI NPS 1986). Quaternary resources in the park have only received a cursory examination and more work is needed, though nothing of great significance has been found to date (Chure 2004).

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Paleontological resources, including both organic and inorganic mineralized remains in body or trace form, will be protected, preserved, and managed in their paleoecological context for public education, interpretation, and scientific research.

Source – NPS Management Policies (2001).

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Though limited in scope, the prevention techniques currently employed are designed to not adversely affect resources of any kind and so are not included in this analysis. Please see page 2-25 for a description of these practices.

Mechanical Control
Ground-disturbing activities, such as plowing/discing, digging, could damage sensitive and fragile paleontological sites, such as invertebrate fossils found in the unconsolidated Quarternary soils. However, this impact is likely to be negligible and no onsite monitoring is needed (Chure 2004). The impacts of manual and mechanical treatments to paleontological resources would therefore be negligible, site-specific, and short-term.

Cultural Control
Ground disturbing restoration or revegetation activities such as cultivation, raking, digging, and vehicle (tractor, ATV) and foot traffic could potentially damage previously undiscovered artifacts. Hoof action and rubbing/scratching of grazing animals and/or the erection of fences or containment pens can potentially damage resources close to or above soil and rock surfaces and also accelerate erosion around artifacts.

Fire in fossil-rich areas that also contain fuel materials could potentially cause damage to those resources. Severe fires – those that burn in heavy fuel loads and exhibit long residence time and a substantial downward heat pulse – may damage buried organic and inorganic materials. For reference, in heavy continuous fuels, temperatures at the soil surface may be sufficient to damage stone or ceramic resources by scorching, fracturing, charring, and spalling. Organic matter may be distilled or destroyed at temperatures of 200-300° C. Temperatures of 500-600° C will begin to affect stone materials. Temperatures diminish rapidly with soil depth; when surface temperatures are 500° C, the temperatures at a depth of 5 cm would be only about 200°C. With light to moderate severity fires residence time is usually short and the downward heat pulse is low (Petersburg 2004). Ryan (2002) notes that soil heating is commonly shallow even when surface fires are intense and that fires of moderate severity may consume surface fuel layers and cause charring of the top centimeter of the mineral soil.

A study conducted in Badlands National Park in 2001-2002 found that temperatures and residence times of most prescribed burns are not sufficient enough to cause catastrophic damage (Buenger 2002) to prehistoric resources. Impacts of the fire – mostly black or light brown carbonaceous residues – do not impact the scientific value of the objects. Subsurface temperatures were also found to have negligible impacts to buried objects. Fuel loading and duff accumulations in vegetation communities at DINO are generally light; unpublished monitoring data collected in the monument indicates that soil heating in sagebrush fires seldom recorded temperatures on bare soil surfaces in excess of 50-55˚ C (Petersburg 2004). These impacts would have occurred naturally many times on the landscape over paleontological resources in their original deposition and are predicted to be within the normal expected range of fire effects.

In addition, foot and vehicle traffic caused by prescribed fire containment or suppression activities could damage artifacts by displacing surface materials that protect them. Hand line construction activities could expose buried materials that lead to erosion or theft.

However, no catastrophic impacts to paleontological resources are expected since these activities would be planned and performed in areas suspected or known to contain resources of paleontological value only after consultation with the staff paleontologist. The impacts of cultural controls to paleontological resources would therefore be negligible to minor, site-specific, and short to long-term.

Chemical Control

The main risk is foot and vehicle traffic (such as a tractor or ATV) during chemical application that could damage fragile fossils. These types of activities would be performed in areas suspected or known to contain resources of paleontological value only after consultation with the staff paleontologist. The impacts of chemical treatments to paleontological resources would therefore be negligible to minor, site-specific, and short-term.

Summary of Alternative I

Use of current management practices under this alternative would not alter or diminish the overall integrity of the paleontological sites or resources. This alternative is not expected to be the most effective at adequately managing range expansions of existing aggressive species nor is it expected to adequately prevent new species introductions, that could result in long-term minor impacts through destabilization of artifacts and degradation of context of paleontological sites. With the guidance of park staff adverse impacts of current management practices on paleontological resources would therefore be negligible to minor, site-specific, and short-and long-term.

Cumulative Effects of Alternative I

Past land practices (prior to monument establishment), such as ranching and farming, probably disturbed, damaged, or destroyed some paleontological sites and artifacts. Road and trail maintenance and construction could adversely affect these resources. Consultation with staff, particularly the staff paleontologist, to evaluate and mitigate potential impacts occurs during the planning phase of these types of projects. Visitor use could cause loss or damage to paleontological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could uncover some resources that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on paleontological resources . Under all alternatives, DINO would avoid surface-disturbing activities in areas of known paleontological resources without first consulting staff. Currently unknown or undocumented sites could be affected by treatments, but in the event such sites are discovered, treatments would stop until staff or SHPO can evaluate these resources.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to paleontological resources, Alternative I would have negligible to minor, site-specific, and short- to short-term impacts.

Impairment

Because there would be no major adverse impacts to paleontological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative I is selected.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

The impacts of using mechanical, cultural, and chemical IPM techniques on paleontological resources are the same as described in Alternative I. Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A description of proposed prevention strategies can be found on page 2-13.

Biological Control
There are no known direct impacts from biological control to paleontological resources. Impacts of biological control agents to these resources would therefore be negligible.

Summary of Alternative II
IPM would not inhibit the maintenance of the desired condition to have paleontological sites remain in context. In general, disturbance to artifacts and sites would be negligible to minor and site-specific within a relatively small area. Control of invasive plants in these areas is expected to improve or restore the context in which these resources exist as well as arrest further or potential destabilization of soils or rock that protect artifacts. Removal of invasive species in general using the full rage of IPM techniques is expected to have long-term minor benefits for the protection, stabilization, and context of paleontological sites by enhancing native plant and soil communities. As native plant communities are restored, impacts to paleontological resources would be ameliorated. Mitigation measures would be implemented to minimize the potential for accidental impacts to unknown resources. The overall impacts of integrated plant management on paleontological resources would therefore be beneficial, negligible to minor, site-specific, and long-term.

Cumulative Effects for Alternative II
Past land practices (prior to monument establishment), such as ranching and farming, probably disturbed, damaged, or destroyed some paleontological sites and artifacts. Road and trail maintenance and construction could adversely affect these resources. Consultation with staff, particularly the staff paleontologist, to evaluate and mitigate potential impacts occurs during the planning phase of these types of projects. Visitor use could cause loss or damage to paleontological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could uncover some resources that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on paleontological resources. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known paleontological resources without first consulting staff. Currently unknown or undocumented sites could be affected by treatments, but in the event such sites are discovered, treatments would stop until staff or SHPO can evaluate these resources. It is expected that under Alternative II managers will have the most flexibility and will be most effective and efficient in treating species that may threaten context and integrity of paleontological resources in the monument.

Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to paleontological resources, Alternative II would have beneficial, negligible to minor, site-specific impacts on paleontological resources.

Impairment
Because there would be no major adverse impacts to paleontological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative II is selected.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention / early detection) to manage invasive plants.

The impacts of using mechanical, cultural, and prevention IPM techniques to paleontological resources are the same as described in Alternative II. Alternative III would eliminate the risk of any damage caused by chemical application to resources by foot and vehicle. There is no anticipated risk of damage to paleontological resources by use of biocontrol agents.

However, the effectiveness of invasive species control is likely to be significantly reduced in situations where a combination of techniques that includes the use of biocontrol and/or chemical control is shown to be most effective and efficient. The likelihood of damage to paleontological resources caused by repeated entry of a mower or weed whip operator exceeds that of the one to few entries of a mower or weed whip operator and an ATV or backpack sprayer operator to control the target infestation(s). Also, there is a risk of further loss of soil quality and quantity that may help to protect artifacts the longer the infestation(s) exists.

Similar results could occur if biocontrol agents are banned from use in the monument. Proper and effective use of biocontrol calls for use in combination with other techniques on infestation that are so widespread that the use of other techniques used alone or in combination are not sufficient to arrest the spread of the infestation and/or species. The use of biocontrol can help to prevent or reduce further degradation by widespread invasive species of vegetation and soil environments that protect paleontological resources from the accelerated erosion that occurs with the persistence and dominance of invasive species.

Using mechanical, cultural, and expanded prevention techniques for invasive plant management may affect the desired condition of maintaining and preserving paleontological resources in context. Mitigation measures would eliminate adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations.

Summary of Alternative III
The overall impacts of using only mechanical, cultural, and expanded prevention techniques for invasive plant management to paleontological resources would be indirectly adverse, site-specific, long-term, and minor.

Cumulative Effects for Alternative III
Past land practices (prior to monument establishment) such as ranching and farming probably disturbed, damaged, or destroyed some paleontological sites and artifacts. Road and trail maintenance and construction could also adversely affect these resources. However, consultation with staff, particularly the staff paleontologist, to evaluate and mitigate potential impacts occurs during the planning phase of these types of projects. Visitor use could cause loss or damage to paleontological resources, particularly from the collection of artifacts from the backcountry. Wildland fire could uncover some artifacts that would otherwise be unknown. The monument staff anticipates developing a livestock management plan and a Wilderness stewardship plan over the next several years, both of which would be consistent with this final plan.

Implementation or continuation of invasive plant management activities under any of the alternatives would have negligible additive effects on paleontological resources. Under all alternatives, DINO would avoid surface-disturbing activities in areas of known paleontological resources without first consulting staff. Currently unknown or undocumented sites could be affected by treatments, however, in the event such sites are discovered, treatments would stop until staff could evaluate these sites. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to paleontological resources, Alternative III with the use of only mechanical, cultural, and expanded prevention techniques, would have directly adverse, site-specific, long-term and moderate impacts.

Impairment
Because there would be no major adverse impacts to paleontological resources whose conservation is 1) necessary to fulfill specific purposes identified in the enabling legislation of Dinosaur National Monument; 2) key to the natural or cultural integrity of the monument; 3) identified as a goal in the General Management Plan (1986) or relevant NPS planning documents, there would be no impairment of the monument's resources or values if Alternative III is selected.

Land Use and Park Operations

Affected Environment

Land Use

Land uses within the monument include recreation, grazing, natural and cultural resources preservation, and management and infrastructure. Infrastructure includes the Dinosaur Quarry and museum (Jensen, UT), monument visitor center and headquarters (Dinosaur, CO), housing areas, utilities, roads, trails, and developed campgrounds. The lands surrounding the monument support similar and additional different uses. Typical of the surrounding landscape, land uses surrounding the monument in Uintah and Moffat counties reply heavily on public resources. In both counties, oil and gas exploration and agriculture plays important roles in the economy and are reflected in management and planning (Miller 2002). This analysis primarily addresses grazing as the main agricultural land use in the monument that may be impacted by implementation of a monument-wide invasive species management plan.

Park Operations

There are five management divisions at DINO: Administration, Research and Resource Management, Facilities Management, Interpretation and Visitor Services, and Visitor and Resource Protection. It is expected that implementation of a comprehensive monument-wide invasive species management plan will have direct effects on Facilities Management and Research and Resource Management operations.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – Environmental leadership will be demonstrated in all aspects of NPS, including park operations, facilities design, construction, and management. Agricultural uses and activities are authorized in parks in accordance with the direction provided by park's enabling legislation and general management plan and are allowed if they are retained as a right subsequent to NPS land acquisition and/or contribute to the maintenance of a cultural landscape. Where domestic or feral livestock use occurs, NPS will foster "Best Management Practices" that protect vegetation and wildlife habitat, safeguard sensitive species, control proliferation of invasive species, conserve soil, protect riparian area and ground water, avoid toxic contamination, and preserve cultural sites.

Source – NPS Management Policies (2001); Executive Order 13148 Greening the Government through Leadership in Environmental Management; Director's Order 77-3 Domestic and Feral Livestock; Director's Order 53 Species Park Uses

Impacts of Alternative I: Continuation of Current Management Practices – use of mechanical, cultural, chemical controls and limited prevention techniques to manage invasive plants.

Implementation of Alternative I will result in invasive species control at some level, but because this alternative does not expand current efforts for early detection and prevention/best management practices or other more aggressive approaches, costs for control of weeds is expected to rise for both individual livestock and monument operations. It is expected that the condition of leased grazing allotments and areas along maintained roads and trails within the monument boundaries will likely deteriorate over time as weed infestations expand.

Existing relations would continue with park neighbors, as well as state and local officials, who have expressed concern about invasive species spreading from each park onto neighboring lands. Some lessees may become frustrated by the lack of proactive action and may express adverse opinions about some monument's current management programs. Other landowners may continue to build relationships with the monument as part of ongoing outreach programs.

Current management practices plan could slightly affect park operations. Funding for its implementation would come from a continuation of existing funding used for invasive species control and outreach. The monument would not be able to take full advantage of certain NPS NCPN resources, particularly the Colorado Plateau EPMT, without acceptable weed plans and compliance. There would likely be a negligible increase in administrative support for personnel and procurement as well as increased storage space needs and fuel use.

Summary of Alternative I
The impacts of current management practices on park operations and land use would therefore be directly adverse, monument-wide, long-term and negligible to moderate.

Cumulative Effects for Alternative I
Current management practices do not have significant impacts to divisional work plans, training, or budgets (outside the weed management programs within the Resource Management division). It is not expected to be adequately effective in managing range expansion of existing invasive species populations or at adequately preventing new species introductions, causing long-term monument-wide impacts of minor to moderate adverse consequences for monument operations and lessees as labor and control costs increase.

When combined with other past, present, and foreseeable future actions that would result in impacts to land use and park operations, Alternative I would have directly adverse, monument-wide, long-term and negligible to moderate impacts.

Impacts of Alternative II: Preferred Alternative – Full use of IPM techniques (mechanical, cultural, chemical, biological control, early detection, and expanded prevention) to manage invasive plants.

It is expected that implementation of Alternative II will result in the most effective, safe, and efficient management of invasive species in the monument. The availability and access to all management tools will allow more flexibility and creativity in achieving goals to benefit overall land uses and park operations. Selection of the preferred alternative will formalize adoption of the Land Use and Park Operations Best Management Practices presented in Appendix D. For example, adopting the proposed weed-free forage policy proposed in the BMPs and continuing to purchase only weed-free road/trail base will benefit livestock operators and park operations by preventing spread and introductions of species that would cost money over the long-term to control. A proactive IPM approach would improve relations with park neighbors as well as state and local officials who have expressed concern about invasive plants spreading from the monument onto neighboring lands. The impacts of integrated plant management on park operations and land use would therefore be beneficial, monument-wide, long-term, and moderate.

However, there will also be both short-term and sustained costs in implementing this alternative. Requiring weed-free forage and road/trail base will likely cost the park and livestock operators more since they will not be able to necessarily accept the lowest price or bid for these products. Also a revision of the monument's roadside management procedures will include adopting the proposed best management practices for roadside management (Appendix D), which could involve short and long-term costs to park operations.

If this alternative is selected, additional capital improvement and natural resource funding from new and existing sources will be sought to implement necessary improvements in facilities or park operations to help alleviate any additional cost burden on the monument caused by proposed invasive plant management requirements. Some of these costs include the negligible increase in administrative support for personnel and procurement as well as a minor increase in storage space needs, office space and equipment needs, vehicle support, and fuel. They also include the development and implementation of a roadside restoration and revegetation plan as well expansion and improvements to the existing native plant nursery in order to supply native plant materials for vegetation management and restoration projects. Finally, the construction of an EPA-approved (pesticide and hazardous materials) disposal facility is proposed under this alternative, as one does not exist in the three surrounding counties of Moffat, Rio Blanco, and Uintah for proper material and container disposal.

Summary of Alternative II
Overall, impacts of this alternative would be beneficial, monument-wide, long-term and moderate.

Cumulative Effects for Alternative II
Current management practices do not have significant impacts to divisional work plans, training, or budgets (outside the weed management programs within the Resource Management division). It is not expected to be adequately effective in managing range expansion of existing invasive species populations or at adequately preventing new species introductions, causing long-term monument-wide impacts of minor to moderate adverse consequences for monument operations and lessees as labor and control costs increase.

Under the preferred alternative, lessees and staff from other divisions and natural resource focus areas will have to increase awareness and possibly make changes in current operating procedures to accommodate proactive and preventative operating procedures. Funding invasive plant management activities would come from new sources or from a continuation of existing funding used for management. There would likely be a negligible to minor increase in administrative support for personnel and procurement as well as increased storage space needs and fuel use. In the long-term, land use and monument operations would benefit overall as a more proactive and comprehensive management strategy reduces introductions and spread, thereby improving assets such as range, roadside, and fuel conditions. A net, long-term cost reduction is anticipated if the preferred alternative is selected. If proposed roadside management projects and practices are implemented, costs of annual mowing and herbicide application could be reduced. If proposed prescribed grazing BMPs are adopted, range condition will be preserved or enhanced.

When combined with other past, present, and foreseeable future actions that would result in impacts to land use and park operations, the additive impacts of integrated plant management on park operations and land use would therefore be beneficial, long-term, monument-wide and moderate.

Impacts of Alternative III: Limited use of IPM techniques (mechanical, cultural, and expanded prevention / early detection) to manage invasive plants.

The elimination of chemical control will eliminate direct costs associated with herbicide purchase and applicator labor. The elimination of chemical control techniques will also eliminate any risks associated with applicator safety. However, it is also expected that the elimination of chemical and biological control will dramatically increase time and labor costs for both livestock operators and park staff over the long term without ensuring a high rate of success in the long-term management of invasive species. There are some target species that cannot be effectively controlled with only mechanical and cultural techniques that would persist and likely expand, compromising the quality and quantity of forage for agricultural producers and presenting significant management challenges for NPS resource and facilities management staff. Existing relations would continue with park neighbors, as well as state and local officials, who have expressed concern about invasive plants spreading from each park onto neighboring lands, however those relations would quickly sour as lessees, neighboring landowners, and regional interests become frustrated by the ineffectiveness of the invasive plant management program.

Summary of Alternative III

The impacts of invasive plant management on park operations and land use under this alternative would therefore be directly adverse, monument-wide, long-term, and moderate.

Cumulative Effects of Alternative III

Current management practices do not have significant impacts to divisional work plans, training, or budgets (outside the weed management programs within the Resource Management division), however they are not expected to be adequately effective in managing range expansion of existing invasive species populations or at adequately preventing new species introductions, causing long-term monument-wide impacts of minor to moderate adverse consequences for monument operations and lessees as labor and control costs increase.

Over time, implementation of Alternative III would have only negligible benefits in localized areas of the monument, even with the implementation of expanded prevention and early detection techniques because of the type, amount, and location of existing weed infestations. Direct and indirect adverse impacts, however, are expected to be long-term, monument-wide, and moderate in consequence, as reliance on only two control techniques (which may or may not be effective) will increase the time, money, and labor costs to the monument and livestock operators over time and will far exceed those expected under implementation of Alternative I or II in order to maintain invasive populations below an ecologically and economically viable threshold. This alternative is expected to provide the least long-term control of invasive species.

When combined with other past, present, and foreseeable future actions that would result in impacts to land use and park operations, Alternative III with the use of only mechanical, cultural, and expanded prevention techniques, would have directly adverse, monument-wide, long-term and moderate impacts.

Socioeconomics

Affected Environment

NEPA requires an analysis of impacts to the “human environment” which includes economic, social and demographic elements in the affected area. Dinosaur National Monument lies in Moffat County, CO and Uintah County, UT. Most of the population growth in these two counties between 1977 and 1982 came as a result of energy development in the region.

Moffat County, CO is 4,742 square miles in land area and has a population density of 2.8 persons per square mile. The 2000 census data reports that of the 13,184 residents, the majority of the county’s population is white (88%), followed by Hispanic (of any origin) (9%). The top three industries in the county (by percent of residents employed) are agriculture/mining, education/ health/social services, and construction. The median household income is $41,528.

Uintah County, UT is 4,477 square miles in land area has a population density of 5.6 persons per square mile. The 2000 census data reports that of the 25,224 residents, the majority of the county’s population is white (88%) followed by American Indian (9%) and Hispanic (of any origin)(3%). The top three industries in the county (by percent of residents employed) are mining, retail trade, and educational services. The median household income (as reported in 1999) is $34,518.

Regulations and Policies

Current laws and policies require that the following conditions be achieved in the park:

Desired Conditions – A condition where an understanding of park visitors, the nonvisiting public, gateway communities and regions, and human interactions with park resources is provided.

Source – NPS Management Policies (2001); Director’s Order 78 – Social Science

Because of the different nature of this impact topic compared to previous impact topics, the following analysis is a discussion of expected benefits and impacts to socioeconomics under each alternative.

The control at any level of invasive plants under any of the alternatives considered will decrease the opportunity for their spread onto private or federal lands adjacent to the monument and reduce the individual landowner's control costs (thereby indirectly benefiting monument neighbors and the greater region), though the degree to which this may happen depends upon the constraints of the alternative chosen. Implementation of the preferred alternative (Alternative II) may have moderate beneficial impacts to the region since it will treat the most acres and result in the most safe, effective, and efficient management of invasive species both in and outside the monument. The availability and access to all management techniques allows the most flexibility and creativity in solving invasive species issues that affect the larger region. Both Alternatives I & III limit the use of techniques that are expected to be important in preventing and managing the spread of invasive species over a large area and could result in minor to moderate adverse effects to the greater region since implementation will likely result in additional financial burdens on local landowners.

Proposed measures which involve the use of prescribed grazing specifically as a weed management tool may have negligible to minor beneficial economic implications only to those operators and permittees willing to pursue such projects and do not affect general grazing management operations of current permittees.

Other impacts such as volunteer participation, local employment and/or cooperative efforts with Moffat and Uintah Counties for weed management activities, infusion of budgeted dollars for weed management equipment into local economies, etc. are expected to be mostly beneficial, though variable over time and not easily measurable in quantifiable terms. Among the three alternatives these impacts are expected to be similar and of no measurable consequence to the human environment.

The only socioeconomic impacts that could reasonably be measured as adverse in the implementation of a weed plan would occur if a “no invasive plant management or control” (or “do nothing”) alternative was considered and chosen. Under this alternative, invasive species would degrade and most certainly impair surrounding and adjacent land use and values. However, this alternative is not a viable option because it is in direct violation of the park’s enabling legislation requirements to protect natural resources, the NPS Organic Act, NPS policies, or federal, state, and county noxious weed acts and provisions.

Summary

Invasive plant management would not inhibit the maintenance of the desired condition to provide an understanding to park visitors, the non-visiting public, gateway communities and regions, of human interactions with park resources. The overall impacts of Alternatives I and III on social and economic conditions would therefore be adverse, region-wide, ongoing and long-term, and minor to moderate. Impacts under Alternative II are expected to be beneficial, region-wide, long-term, and minor to moderate.

Cumulative Effects

Under all alternatives, implementation or continuation of invasive plant management activities under any of the alternatives would have minor to moderate beneficial additive effects to invasive management efforts by neighbors throughout northwestern CO and northeastern UT. It is expected that under Alternative II managers will have the most flexibility in treating the most acres and most invasive species than under Alternatives I or III and will be most effective and efficient in treating species that move across state and county lines.

Chapter 4: Consultation, Coordination, and References

The Division of Resource Management developed this plan and EA with input from the Intermountain Region Support Office.

Principal Preparers
1. Emily Spencer, Dinosaur National Monument
2. Christo Morris, Utah State University

List of Agencies and Organizations

The following agencies, universities, and organizations were contacted for information or assisted in identifying important issues, developing alternatives, or analyzing impacts; or that reviewed and commented upon the management plan and EA.

1. Uintah County, UT
2. Moffat County, CO
3. Environmental Quality Division, National Park Service, Intermountain Region
4. U.S. Fish and Wildlife Service
5. Center for Invasive Plant Management
6. Utah Section of the Society for Range Management

List of Persons Consulted

The following people were involved in the development of this plan and EA. They provided assistance in identifying issues, developing alternatives, or analyzing impacts related to this plan. They did not necessarily review the entire plan and EA and the contents of the preferred alternative do not necessarily reflect the views of each individual consulted.

Tamara Naumann, NPS
Wayne Prokopetz, NPS
Mary Risser, NPS
Steve Petersburg, NPS (retired)
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Dan Chure, NPS
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Laurie Domler, NPS
Chris Turk, NPS

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Appendix A: Public Scoping / NEPA Documentation

This appendices includes the following components in order:

1. Memorandum from DINO Superintendent initiating Invasive Plant Management Planning process
2. Environmental Screening Form
3. Initial scoping letter and project briefing statement
4. Initial scoping response letters/comments

United States Department of the Interior

NATIONAL PARK SERVICE
Dinosaur National Monument
4545 Highway 40
Dinosaur, CO 81610

January 23, 2004

Dear Interested Party:

The National Park Service is in the initial stages of developing an Invasive Plant Management Plan for Dinosaur National Monument. Prior to preparing an environmental assessment, the National Park Service (NPS) is seeking public comment to help identify issues associated with the proposed plan. It is the intention of the National Park Service to develop this plan by fall 2004.

Non-native, invasive plants are invading our national parks, causing tremendous damage to our resources, thereby threatening the structure, organization, function, and overall integrity of the natural ecosystems the NPS aspires to protect. The NPS spends millions of dollars each year combating invasive plants in an effort to preserve park resources, and still the problem is not solved. Outside park boundaries, federal, state, and local agencies fight the same battles. Farmers and ranchers lose millions more trying to control nonnative plants that drastically reduce land use and productivity. Recent inventory work has identified over 1000 acres (approximately 5%) of Dinosaur National Monument's 211,000 acres as infested by one or more of 20 invasive weeds. The proposed plan will assist the park in managing this threat to ecosystem health and function and will provide a framework for cooperation with neighbors, partners and stakeholders with common concerns.

We welcome your comments and concerns regarding the management of invasive species as we begin to develop this plan. Enclosed is a briefing statement that further details the direction and scope this effort will include. **Comments on this initial stage of plan development must be received in writing by close of business on February 20, 2004** and should be sent to Superintendent, Dinosaur National Monument, 4545 E. Highway 40, Dinosaur, Colorado 81610; by fax to 970-374-3003; or by email DINO_Superintendent@nps.gov.

For questions or comments regarding the scoping process or proposed plan, please contact Emily Spencer, Weed Management Planning Specialist, at 970-374-2501 ext. 3.

Sincerely,

/S/

Chas Cartwright
Superintendent
enclosure

BRIEFING STATEMENT

Prepared by
Emily Spencer, Weed Management Planning Specialist
NPS—Dinosaur National Monument
January 5, 2004

Subject: Notice of Intent to Prepare an Invasive Plant Management Plan and Environmental Assessment—Invitation to Participate

What is the Invasive Plant Management Plan?
Based upon recent invasive plant inventories, "the plan" will outline a long-term, fully integrated weed management program, including components of education, partnership, prevention, early detection, inventory intervals, data management, monitoring, invasive species ranking based on risk assessment, and recommendations for least damaging treatment and restoration alternatives.

Why is the plan needed?
The National Park Service (NPS) spends millions of dollars each year combating invasive plants in an effort to preserve park resources, and still the problem is not solved. Outside park boundaries, federal, state, and local agencies fight the same battles. Farmers and ranchers lose millions more trying to control nonnative plants that drastically reduce land use and productivity. The following is a brief perspective on the spread and cost of invasive plants:

- Invasive weeds occur on more than 17 million acres of federal lands in the Western U.S (USDA Forest Service 1998) and estimates indicate that nonnative plants infest 4,600 *new* acres of federal land *each day*, spreading into areas larger than the state of Delaware (1.2 million acres!) *each year*.
- Steve Dewey (2003) estimates that noxious weeds invade nearly as many new acres of federal land each year as are burned by wildfires.
- Invasive nonnative plants infest an estimated 7 million acres of NPS lands.

The economic consequence of invasive species is $1.4 trillion annually worldwide, $137 billion annually in the U.S. alone (David Gann, TNC, 2003, Tamarisk Symposium).

In addition, a federal management plan (meeting the Invasive Species Challenge) was issued by the National Invasive Species Council on January 18, 2001. National Park Service Director's Order 12 (DO-12) requires a NEPA-compliant program for invasive weed management. The objective of the plan is to provide coordinated, sound integrated invasive plant management guidance to Dinosaur National Monument within the framework and requirements of DO-12 and the NEPA process.

Recent inventory work has identified over 1000 acres of Dinosaur's 211,000 acres as infested by one or more of 20 invasive weeds. The proposed plan will assist the park in managing this threat to ecosystem health and function and will provide a framework for cooperation with neighbors, partners and stakeholders with common concerns.

Goals of the Plan

The goals of the Invasive Plant Management Plan are to:

- *Preserve, protect, and restore natural conditions and ecological processes of Dinosaur National Monument by eradicating, significantly reducing, or containing infestations of 20 known invasive plants,*

- Prevent further introductions of invasive species already present in the monument as well as new species introductions by increasing visitor and staff awareness through education and implementation of best management practices,

- Establish protocols, decision-making tools, schedules, and treatment methods for routine weed management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs)

Proposed Actions

1. **Inventory and Monitor invasive plants in Dinosaur National Monument**
Describes past, recent, and future inventory and monitoring efforts; tools, techniques, and methodology used for inventory & monitoring (I&M); who performs I&M; how often I&M will occur

2. **Prioritize both invasive plant species and locations to be controlled**
Describes reasoning behind deciding how, when, and where to control which species and the tools and criteria used in making those decisions

3. **Identify control techniques most appropriate for each species**
Will expand on decision protocol used when determining appropriate treatment:

A. The control technique must be effective at controlling invasive plants or managing infestations at an acceptable threshold level.
B. The control technique poses little or no risk to native vegetation, wetlands, wildlife, or other natural resources.
C. The control technique poses little or no risk to cultural resources
D. The control technique poses little or no risk to the human environment or to the safety of park visitors or park employees
E. The control technique must be cost-effective to implement

4. **Apply the most appropriate control technique for each species**
Monument will evaluate and recommend specific actions for control / management depending on size, location, and management goal (eradication, suppression, or containment) of infestation.

5. **Track control efforts**
Monument will employ a park-specific version of an NPS-wide database to track all control efforts. Minimum data collection protocols will be established. When possible and as time allows, "legacy" data will be entered to reconstruct control history in monument.

6. Monitor effectiveness of control efforts

Monitoring is an essential strategy in evaluating control techniques. Plan will outline, with assistance from regional Inventory &Monitoring networks, the level of monitoring the monument will perform each year.

7. Restore affected areas

Post-control restoration may be required to prevent reinfestation, depending on characteristics of infestation treated. Park staff will evaluate sites that will need active restoration and will identify a strategy for doing so. Restoration activities will be included in annual work plan.

8. Prevent new infestations by monitoring invasive plant pathways and employing Best Management Practices

Monitor "hot spots" of high use areas and adopt best management practices (BMPs) for specific disturbance activities (fire operations, road/trail repair and maintenance, etc.) to reduce chances of weed introduction and spread

9. Educate visitors and Dinosaur National Monument staff about invasive plants in Dinosaur National Monument and control methods

Park will develop methods of communicating issues about invasive plants to visitors and staff. Plan will identify who will initiate/assist with these actions. Efforts may already include or can include:

i. *Weed warrior program*
ii. *Visitor Centers*
iii. *Interpretive programs*
iv. *Park newsletter*
v. *Press releases*
vi. *Internet websites*
vii. *Staff meetings*
viii. *Staff project days*

10. Work with adjacent landowners, local, state and federal agencies, local interest groups, weed cooperative networks, and others to develop and achieve common goals of invasive plant management.

The spread of invasive plants throughout Colorado/Utah, the American west, and the nation poses a serious environmental and economic threat to public land, ranchland, farmland and private property. Dinosaur National Monument intends to join with other federal, state and local government agencies, private landowners, and non-profit interests to develop joint strategies for curbing this silent threat. Some examples of existing and potential partnerships include:

- Colorado Weed Management Association
- Utah Weed Control Association
- Local Cooperative Weed Management Areas (Uintah, Axial Basin, etc.)
- Dinosaurland RC&D
- Moffat County
- Uintah County

- Uintah County weed board
- Chew Family Ranch and other private interests
- Affiliated American Indian Tribal governments
- Bureau of Reclamation
- Bureau of Land Management
- United States Fish and Wildlife Service
- United States Forest Service
- Northwest Colorado Stewardship Partnership
- Tamarisk Coalition
- Outward Bound West
- National Outdoor Leadership School
- Sierra Club
- Friends of the Yampa

Suggested Alternatives

Alternative I*: Continuation of Current Management Practice – use of mechanical, cultural, and chemical control techniques on invasive plants.*

Dinosaur National Monument currently uses these techniques to control invasive plant infestations within the monument. Because these activities and projects have been relatively small in scale, they fall under a categorical exclusion (CE) under NEPA. In NPS, "CEs are applicable to actions that, under normal circumstances, are not considered major federal actions and that have no measurable impacts on the human environment." (NPS DO-12) The categorical exclusions used to perform these activities read as follows:

"Routine maintenance and repairs to non-historic structures, facilities, utilities, grounds and trails." (NPS Director's Order #12, §3.4.C(3)); and,

"*Restoration of noncontroversial native species into suitable habitats within their historic range*" (NPS Director's Order #12, §3.4.E(2)).

"Removal of individual members of a non-threatened/endangered species or populations of pests and exotic plants that pose an imminent danger to visitors or an immediate threat to park resources." (NPS Director's Order #12, §3.4.E(3)).

If this alternative is selected, Dinosaur National Monument would continue to conduct invasive plant control work within the park as it has using mechanical, cultural, and chemical control techniques. To see the complete text of Director's Order 12 and its reference to invasive species management, please see http://www.nps.gov/policy/DOrders/RM12.pdf, section 3.

Alternative II*: Preferred Alternative – use of mechanical, cultural, chemical, biological control, and prevention techniques to manage invasive plants.*

We envision that the preferred alternative would consider the use of the full range of IPM techniques available both now and in the future for proactive, responsible integrated weed management. This more comprehensive plan would include actions for increased education and monitoring activities to address prevention of the introduction and spread of invasive species in the monument. Using the full range of IPM techniques would prevent unacceptable levels of invasive plants using the most economical means while posing the least hazard to people, property, and the environment.

Alternative III: *Use of mechanical, cultural, and prevention techniques to manage invasive plants.*

This alternative proposes the consideration of a more limited range of tools, eliminating potentially controversial techniques such as pesticides and biological control.

Alternatives Excluded From Further Consideration

Alternative IV: *No invasive plant management or control.*

This alternative was excluded from further consideration because it does not meet the requirements of the park's enabling legislation to protect natural resources, the NPS Organic Act, NPS policies, or federal, state, and county noxious weed acts and provisions.

Anticipated timelines
Public scoping will begin in January 2004. A Draft Integrated Weed Management Plan and Environmental Assessment will be ready for public review by mid-summer. We would like to finalize and adopt a plan in the fall of 2004.

Public Participation
We invite your participation and appreciate your interest in the development of this much-needed plan. An outline of suggested alternatives has been prepared. These will evolve and change as we progress with the planning process and receive input from stakeholders and other interested parties.

Contact information
Comments and questions regarding Dinosaur National Monument's Invasive Plant Management Plan and EA are welcome. Please contact:

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Appendix B: Users Guide to Integrated Pest Management Decision Matrix

Some sections adapted from Morse et al. (2004) and City of Boulder (2003).

IDENTIFY INVASIVE PLANT SPECIES

Invasive Species Identification Screening Questions

The following three screening questions are used to separate those species that are relatively innocuous from those that are invasive or have a high potential to become invasive and should be considered before investing substantial effort in assessing a species:

1. Is this species currently established outside cultivation as a non-native *(i.e.,* as a direct or indirect result of human activity) somewhere within the region of interest?
   - **Yes.** Proceed to screening question 2 below.
   - **No.** STOP. The Invasive Species Priority Assessment is not applicable to this species.

   Note: If this question is not readily answered, assessment of the species may either be deferred, or provisionally begun while further information on the species' status in the region is sought.

2. Is this species known or suspected to be present in conservation areas or other native species habitats somewhere within the region of interest?
   - **Yes.** Proceed to screening question 3 below.
   - **No.** STOP. This species is an insignificant threat to natural biodiversity in the region of interest.

3. Is this species known to meet criteria for invasive as defined by NPS as "an aggressive exotic plant that is known to displace native plant species in otherwise intact native vegetation communities"?
   - **Yes.** Proceed to the priority assessment and begin implementation of prevention and early detection Best Management Practices (such as those in Appendix D) for all species identified as invasive.
   - **No.** STOP. This species is not considered invasive as defined by NPS or needs more supporting data of its invasive nature.

PRIORITY ASSESSMENT

Taking Management Action – Priority or Not?

Because it is infeasible to control every invasive plant that occurs in a park or monument, it makes sense to focus management efforts on those species that have or *could* have the greatest impact to monument resources and to the highest value at-risk habitats.

Invasive plants are run through a ranking process that helps managers sort and prioritize invasive species and affected habitats based on several aspects of the species' relative invasiveness, relative importance, or quality of affected habitat:

1. Ecological Impact (risk to regional biodiversity, adverse impacts to soil resources, capacity to alter forage availability, etc.)
2. Current Distribution and Abundance
3. Trend in Distribution and Abundance
4. Control Feasibility / Management Difficulty

Based on consideration of all these factors, a person with good taxonomic skills and knowledge of local or regional ecology can use a ranking process to set priorities for resource allocation.

Initiating on-the-ground management action will then be determined by evaluating inventory data in combination with local priorities that can be site (location) and/or species driven. If the site and/or species of focus is identified as a priority for the monument, management action is deemed necessary. The decision process that follows will consider the potential actions to be taken to address a particular species on a particular site for a particular time period. The proposed project and site will be reviewed by the monument's NEPA interdisciplinary team staff annually to determine if the project 1) falls under the parameters of the monument-wide IPM plan and EA and 2) if sensitive natural or cultural resources or the human environment could be adversely impacted as a result of management (or continuing management).

MANAGEMENT GOAL

Determining Management Goals
Once a particular species and/or site is chosen and management action is deemed necessary, a desired outcome, or management goal, must be established. Goals for treatment of a species on a particular site will be determined by circumstances and practical realities reflected in the IPM Decision Matrix, illustrated in Figure 2 in the main document. Alternatives include:

1. **Eradication**: reducing the reproductive success of a noxious weed species or specified noxious weed population in largely uninfested regions to zero and eliminating the species or population within a specified period of time. Once all specified weed populations are eliminated or prevented from reproducing, intensive efforts continue until the existing seed bank is exhausted; may be legally mandated or desirable for a new invader or new site.
2. **Containment:** maintaining an intensively managed buffer zone that separates infested regions, where suppression activities prevail, from largely uninfested regions where eradication activities prevail.
3. **Suppression:** reducing the vigor of noxious weed populations within an infested region, decreasing the propensity of noxious weed species to spread to surrounding lands, and mitigating the negative effects of noxious weed populations on infested lands. This strategy inflicts some damage on the pest with the goal of lessening the rate of spread, but

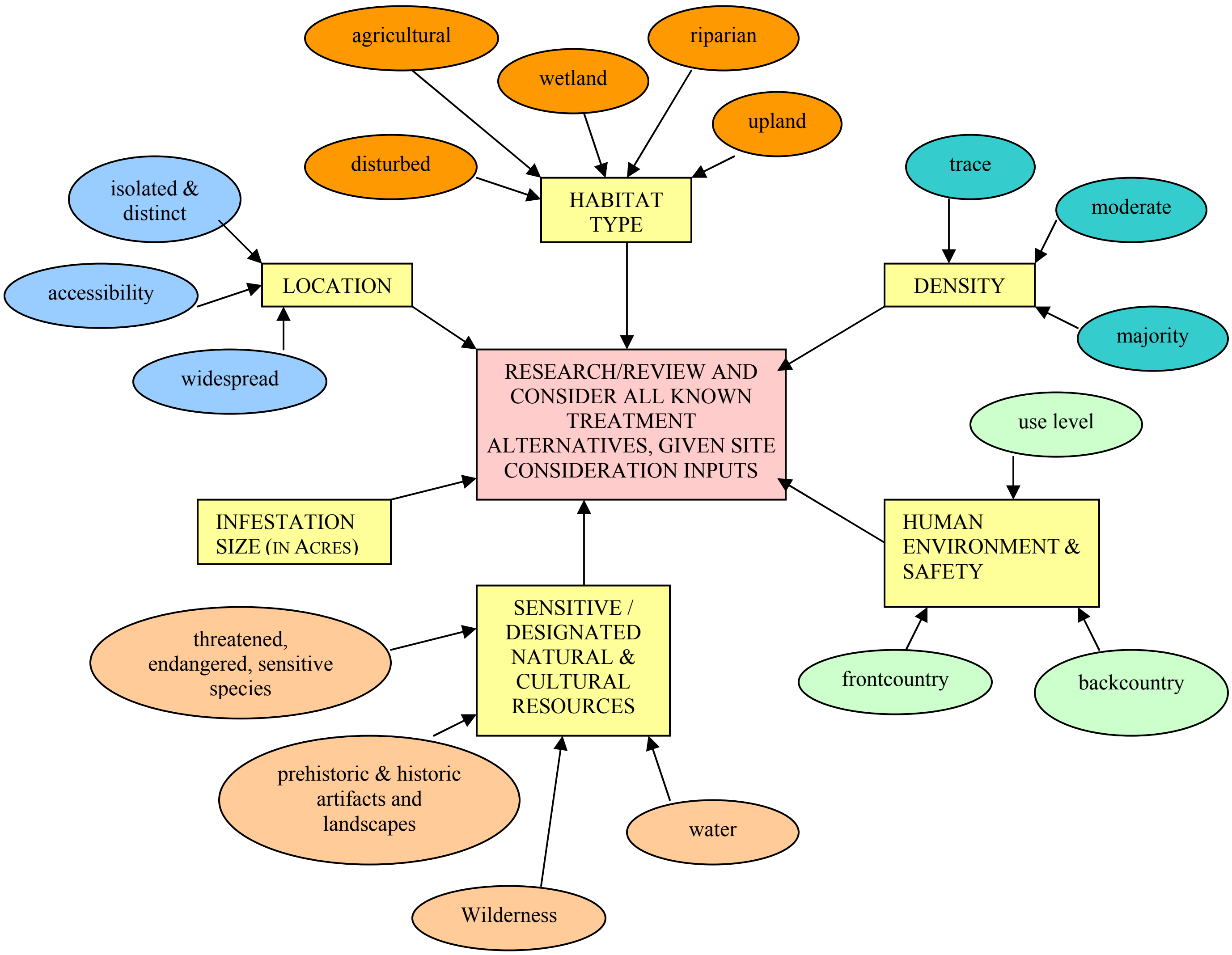
does not usually mean reducing the current infestation. As better techniques are made available or environmental circumstances render a species more susceptible to containment or eradication strategies, areas identified for suppression may be upgraded to containment or eradication status.

In order to appropriately establish a management goal, invasive species problems should always be run through the decision process beginning with the highest goal of eradication. Whether or not the decision-maker(s) reverts to containment or suppression goals depends on local information known about the species itself and the site it occupies. For example, one may assume that a widespread species (such as tamarisk) would automatically be given a management goal of suppression. From a monument-wide perspective, this may be the appropriate management goal. However, if the problem site in the monument is a high-value habitat and tamarisk is present only in small and isolated infestations, then a more appropriate goal may be containment or even eradication *at the particular site,* depending on other site considerations.

RESEARCH/REVIEW AND CONSIDER ALL KNOWN TREATMENT ALTERNATIVES, GIVEN SITE CONSIDERATION INPUTS

On-the-ground Management: Review of Available Techniques

Tool and treatment technique(s) selection will depend on many different variables, called site considerations. These considerations include biotic and abiotic resources and factors that, if not considered properly, are likely to adversely affect the success of the treatment and restoration strategy. In the interest of space, this step is not fully diagramed in the matrix but is detailed below. Please note that the site considerations below represent only a sample of all possible variables.



SELECT TREATMENT TECHNIQUES & IDENTIFY CONSERVATION MEASURES REQUIRED TO ELIMINATE OR MITIGATE ADVERSE IMPACTS

Treatment Selection and On-the-ground Implementation

Once appropriate treatment techniques and tools are identified, resulting impacts caused by their use also need to be identified. All tools and techniques will have some type of consequence, whether intentional or unintended, benefical or adverse, direct or indirect. At this point in the decision-making process, steps need to be identified to reduce or eliminate any potential adverse impact to the site considerations identified above. These steps can be conservation measures that are practices incorporated into the planning phase of the treatment to *prevent* potential adverse impacts (e.g.weed control treatments will occur pre-emergence or post-seed set for the threatened orchid, *Spiranthes diluvialis*) or they can be mitigation measures that fix or correct an impact after action has occurred (e.g. native trees will be planted after tamarisk is removed in riparian areas).

REVIEW ECONOMIC VIABILITY & FEASIBILITY OF SELECTED TECHNIQUES

FEASIBLE/ AFFORDABLE

If the selected treatment techniques and conservation / mitigation measures are affordable, effective, and practical then the treatment plan is approved for implementation.

IMPLEMENT & MONITOR

At a minimum, implementation of any treatment plan will include informal documentation (monitoring) of its effectiveness. More formal monitoring will occur in cases where specific biological or ecological thresholds are identified prior to treatment implementation.

REVIEW ECONOMIC VIABILITY & FEASIBILITY OF SELECTED TECHNIQUES

INFEASIBLE/ TOO EXPENSIVE

If the treatment or conservation / mitigation measures selected are NOT affordable, effective, and practical then the treatment plan cannot be approved as it stands and the decision-maker(s) needs to revert to lesser goals of containment or suppression, as indicated in Figure 2.

NO ACTION

There may be cases when all known treatments and conservation / mitigation practices are still not affordable, effective, or practical and a determination of "No Action" must be made. This is not necessarily a decision to not address the problem at all (a "live with it" decision), rather, it is an acknowledgement that the problem may need to be monitored further and re-evaluated at a later date when more data or new control technologies/strategies become available or if changes in environmental circumstances render the problem more easily addressed using available techniques and strategies.

Appendix C

Cub Creek Watershed
Integrated Weed Management Plan

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January 2005

Table of Contents

Introduction

Non-native plants, sometimes referred to as weeds, noxious weeds, or exotic-invasive species, are becoming an increasing threat to public lands nation-wide, which are estimated to be invaded at a rate of 700,000 ha yr^{-1} (1.7 million acres) (Svejcar 2003). In 1996 non-native plants were estimated to infest 2.8 million ha (7 million acres) of National Park Service lands (NPS 1996). Environmental impacts include: reduced biodiversity (Randall 1996), degraded wildlife habitat (Trammel and Butler 1995, Thompson 1996), and changes in disturbance regimes (Graf 1978, Lacey et al. 1989, Whisenant 1989). Non-native species are considered to be the second greatest danger to biodiversity; just behind outright habitat destruction (Randall 1996). Impacts caused by non-native species are generally considered a function of the extent of the invasion, the density of the invasion and the impact caused by each individual. Impacts can also be organized hierarchically, including: genetic, individual, population, community and ecosystem level impacts (Parker et al. 1999). Non-native species also impact economic systems. Decreases in property value, loss of forage for livestock and costs associated with treatment are the three main economic impacts of weed infestations (Olson 1999b). In the Cub Creek watershed, non-native plants threaten habitat for endangered species, decrease forage for wildlife and livestock, and are spreading to adjacent properties.

It is generally agreed that the use of multiple and varied weed management techniques, known as Integrated Weed Management (IWM), is the most efficient and economic form of weed management (Sheley et al. 1999) and reduces damage to non-target species and ecological systems. IWM techniques include: prevention, education, early detection, inventory, planning, eradication/suppression/containment, and monitoring. Eradication/suppression/containment are accomplished using mechanical, cultural, chemical and biological controls. Using a combination of techniques available in IWM can assist in addressing the complex problems posed by weed management (Sheley et al. 1999). This is the case for the Cub Creek watershed, where conditions for weed management are very complex. Lands within the watershed are managed by the National Park Service (NPS), the Bureau of Land Management (BLM), the state of Utah and by private landowners. Resource issues within the watershed include: archaeological resources, historical resources, threatened and endangered plants, water resources, grazing rights and public access. These all must be considered during the planning process for weed management. It is important to note that monitoring after implementation will determine success of the treatments and provide the information required to make adjustments to these plans.

This plan for Cub Creek is developed under the guidance of the monument-wide Invasive Plant Management Plan and Environmental Assessment. As per Section 106 of the National Historic Preservation Act, DINO seeks compliance separately for this project with the Utah state historic preservation officer (SHPO) to ensure no adverse effects to cultural resources over the course of plan implementation.

This plan is intended to outline effective options for weed management in the Cub Creek watershed, Utah. Some details have not been included to allow contractors and those implementing the plan to make minor adjustments based on their experience and expertise. Also, this plan has been written concurrently with the Invasive Plant Management Plan and Environmental Assessment for Dinosaur National Monument (NPS in press) and adheres to the constraints outlined there. This plan has not been subjected to economic analysis. Therefore, it is possible that, depending on market demands and available resources, some of the options outlined may be deemed unfeasible.

Site Description

The Cub Creek watershed is a small tributary to the Green River (Fig.1) draining approximately 6215 ha (15,360 acres), and is physiographically part of the Uinta Basin. Elevations within the watershed range from 1460-2560 m (4800-8400 ft.). Soils are of well-drained alluvial and colluvial material, and described as fine-loamy, fine sandy-loam, fine sand and coarse-loamy. Clay content ranges from 0-27%, cation exchange capacity (CEC) from 0-20 meq/100g, pH from 7.9-9, and salinity from 0-8 mmhos/cm. (NRCS 2001). Soils are derived primarily from three parent materials. The northern slope of the watershed is formed from Weber sandstone and the southern slope consists of the Moenkopi formation with an exposed cap of the Chinle formation. Between the two is the Park City formation, which, in places, lies underneath Cub Creek (Rowley and Hansen 1979). Annual precipitation ranges from 20-30 cm (8-12 in.) per year with peaks in October and April.

Native plant communities at lower elevations include both Wyoming and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata* and *wyomingensis*), greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), needle-and-thread grass (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), alkali sacaton (*Sporobolus airoides*) western wheatgrass (*Pascopyrum smithii*), cryptantha (*Cryptantha gracilis*), sego lilly (*Calochortus nuttalii*), globemallow (*Sphaeralcea parviflora*) and phlox (*Phlox longifolia*) (Martin 2001, NRCS 2001). Mid elevations are dominated by pinyon-juniper (*Pinus edulis* and *Juniperus osteosperma*) woodland, and higher elevations are a mixture of mountain shrubs. Riparian plant communities associated with Cub Creek, the wet meadows that drain into it and a series of box canyons that cut into the sandstone slopes, consist of box elder (*Acer negundo*), coyote willow (*Salix exigua*), Bebb willow (*S. bebbiana*), yellow willow (*S. lutea*), Rio Grande cottonwood (*Populus deltoides*), lanceleaf cottonwood (*P. acuminata*), narrowleaf cottonwood (*P. angustifolia*), common reed (*Phragmites australis*), wild iris (*Iris missouriensis*), rushes (*Juncus* spp.) and bulrushes (*Scirpus* spp.) (Martin 2001, Naumann 2003). Within the watershed are also a number of special-status plant species:

Common Name:	**Scientific Name:**	**Listed by:**
Jones' blue star	**Amsonia jonesii**	CO
Park rockcress	*Arabis vivariensis*	CO, UT
Grass milvetch	*Astragalus chloodes*	CO, UT
Dinosaur milkvetch	*Astragalus saurinus*	CO, UT
Ownbey thistle	*Cirsium ownbeyi*	CO, UT
Rollins cryptanth	*Cryptantha rollinsii*	CO, UT
Uinta basin spring parsley	*Cymopterus duchesnensis*	CO, UT
Hellborine	*Epicactis gigantea*	CO, UT
Dinosaur buckwheat	*Eriogonum saurinum*	CO, UT
Orchard snakeweed	*Gutierrezia pomariensis*	UT
Purpledisk helianthella	*Helianthella microcephala*	UT
Uintah Basin stickleaf	*Mentzelia multicaulis*	CO, UT
Bessey locoweed	*Oxytropsis besseyi*	CO, UT
Large-flowered breadroot	*Pediomelum megalanthum*	CO, UT
Blue mountain penstemon	*Penstemon scariosus*	CO, UT
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	USFWS
Cisco woody aster	*Xylorhiza venusta*	UT

These species are distributed primarily along the length of Cub Creek and along washes and tributaries that flow into Cub Creek. Many of the pastures around the Josie Morris homestead harbor or are considered potential habitat for special-status species, especially Ute ladies-tresses orchid. There are also a number of special-status fish species in waters downstream including: the Colorado pikeminnow (*Ptychocheilus lucinus*), razorback sucker (*Xyranchen texanus*), bonytail (*Gila elegans*) and humpback chub (*Gila cypha*) (USFWS 2004).

Humans have long been drawn to the Cub Creek area, due to its amenities, including abundant water and wildlife, protection from weather afforded by the cliffs, southern exposure and dramatic scenery. Rock art from Fremont cultures (circa A.D. 750-1300) is scattered throughout the watershed, as well as remains of campsites, rock shelters and sixty villages (Martin 2001). Of particular interest are the village remains, which consist of foundations from pit houses buried approximately 25cm (10in.) below the soil surface and occur throughout the watershed, including the pastures below the Josie Morris Ranch (Prokopetz 2005).

In 1915 the area was homesteaded by Josie Bassett Morris. She lived there in a cabin without access to electricity or telephone service until her death at the age of 90 in 1964 (McClure 1989). Josie made her living from the land; hunting, grazing livestock, maintaining gardens and an orchard, and running a whiskey still. She also plowed nearly 32ha (80 acres) of fields down approximately 15cm (6 in.) over the course of her tenure on the land. In her fields, Josie Morris grew alfalfa and field corn, which she irrigated with water from an intricate set of ditches and holding ponds (McKnight 1976, Prokopetz 2005). The homestead has been described as uniquely “feminine”, based on its location and layout and is considered indicative of the independent spirit of frontier women. The National Park Service is currently involved in efforts to maintain and restore elements of her homestead, including dwellings, outbuildings, orchards and irrigation ditches, as a “cultural landscape” (Martin 2001).

Lands within the watershed are currently owned and managed by a variety of agencies and parties. The BLM manages approximately 40% of the watershed, NPS manages 28.6%, private landowners manage 20% and the the State of Utah manages 11.4% (BLM 2004). Current uses consist primarily of public visitation and grazing. The Josie Morris homestead and nearby petroglyphs attract a large number of visitors during the summer tourist season. The Chew family, which owns property at the confluence of Cub Creek and the Green River, also maintains grazing rights in the watershed. Since 1941 they have used the Cub Creek watershed as a travel corridor for 30-60 cattle during two weeks in late April, while moving their herds from their winter range in Utah to summer range in Colorado. Both winter and summer ranges consist of combinations of US Forest Service, BLM, NPS and private properties. Winter range in Utah includes the area around the Josie Morris Ranch, where 30-60 cattle graze during the months of January and February (Chew 2005).

Inventory

In response to a request from the Chew family, a survey for weeds around the Josie Morris homestead was conducted in 1977 by staff from Dinosaur National Monument (DINO). It was estimated that approximately 8ha (20 acres) were dominated by Russian knapweed (*Acroptilon repens*) in pastures, along Cub Creek and in one of the box canyons. Canada thistle (*Cirsium arvense*) was also noted in small infestations covering less than .4ha (1 acre). A hand-drawn map was produced indicating the distribution of the weeds (NPS 1977).

During the summer of 2002 an extensive survey was conducted throughout the Cub Creek watershed, as well as in other select areas of DINO, for non-native plants (Dewey et al. 2003). Surveys were conducted by determining features (roads, trails, waterways…etc.) and general locations that were likely to be infested by weeds. Survey routes were established based on historical records, geology and topography, and traveled either by foot, vehicle or boat by crews of 2-4 people. Information was collected by global positioning system (GPS) units, or hand-drawn on maps if GPS signals were not available. Data were stored and presented in a geographic information system (GIS).

Results of the survey in the Cub Creek watershed indicated that 10 species designated for control were present on NPS lands (Fig.2): Russian knapweed (*Acroptilon repens*), Canada thistle (*Cirsium arvense*), saltcedar (*Tamarix ramossissima*), Russian olive (*Elaeagnus angustifolia*), hoary cress (*Cardaria draba*), bull thistle (*Cirsium vulgare*), burdock (*Arctium minus*), yellow sweetclover (*Melilotus officinalis*), Scotch thistle (*Onopordum acanthium*) and houndstongue (*Cynoglossum officinale*). The bulk of these infestations are clustered near the Josie Morris homestead, with satellite populations extending both up and down the watershed, suggesting that they are spreading from the homestead. Quackgrass (*Elytrigia repens*) and cheatgrass (*Bromus tectorum*) are also prevalent in the watershed; however, they were not mapped because they are so widespread. A previous botanical survey of the homestead also recommended including white poplar (*Populus alba*) for control (Martin 2001). It is an ornamental that was planted at the Morris homestead. It is clearly expanding its range around the homestead, especially into riparian areas, and can be expected to become a problem in the future. Species found in the watershed that may be targeted for control on non-NPS lands include musk thistle (*Carduus nutans*), diffuse knapweed (*Centaurea diffusa*) and perennial pepperweed (*Lepidium latifolium*).

Of the weed species mapped on NPS lands, Russian knapweed is by far the most prevalent, occupying approximately 28 ha (70 acres) with cover values varying from low to high (6-100%) and in infestations ranging in size from 5.6 ha (14 acres) to individual plants (Fig.2). Canada thistle occupies approximately 4.3 ha (11 acres), also in low to high coverages, but all in small infestations ranging from 1 ha (2.5 acres) to several plants. Saltcedar inhabits approximately 8 ha (19 acres) in small infestations ranging from individual plants to .5 ha (1 acre), and from low to moderate coverages. Sweetclover covers a total of 5 ha (12.8 acres), with infestations ranging from .4ha (1 acre) to individual plants. Bull thistle has multiple small infestations and one large infestation of .4 ha (1 acre) at low coverage, totaling .7ha (1.9acres). Houndstongue covers .3ha (.85 acres) in infestations ranging from .1ha (.25 acres) to individual plants. Musk thistle, diffuse knapweed, Scotch thistle, perennial pepperweed, Russian olive, hoary cress and burdock all exist as small infestations, ranging from a total of .04ha (.1 acre) to individual plants.

Goals and Objectives

Goals:

1. Prevent the spread of weeds from NPS-managed lands to adjacent lands (NPS 1986, 1997b), and vice versa.
2. Establish and maintain healthy, diverse, weed-resistant plant communities (NPS 1916, 1986, 2002).
3. Maintain existing populations of special-status species (NPS 1916).
4. Maintain cultural, historical and archaeological resources (NPS 1986).
5. Provide opportunities for public education (NPS 2001).

Objectives:

1. Eradicate small satellite populations of priority species in order to prevent their spread within and beyond NPS lands within 2 years of detection, especially along travel corridors.
2. Suppress large infestations of Russian knapweed by 95-100% over the course of 5 years.
3. Establish healthy, diverse, plant communities through revegetation within 5 years of treatment.
4. Consult with NPS cultural resources staff during planning.
5. Use interpretation, volunteer programs and develop school curricula to educate NPS personnel and the public.

Integrated Weed Management

Prevention

There are a number of measures that can be implemented in the Cub Creek watershed that will help prevent weeds from spreading. Implementing these preventative measures will help save money in the long run and reduce environmental risks from weed management activities. The first measure addresses the current practice of using mowing equipment to manage vegetation along roadways in the Cub Creek watershed. There are a number of small, new infestations of Russian knapweed that have become established in the ditches along the access road to the Morris homestead. These have likely become established from propagules that have been transported on mowing equipment after they had been used to maintain the parking area at the Morris homestead, where there are also infestations of Russian knapweed. DINO Best Management Practices for Road and Utility Maintenance policy (found within Appendix D) calls for the thorough washing of equipment used for weed management before being used at other sites (NPS in press). If this is deemed impractical, it may be necessary to halt mowing activities around the Morris homestead until weed management activities have been implemented. Additionally, these BMPs call for collaboration with road maintenance personnel on roadside noxious weed management to further prevention and early detection efforts, since this division spends the most time and resources traveling and maintaining the monument's roads, which serve as one of the primary corridors for weed dispersal.

The second preventative measure addresses the maintenance of the Josie Morris homestead and the changes that she made to the landscape. Of particular concern are the plants that she brought in during her tenure that might spread throughout the watershed. The white poplars have already clearly demonstrated their potential to spread into riparian areas around the Josie Morris homestead (Martin 2001). Black Locust (Robinia pseudoacaia) has not spread within the Cub Creek watershed, however, it is known to be invasive in arid environments and should be monitored (Converse 2003). Since the National Park Service is mandated to protect both natural and cultural resources (NPS 1916, 1986), there is no easy solution to a conflict between resources. Removal of the original trees would alter the historical integrity of the site, while allowing them to persist endangers the health of the watershed. In Capitol Reef National Park, a similar conflict was solved by allowing the original trees to persist for their natural lives, but agreeing to replace them with non-invasive species when they had died of natural causes (NPS 1997a). In Cub Creek, this would require controlling the offspring of the original trees on a regular basis to prevent invasion of the watershed, until the parent trees have died.

In order to prevent the establishment of new weed species in the Cub Creek watershed, attention should be paid to early detection and rapid eradication of weed species found in surrounding areas. These include: purple loosestrife (Lythrum salicari), dyer's woad (Isatis tinctoria), squarrose knapweed (Centaurea virgata), Dalmatian toadflax (Linaria dalmatica), yellow toadflax (Linaria vulgaris) and yellow starthistle (Centaurea solstitialis) (Merritt et al. 2000, DPI 2002). Other preventative measures will include those outlined in Appendix D of the Invasive Plant Management Plan and Environmental Assessment for Dinosaur National Monument (NPS in press) and adherence to the goals and objectives of the Draft Livestock Management Plan and Environmental Impact Statement (NPS 2002).

Education

Since the Cub Creek area is a highly visited area by the public, education efforts regarding non-native plants in general may be successful in reaching many people. Explaining weed management activities that the public may experience while visiting the Cub Creek area will also improve awareness. Therefore, interpretive signs should be posted in the vicinity of the Josie Morris homestead that address the history of introductions, ecological impacts from non-native species, IWM techniques and justification for the treatments implemented in the Cub Creek watershed.

Another way of educating the public is to involve them in the weed management activities themselves. Opportunities in the Cub Creek area include eradication efforts (e.g. pulling or spudding of annual or biennial species) and monitoring, which will both be discussed later. These are both appropriate activities for volunteer groups since they are labor-intensive, but require minimal training. Groups that may be interested in these activities include: science classes, youth groups, Boy Scout troops or environmental organizations. The following websites provide additional resources for education:

- National Park Service (Aliens in Your Neighborhood - Invasive Species and the National Parks) - www.nps.gov/invspcurr/alienhome.htm
- BLM Utah Invasive Plants Homepage -www.blm.gov/utah/resources/weeds/index.html
- BLM Partners Against Weeds - www.blm.gov/education/weed/paws
- BLM Weeds website -www.blm.gov/weeds
- BLM Learning Landscapes: Invasive Species - www.blm.gov/education/LearningLandscapes/explorers/lifetime/ invasive.html
- BLM Colorado Invasive Plants Homepage -www.co.blm.gov/botany/weedhome.htm
- Center for Invasive Plant Management (Western Weed Resources Catalog) - www.weedcenter.org/inv_plant_info/weedresource_cat.htm
- Washington State Noxious Weed Control Board (Education) - www.nwcb.wa.gov/education/educationhome.html

Eradication/suppression/containment

The first steps in managing existing weed infestations are to determine management objectives and prioritize infestations for treatment. Management objectives include eradication, suppression and containment. Eradication is defined as "the destruction of every individual of a species from an area…" (Zamora and Thill 1999). Containment consists of "restrict(ing) the encroachment of noxious weeds onto adjacent lands" (Sheley et al. 1999). Suppression is the middle ground between the two, and consists of reducing the density and/or extent of an infestation. It is intended to apply to infestations where containment does not meet management objectives, but full eradication may not be logistically or economically possible. As mentioned earlier, two Cub Creek watershed management objectives are to eradicate satellite populations and suppress large infestations.

Infestations can be prioritized for treatment based on four factors: the size of the infestation, difficulty of controlling that species, potential of the species for spreading and potential ecological impacts of that species (CNAP 2000). However, since the ecological impacts of many species are unknown until they have become so widespread that they can no longer be controlled (Parker et al. 1999), and since the difficulty of control is generally related to the size of the infestation, the general rule is to treat small infestations first, to prevent them from becoming large (Dewey 2003). Therefore, small infestations, ranging in size from individual plants to 2ha (5acres), indicated on the DINO weed inventory GIS by "points", should be treated first. Larger infestations indicated by "lines" or "areas" should then be prioritized based on the other factors. Prioritization on NPS lands should follow this order: "point" infestations of burdock, houndstongue, bull thistle, Russian olive, white poplar, saltcedar, hoary cress, Canada thistle and Russian knapweed, and then "area" infestations in the same order. Cheatgrass and quackgrass are of the lowest priority because of the extent of their spread. It is important to note that the "point" infestations of weeds on non-NPS lands should be prioritized for early treatment as well, before they expand, becoming more difficult to control, and cross property boundaries.

There are many different types of treatments for weeds, which can be used in different combinations to increase effectiveness and reduce costs and potential environmental or other risks. Treatments are generally divided into four categories: mechanical, cultural, chemical and biological treatments (Sheley et al. 1999). Mechanical treatments include cutting or mowing, and range in scale from individual plants, such as cutting with a chainsaw, to large-scale, such as a tractor-drawn mower. Cultural techniques are actions that indirectly affect weeds, such as prescribed fire, selective grazing or establishing desirable vegetation (revegetation). Chemical controls involve the use of selective, broad-spectrum, soil-active and/or foliar-active herbicides. Biological controls include insects and pathogens that are usually introduced from an invasive plant's place of origin and impact plants by direct damage to leaves, stems or roots, or by interrupting reproduction. Treatments are chosen based on effectiveness, risk of damage to non-target organisms, size or density of infestations and economic constraints. It is important to note that the success of IWM is dependent on the proper application of these treatments and that factors such as timing, rates and local environmental features must be taken into consideration.

For all herbicide treatments, glyphosate has been considered first, due to its low soil mobility, persistence and toxicity (Tu et al. 2001). However, if there is no literature to suggest that it is adequately effective, alternative herbicides will be recommended. Also, due to its non-selective nature, glyphosate can negatively affect non-target species. Therefore, in situations where target species are mixed with desirable species and a selective application technique such as spot-spraying or wicking is not feasible, selective herbicides are recommended to avoid damage to desirable species.

Weed treatments in areas known or suspected to harbor special-status plant species will be surveyed prior to treatment in accordance with guidelines outlined in the Invasive Plant Management Plan and Environmental Assessment for DINO (NPS in press). Special attention will be given to the channel of Cub Creek, all wet meadows and previously irrigated pastures. Special-status plants or areas containing special-status plants will be marked to prevent accidental damage. If treatments must be applied to areas where special status individuals exist, the treatment will be modified to prevent damage or the population(s) will be protected by marking or fencing. For example, some herbicide applications can be delayed until fall, when special status species may be dormant and less susceptible to damage. If this is not possible, herbicides can be applied in a more selective manner, such as spot-spraying or with a wick applicator, depending on proximity to special-status individuals. Any species given special status in the future will be afforded the same protections (NPS 2001).

The following treatments are suggested for weed species targeted for control on NPS and non-NPS lands, based on scientific and professional literature:

Burdock, houndstongue, yellow sweetclover, bull thistle, musk thistle and Scotch thistle: All of these species are biennial or short-lived perennials, and rely on seed production to maintain and increase populations. Therefore, preventing seed production can be an effective control technique (Meunscher 1980). This can be accomplished easily, by cutting off the stalks during flowering, before the seeds have ripened. By cutting off the stem below the root crown (spudding) it is possible to prevent a first-year plant from re-emerging for a second year. Small infestations can easily be spudded without too much soil disturbance or labor costs, and the tools can easily be carried to remote infestations. Larger infestations may require a weed-whip equipped with a cutting blade to efficiently treat. Herbicide is another treatment option that may be useful for larger infestations, as long as it prevents seed production. The table below outlines specific rates and times of year for herbicide application for the weed species discussed above (the herbicides that pose the least risk to the environment based on mobility, toxicity and persistence are listed. A selective herbicide is also included for situations where desirable grasses are mixed with infestations):

Species (total area)	**Herbicide**	**Application rate(formulation)**	**Time of year**	**Reference**
Burdock .04ha(.1 acre)	Glyphosate 2,4-D	2% .18-.72 L/ha(.08-.3 Q/ac)(SL)	before seed-set vegetative growth	(Dunham 1970, Whitson et al. 2000, Monsanto 2003)
Houndstongue* .3ha(.85acres)	2,4-D	1.12 kg/ha (1 lb/ac)(WP)	early spring	(Dickerson and Fay 1982)
Yellow sweetclover 5ha(12.8 acres)	glyphosate 2,4-D	2% 2.4-4.8 L/ha(2-4pts/ac)	before seed-set	(Goplen and Gross 1977, Tu et al. 2001, Monsanto 2003, Gordon 2004)
Bull thistle* .8ha(1.9 acres)	2,4-D	.16kg/ha(.15 lbs/ac)(WP)	spring	(Beck 1991)
Musk thistle** <.04ha(<.1 acre)	2,4-D	.24kg/ha(.22 lbs/ac)(WP)	spring	(Feldman et al. 1968)
Scotch thistle* <.04ha(<.1 acre)	2,4-D	.32kg/ha(.29 lbs/ac)(WP)	before bolting	(Beck 1991)

*not listed on RoundupPro herbicide label (Monsanto 2003) or tested with glyphosate in other scientific literature, **suppression only by glyphosate (Monsanto 2003)

L=liters, SL=soluble liquid, WP=wettable powder

Sites where these plants have become established must be monitored for several years after seed production has been halted to ensure that seeds already deposited in the soil do not reestablish the infestation. Revegetation may be required on sites where larger infestations have displaced desirable vegetation.

Diffuse knapweed: Since this species occurs only as a few individual plants within the Cub Creek watershed and can be difficult to control once well established, it should be given very high priority for treatment. It can act as an annual, biennial or perennial, and can be controlled by preventing seed production by pulling or cutting before fruits are ripe. However, it has been separated from the biennial species for a number of reasons. First, it is suspected of containing a carcinogenic compound that causes tumors in humans (Carpenter and Murray 2004b). Extreme caution should be taken when working with this plant, especially around open wounds, and gloves should be worn at all times when handling it. Secondly, it has the potential to reestablish itself multiple times during the growing season. Therefore, it may have to be treated up to three times each year (Carpenter and Murray 2004b). Herbicide application may be a desirable option to prevent exposure to the potentially carcinogenic compounds and to prevent resprouts. Glyphosate at 2% concentration (Monsanto 2003) or 2,4-D applied at 1-1.5 kg/ha(.9-1.4 lbs/ac) (Watson and Renney 1974), during active growth are both effective. Targeting rosettes and emerging seedlings in the fall will help to exhaust the seedbank, but spring control will likely be required to prevent new seed production.

Saltcedar, white poplar and Russian olive: Saltcedar covers 7.8ha (19.3acres), Russian olive covers <.04ha (<.1acre) and white poplar was not mapped. However, since they all exist as small infestations ranging from .04-.4ha (.1-1 acre) and are interspersed with well-established native vegetation, they do not warrant the use of any of the large-scale treatments. Instead, the use of a very selective treatment is necessary. The cut-stump or frill-cut methods are especially practical in this situation (Neill 1987, Remaley and Swearingen 1998, Stannard et al. 2002). The cut-stump technique consists of cutting the trunk as close to the soil surface as possible and immediately applying herbicide, either by painting or spraying to prevent resprouting (Neill 1987). The frill-cut method consists of using a hatchet to cut into the cambium layer, while the tree is still standing, and applying herbicide directly to the cut area (Tu et al. 2001). Both of these treatments are most effective when done in fall. For the species mentioned here, either undiluted glyphosate (Roundup, Aquamaster) or triclopyr (Garlon or PathfinderII) are considered effective. Cut material can be removed from the site or piled in a way that does not hinder desirable vegetation. Some resprouting could occur and should be monitored the following year.

Resprouts can be treated in the same manner. None of the infestations require revegetation, since they are all small and interspersed with desirable vegetation.

The source for the invading white poplar seedlings is from trees that are associated with the Josie Morris homestead and are of cultural value. If it is decided that those original trees should be removed to prevent the threat of recurring invasions, it should be done after the Russian knapweed has been eliminated from the area around the homestead. It appears that the shade from the white poplars is limiting the spread of the Russian knapweed (Dall'armellina and Zimdahl 1988).

Hoary cress: Since this species reproduces vegetatively from a creeping root system, mechanical treatments are only mildly effective. Also, it only exists as a single small infestation, less than .04ha (.1acre) in the Cub Creek watershed and should be eradicated quickly and completely. Therefore, chemical treatments will be critical in preventing its spread. 2,4-D (marketed under many trade names) is known to be effective at .32-.48 kg/ha(.29-.44 lbs/ac), applied pre-bloom (William et al. 2002), and has relatively few environmental risks. If that is found to be ineffective, chlorsulfuron (Telar) can be applied instead, also at pre-bloom, at .02 L/ha(.008Q/ac). However, it has a longer half-life and should be used only if necessary. Both 2,4-D and chlorsufuron are selective herbicides and won't affect grasses. Near water, imazapyr (Habitat) can be used at rates of .2-.4 L/ha(.08-.16Q/ac), applied during flowering to monocultures or selectively with a wick applicator (BASF 2003).

Perennial pepperweed: This species also reproduces vegetatively with a creeping root system and is represented by a single infestation less than .04ha (.1 acre). Mechanical treatments have been found to be somewhat effective in reducing size and cover if repeated 1-3 times per year for several years. Mowing or cutting every two weeks while the plant is at the flower bud stage can reduce an infestation. Mowing and then applying herbicide to the regrowth has been shown to require less herbicide than herbicide alone (Renz and DiTomaso 1998). Glyphosate (Roundup, Aquamaster) is registered for use on this species applied at rates of 1.75L/ha (4qts/acre) or as a 2% solution (Monsanto 2003) during the flowerbud phase, and can be used near water if applied as Aquamaster. For situations where a selective herbicide is desirable chlorsulfuron (Telar) is effective, applied at .11kg/ha(.9 lbs/ac) (Young et al. 1999) also during the flowerbud phase and won't affect grasses.

Canada thistle: This species also reproduces vegetatively by a creeping root system, however, it is well established in the watershed. It covers a total of 4.3ha (10.8 acres) in small infestations primarily of .04ha (.1 acres), but also as single plants and infestations up to .1ha (2.5 acres). It is somewhat affected by repeated mechanical treatments, such as mowing every 3 weeks (Beck and Sebastian 2000); however, full control requires herbicide application and mowing may damage associated desirable species. Glyphosate (Aquamaster, Roundup) is effective when applied to the fall rosette at low concentrations (2.5-4%), and Aquamaster can be used on infestations near water (Boerboom and Wyse 1988). Higher concentrations do not necessarily improve efficacy, and response varies considerably between ecotypes. Since glyphosate is a non-selective herbicide, it should be applied with a wick applicator to infestations that are interspersed with desirable vegetation. Clopyralid or clopyralid + 2,4-D (Transline or Curtail) are also effective, and can be applied during June or in the fall at .56 kg/ha(.51 lbs/ac) and .028 +.112 kg/ha(.025+.1 lbs/ac), respectively (Donald 1993, Nuzzo 2003). These herbicides are better suited for infestations further from water, and where a selective herbicide is necessary to retain desirable grasses (Donald 1993). Large monocultures that will leave bare soil after treatment should be seeded with seed mix A in early fall (see Restoration/Revegetation section).

Russian knapweed: This species also reproduces vegetatively from a creeping root system and is well established in the watershed. It covers a total of 28.6ha (71 acres) in infestations ranging in size from 4.8ha (14.5 acres) to individual plants. Small infestations are treated best with herbicide applied either with a wick or as a spot-spray, depending on whether the associated vegetation is susceptible to the herbicide. Glyphosate (Roundup, Aquamaster) has been shown to be effective against Russian knapweed when applied at 1.1 kg/ha(1 lb/ac) or as a 2% solution in June or August (Bottoms and Whitson 1998, Benz et al. 1999, Monsanto 2003); however, past use at DINO has shown it to be ineffective (Naumann 2003), probably because of water stress. Glyphosate may be more effective near water or after years with high precipitation, due to better translocation of the herbicide within the plant (Morrison et al. 1995). Lower rates of application of glyphosate may also improve translocation (Boerboom and Wyse 1988). Clopyralid or clopyralid +2,4-D (Transline or Curtail) are also effective herbicides that will not affect grasses

(Bottoms and Whitson 1998, Benz et al. 1999), but can't be used near water. They should be applied at rates of .32kg/ha(.29lbs/ac) and .32 +1.65 kg/ha(.29+1.5 lbs/ac), respectively in July, August or in October after a frost. Large areas treated with herbicide should be reseeded during early fall (see Restoration/Revegetation section).

Due to their size, the largest of the Russian knapweed infestations (Fig.3) should receive customized treatments in order to reduce the risk of water contamination through herbicide use and retain desirable vegetation. It is especially important to retain desirable vegetation associated with large infestations to help prevent recolonization by weeds and to minimize soil erosion. Also, desirable vegetation, including sagebrush and perennial grasses, can be difficult to reestablish, due to unpredictable precipitation (see Restoration/revegetation section).

In order to accomplish the goals of effective weed management, economic efficiency and minimal environmental risk, all available IWM treatments have been considered for the largest Russian knapweed infestations. A number of treatments that are typically appropriate for use on large-scale weed infestations have been rejected for various reasons. Fire has been found to increase Russian knapweed, since it only affects above-ground growth and creates disturbance that may eliminate competing, fire-sensitive vegetation (Naumann 2003). Flooding has been found to suppress Russian knapweed (Selleck 1964); however, there is no information regarding the specifics, such as quantity or duration.

The extent of the Russian knapweed infestations in the Cub Creek watershed would also normally warrant the use of biological controls; however, their use has been rejected based on risk to special-status non-target species. As mentioned earlier, there are a number of special status plant species within the Cub Creek watershed, as well as in the vicinity of the Josie Morris homestead. Some of these are in the Asteraceae family with Russian knapweed, such as Ownby thistle, orchard snakeweed, purpledisk helianthella and cisco woody aster. Risk to non-target species is evaluated based on degree of relatedness (Deloach 1991, Rees et al. 1996). Therefore an organism in the same family as the target organism is considered at-risk of being damaged by the biocontrol. Since these species are already considered at-risk species, the use of biocontrols has been rejected.

Plowing or discing the larger Russian knapweed infestations has also been rejected based on risk. Even though it is known to be an effective treatment when repeated regularly (Derscheid et al. 1961) and many areas where the infestations occur have been plowed in the relatively recent past, the risk of erosion caused by soil disturbance combined with the difficulties of revegetation due to unpredictable precipitation is too high. The soils where Russian knapweed infestations occur that would be appropriate for plowing or disking based on accessibility and low damage to non-target species are considered high risk from wind erosion and medium to high risk from sheet and rill erosion (NRCS 2001). There is also the potential for causing damage to cultural resources located within the treatment area. Of particular concern are the pit house foundations that have been found in the pastures. They would require protection during any plowing or disking treatment. Therefore, based on potential detrimental environmental and cultural impacts, plowing or discing has not been recommended for any infestations within the Cub Creek watershed.

IWM treatments that were chosen include: mowing, selective grazing, herbicide application and revegetation. For prescriptive grazing, either goats or sheep can be used on Russian knapweed, since they are accustomed to a diet of forbs and seem to be able to neutralize the organic compounds that can be toxic to other animals, such as horses (Young et al. 1970, Tu et al. 2001). Cattle have not been considered since they are more likely to graze available grasses, rather than forbs (Holochek et al. 2004). Time-controlled grazing is most effective for weed control in monocultures. Heavy stocking rates ensure that target species are grazed fully and uniformly (DiTomaso 2000). A rest period of 3-4 weeks will allow the plant time to regrow (Derscheid et al. 1961) and deplete carbohydrate reserves stored in the root system, which are usually lowest during the bolt stage, just before flowering (DiTomaso 2000). Therefore, each infestation should be grazed long enough for complete defoliation, which will depend on the size of the infestation and climatic conditions. Once an infestation has been grazed, the herd will be moved to another infestation. This will be repeated until all infestations have been grazed and so that the entire process takes 3-4weeks and the cycle can be repeated. A herd size of approximately 63 sheep or 95 goats should be adequate. This is based on a total prescriptive grazing area of 9.4ha (23.6ac), forage production calculated from the ecological site description, average consumption of forage by goats and sheep, 100% utilization and a 120 day grazing period (NRCS 2001, Holochek et al. 2004). This results in an overall stocking density of 7-8 sheep/ha (3 sheep/ac) and 10 goats/ha (4 goats/ac), which is roughly consistent with recommended stocking densities for control of leafy spurge (Euphorbia esula) (Merritt et al. 2002). It should be noted that grazing may initially increase stem density by removing apical dominance, but that resprouts should be smaller and less vigorous and eventually less dense (Olson 1999a, Carpenter and Murray 2003). Grazing should be initiated during the bolting stage (late May) and continued into mid-fall to prevent the replenishing of energy reserves. Temporary fencing will be required to concentrate utilization on target species (Tu et al. 2001, Merritt et al. 2002), and protect non-target species, and can later be used to temporarily exclude both native ungulates and livestock from restored areas, as outlined in the Invasive Plant Management Plan and Environmental Assessment for DINO (NPS in press).

To further comply with this plan, all sheep or goats used for prescriptive grazing must be tested for diseases to protect wildlife and livestock. Bighorn sheep, which have been reintroduced to DINO are especially vulnerable to disease transmission from domestic sheep and goats (Jessup and Boyce 1996). Animals recruited from outside the watershed for prescriptive grazing also must be fed weed-free forage for 48 hours prior to use in order to prevent introduction of undesirable plants in feces (Olson 1999a). A herder to manage livestock, water for livestock and supplemental weed-free feed to provide a balanced diet may all be necessary for successful prescriptive grazing (Tu et al. 2001).

The mowing treatment is intended to mimic prescriptive grazing for infestations where the target species are mixed with desirable vegetation and use of livestock would endanger desirable vegetation or on infestations that are too small to warrant the use of livestock. It should be initiated during the bolting stage (mid-May) and repeated every 3-4 weeks until mid-fall. Mowing can be implemented with a hand-held weed whip, to minimize damage to non-target species while accessing the infestations and during treatments.

Because of its extensive root system and the ability to reproduce from root buds, it is not possible to eliminate Russian knapweed by the defoliating action of grazing or mowing alone. Therefore, a systemic herbicide will be necessary to eliminate remaining underground roots once grazing and mowing have reduced the infestations in density and size. Effective herbicides are the same as for small infestations, and include: glyphosate (Roundup, Aquamaster), clopyralid (Transline) and clopyralid + 2,4-D (Curtail) applied at rates of 1.1kg/ha(1 lb/ac), .24 L/ha(.1q/ac) and .32 +1.65 kg/ha(.29+1.5 lbs/ac) , respectively(Bottoms and Whitson 1998, Benz et al. 1999, Carpenter and Murray 2003). They can be applied as a broadcast spray, spot-spray or with a wick, depending on the associated vegetation. Glyphosate should be applied in June or August. Clopyralid and clopyralid+2,4-D can be applied during July, August or in October, after a frost.

Below are descriptions of the largest infestations and customized IWM treatments (numbers correspond to labels in Fig.3):

1) Size: .24ha (.6 acres) Description: -Desirable tree and shrub overstory with an understory of Russian knapweed and wild licorice (*Glycyrrhiza lepidota*). This infestation is located below the main pasture, down in the incised channel of Cub Creek. It is close to water and can be difficult to access.

Treatment: There are some parts of this infestation that can be mowed repeatedly during the first season. Other parts are on steep slopes and probably are not suitable for mowing. These areas will be treated with herbicide only. Since it is near water, glyphosate (Aquamaster) should be used. Care should be taken to keep herbicide from contacting desirable vegetation by spot-spraying or using a wick, if necessary. Where Russian knapweed is mixed with wild licorice, there is no need to try to avoid the wild licorice, as it is a disturbance-adapted native. Areas that are mowed can be treated with herbicide the following year. The infestation should be checked in early fall of year 2 to evaluate the effectiveness of the herbicide and repeated mowing. If glyphosate is found to be ineffective, clopyralid or clopyralid+2,4-D (Transline or Curtail) can be applied the following year (year 3) with a wick applicator to reduce the risk of contaminating water. If the glyphosate is only partially effective (40-50% mortality), treatment should be repeated the following year (year 2) and seeding should wait until only spot-spraying of glyphosate is necessary.

2) Size: 1.6ha (4 acres) Description: Dense overstory of sagebrush and some greasewood with an understory of Russian knapweed and cheatgrass. The infestation is located on the bench above the main channel of Cub Creek.

Treatment: This infestation will be difficult to treat since it is mixed with dense desirable vegetation. Some thinning of the sagebrush may be required to gain access, and some mortality may occur accidentally from herbicide treatments. However, it is crucial that the canopy not be opened up any more than necessary, since shade limits the spread of Russian knapweed (Dall'armellina and Zimdahl 1988). Treatment options for this infestation include mowing repeatedly around the sagebrush with hand-held weed-whips or applying herbicide with spot-sprays or wicks, where mowing is not possible. Glyphosate (Roundup), clopyralid or clopyralid+2,4-D (Transline or Curtail) can all be used, since it is not in the vicinity of water. All of these herbicides will damage sagebrush, so it is crucial that they be applied carefully. In early fall, the effects of the mowing treatment will be evaluated by methods outlined in the Monitoring section.

3) Size: 9.6ha (24 acres) Description: Overstory of Russian knapweed with an understory of undesirable grasses or Russian knapweed monoculture. Parts of this infestation are in pastures that were irrigated at one time and may harbor the federally listed Ute ladies'-tresses orchid or other special status species.
Treatment: Surveys will be performed before any actions are taken to determine the locations of any special-status species, at a time when they are most visible. Individuals will be protected from treatments by marking, fencing, altering the treatment, or all three. If none are found, these infestations are very amenable to a repeated grazing treatment. There is little desirable vegetation that would restrict access or be at risk of damage from the livestock. Fencing will be required to concentrate livestock on the target species and can be used during revegetation to exclude livestock and wildlife from newly established grasses. Any portions of the infestations that are excluded from the grazing treatment can receive a repeated mowing treatment or herbicide application. In early fall, the success of the grazing treatment should be evaluated as described in the Monitoring section.

4) Size: 1.4ha (3.6 acres) Description: Desirable trees and shrubs with an understory of desirable grasses and Russian knapweed. This infestation is on a shallow slope and has a perennial stream running through it.
Treatment: There are some portions of this infestation that are monocultures of Russian knapweed, and large enough to make grazing worthwhile. Extensive fencing will be required to restrict access to desirable trees and shrubs. Smaller monocultures can receive repeated mowing treatments. Areas where desirable grasses are interspersed with Russian knapweed should receive herbicide treatment with clopyralid or clopyralid+2,4-D (Transline or Curtail), unless near water, where glyphosate (Aquamaster) will be applied with a wick. Grazing and mowing treatments will be evaluated using the methods described in the Monitoring section.

5) Size: 3ha (7.3 acres) Description: These infestations lie within the two box canyons that run north of the Josie Morris homestead. They are both fairly wet and retain considerable desirable vegetation, including the federally listed Ute ladies'-tresses orchid. The emphasis for these infestations is on careful herbicide application after the orchid has gone dormant and is less susceptible to damage from herbicide.
Treatment: Surveys for the endangered Ute ladies'-tresses orchid will be performed before any treatments are implemented, during July, August and September when they are most visible (Naumann 2003). Individuals will be marked by colored flags, or areas where multiple individuals exist will be roped off so that herbicide applicators are clear where extra caution needs to be applied. Herbicide application will take place in October and November, and will include glyphosate (Roundup or Aquamaster, if near water) applied with a wick. No revegetation is required for these infestations.

6) Size: 1.4ha (3.6 acres) Description: Desirable trees, shrubs with an understory of some desirable grasses and Russian knapweed.
Treatment: These infestations have some portions that lack desirable vegetation and are large enough to be suitable for grazing. Portions that are unsuitable for grazing may be mowed, except in places where desirable grasses interspersed with Russian knapweed. These areas should be treated with clopyralid or clopyralid+2,4-D (Transline or Curtail), unless they are near water, in which case they can be treated with glyphosate (Aquamaster), applied with a wick.

Quackgrass: Due to reproduction from underground rhizomes, quackgrass generally requires treatment with herbicide for complete control (CNAP 2000, Batcher 2002). Large monospecific stands may be reduced by repeated mowing or burning. However, followup with herbicides will be required for eradication. Glyphosate (Roundup or Rodeo) is effective at 5% or 1.5 kg/ha(1.38 lbs/ac) and should be applied after flowering. Since it is non-selective, it should be applied with a wick or as a spot treatment to infestations mixed in with desirable vegetation.

Cheatgrass: Because it is so widespread and difficult to control, this species is given the lowest priority for control. Where cheatgrass has formed monocultures it can be controlled using prescribed burning (Naumann 2003); however, in the Cub Creek watershed it exists as an understory species in sagebrush and greasewood, which would be damaged by fire. Grazing by cattle and sheep, and mowing have been found to be effective, when implemented while plants are in the boot stage in early spring (Vallentine and Stevens 1994, Mosley 1996, Ponzetti 1997). It may be possible to make arrangements with the Chew family to time the movement of either their cattle or sheep through the watershed in a way that maximizes utilization of cheatgrass. Also, there are some areas on the flat benches above where sections of Cub Creek are incised where either tractor-drawn or hand-held mowers could be applied. A number of herbicides are also effective against cheatgrass, including glyphosate (Roundup, Rodeo), imazameth (Plateau), fluazifop (Fusilade) at rates of .2-.4kg/ha(.18-.37 lbs/ac), .04-.12 kg/ha(.036-.11 lbs/ac), .16-.24 kg/ha(.15-.22 lbs/ac), respectively, all during active growth (Beck et al. 1995, Carpenter and Murray 2004a). Monitoring should follow the same protocol as for large Russian knapweed infestations. After treatment, sites should be reseeded following procedures outlined below.

Restoration/ revegetation: This practice is usually categorized as a cultural method because the establishment of desirable species contributes to weed management by preventing incoming weeds from establishing and by providing competition to existing weeds. There are a number of techniques available for assisting the establishment of desirable species, which are determined by the plants' life-history traits. Because most of the weeds that are being managed in Cub Creek are broad-leaved forbs, grasses are the preferred restoration species. Selective herbicides used to control broad-leaved weeds will not harm the grasses. Glyphosate applied in fall, also will not negatively impact seedings due to high soil sorption (Vallentine 1989). Grasses are most economically established in the field by seeding with a seed drill or broadcast seeding and raking to improve contact with soil, rather than planting individual live plants. Unfortunately, because of low, unpredictable precipitation, as well as other random events, seedings, as well as plantings, have a high risk of failure (Vallentine 1989). In general, 28cm(11in) of precipitation are required for a successful seeding (Monsen et al. 2004).

The historical species composition of the areas now infested by weeds is not known exactly. However, there were mainly grasses in some of the areas below Josie's' cabin (McKnight 1996), and she probably cleared some sagebrush and greasewood from her pastures (McClure 1989). She also planted alfalfa and corn in the pastures (McKnight 1976). These species may have historic value as part of the "cultural landscape"; however, they are logistically impractical to include for restoration. Sources of information for potential restoration species include surveys made on-site for existing vegetation, range site descriptions, interviews of people familiar with the area, and historical documents and photographs. The area around the Josie Morris homestead has been divided into two seeding zones. Zone A consists of the relatively flat, wetter areas, while zone B consists of the drier, upland slopes (fig.4). Below is a table outlining the recommended species for each zone and recommended pure live seed (PLS) seeding rates:

Zone A

Species:	Recommended PLS rate for single species seeding in kg/ha (lbs/ac) (Vallentine 1989, Granite 2004):
alkali sacaton (*Sporobolus airoides*)	1.1(1)
western wheatgrass (*Pascopyrum smithii*)	7.5(6.9)
bluebunch wheatgrass (*Pseudoroegneria spicata*)*	8(7.4)
thickspike wheatgrass (*Elymus lanceolatus*)	5.1(4.7)
Junegrass (*Koeleria cristata*)**	1.1-2.2(1-2)
Slender wheatgrass (*Elymus trachycaulus*)***	5.9(5.4)
Great Basin wildrye (*Elymus cinereus*)	6.5-12(6-11)

Zone B

needle and thread (*Stipa comata*)	11-15.25(10-14)
indian ricegrass (*Oryzopsis hymenoides*)	5(4.6)
galleta grass (*Hilaria jamseii*)	6(5.5)
thickspike wheatgrass (*Elymus lanceolatus*)	5.1(4.7)
squirrelltail (*Elymus elymoides*)	7.6-13(7-12)

*(Petersburg 2003) **(Chew 2003) ***(Martin 2001) All others (pers. obs.)

Forbs may also be seeded to add diversity, but this should be delayed until application of selective herbicides has been completed. The following species are recommended:

Zone A:

Species:	Recommended PLS rate for single species seeding in kg/ha (lbs/ac) (Granite 2004):
globemallow (*Sphaeralcea parviflora*)	2.2-4.4(2-4)
false dandelion (*Agoseris glauca*)	n/a
Pacific aster (*Aster chilensis*)	1.1(1)
yarrow (*Achillea millefolium*)	1.1(1)

Zone B:

cryptantha (*Cryptantha gracilis*)	n/a
sego lilly (*Calochortus nuttalii*)	n/a
globemallow (*Sphaeralcea parviflora*)	2.2-4.4(2-4)
phlox (*Phlox longifolia*)	n/a
Drummond phlox (*Phlox drummondii*)	4.4-8.7(4-8)
thickleaf penstemon (*Penstemon pachyphullus*)	4.4-8.7 (4-8)
Hooker evening primrose (*Oenothera elata*)	1.1(1)

(Naumann 2003)

Actual rates of each species in a seed mix can be calculated by multiplying the percent composition desired for each species by the recommended single species seeding rates outlined above (Vallentine 1989). Seeding rates will also be determined by what is available both from custom collections and from the seed market. DINO has already collected seed for four of the potential species from the Cub Creek watershed (Naumann 2003): alkali sacaton, bluebunch wheatgrass, Great Basin wildrye and Indian ricegrass. This seed has been increased at an NPS facility and should provide a good base for creating seed mixes. Also, it should be noted that because of the presence of quackgrass (*Elytrigia repens*) in the watershed, and its tendency to hybridize with western wheatgrass, seed from western wheatgrass will not be collected from the vicinity of quackgrass infestations. Western wheatgrass should only be seeded if a large enough quantity of genetically appropriate material is obtained to fill the recommended seeding rate. This will help reduce the amount of hybrids in the watershed (Naumann 2003). Seeding should take place in late fall to prevent winter mortality of seedlings (Vallentine 1989) and only on sites where grazing, mowing and broad-spectrum herbicide treatments will not be applied the following year. Most seeding sites are not accessible to large equipment and so equipment will have to be carried in. This means that in most cases broadcast seeding and hand raking to cover the seeds afterwards are the only options available. A truck pulling a chain or piece of chain-link fence could be used to cover seed in infestation #3, since it is easily accessible to vehicles. Areas that have been reseeded should be excluded from livestock grazing for at least 2 years to allow for establishment of seeded species (Vallentine 1989).

There are a number of ways to reduce the risk of failure associated with seeding. The first is to use a drill-seeder, which deposits the seeds at the ideal depth in the soil, reducing granivory and improving germination (Vallentine 1989). Drill seeding distributes seeds in rows and creates an unnatural look, which can be prevented by making multiple passes at different angles and by broadcast seeding randomly within the rows. A drill-seeder that causes minimal soil disturbance should be selected. This technique is recommended for parts of infestation #3. The pasture southwest of the Josie Morris homestead is the largest, most accessible infestation, and the infestation that would benefit most from soil stabilization. In order to prevent damage to the cultural resources there, pit-house foundations should be marked and avoided during drill-seeding.

The use of non-native species is another technique for improving seeding success. There are a number of perennial non-native grasses that have been found to establish better than natives in the Intermountain West, including: crested wheatgrass (*Agropyron cristatum, A. desertorum*), smooth brome (*Bromus inermis*), tall fescue (*Festucca arundinacea*), pubescent wheatgrass (*Agropyron trycophorum*), Siberian wheatgrass (*Agropyron fragile*), tall wheatgrass (*Agropyron elongatum*), altai wildrye (*Elymus angustus*), and Russian wildrye (*Psathyrostachys juncea*) (Vallentine 1989, Asay et al. 2003). This may seem contrary to NPS policy; however, the need to establish vegetation for weed control and soil stabilization may be more important than establishing native vegetation. Also, non-native species may assist in the establishment of native species by ameliorating physical or chemical stress (Cox and Anderson 2004). Unfortunately, none of the species recommended have been proven to be non-invasive in DINO (in fact, several are already well established in some areas), and given that they are selected for their ease of establishment and vigor, it is very likely that they would spread. For instance, crested wheatgrass, Russian wildrye, pubescent wheatgrass and Siberian wheatgrass have all been shown to spread in sagebrush-bunchgrass communities in southern Idaho (Hull and Klomp 1966, 1967), and both crested wheatgrass and smooth brome have been shown to spread in native prairies (Larson et al. 2001, Heidinga and Wilson 2002).

Should future research demonstrate that a suitable non-native species does not spread into native plant communities, DINO may consider its use if the success of establishing native species is deemed unsatisfactory. Test plots should be set up on-site in fall to test the establishment of the native species grown in local conditions to compare the recommended seeding techniques: broadcast seeding with hand-raking and drill-seeding. If establishment of native species is below 2.7 plants/meter^2 (.25 plants/ft^2) it can be considered poor establishment (Vallentine 1989), and use of non-native species may be justified.

Another alternative that may be considered is the use of a non-native sterile annual covercrop. They establish easily and provide competitive cover against weeds, but do not reproduce (Dorner 2002). They would need to be reseeded every year to maintain their populations, but they allow the land manager some flexibility in establishing native species, especially if a delay in planting is needed in order to obtain suitable native seed or to wait for more favorable climatic conditions. Several seed supply companies carry sterile annual covercrop species, marketed as REGREEN and QuickGuard (Agassiz 2004, Granite 2004). No scientific literature is available evaluating the success of sterile covercrops, in terms of sterility or successful establishment.

Monitoring

Introduction

Monitoring is defined as the collection and analysis of measurements to evaluate change and progress towards a specific goal (Elzinga et al. 1998). Monitoring is also an essential component of the adaptive management cycle. Without monitoring there is no information available to inform managers of the need to alter or to maintain management protocol. Issues that must be considered when designing a monitoring program include: monitoring objectives, setting priorities, monitoring scale, qualitative vs. quantitative data collection, permanent vs. temporary sampling units, quantity of sampling units, monitoring frequency and data analysis (Elzinga et al. 1998). Available resources and time constraints must also be considered.

Monitoring objectives are based on the management objectives outlined for the two types of infestations found in the Cub Creek watershed. Satellite populations are defined as those infestations designated by "points" in the DINO weed inventory GIS (Dewey et al. 2003). Large infestations are indicated by "areas" in the GIS. These two types of infestations differ in their detection, priority for treatment, intensity of treatment, risk of failure, risk of environmental impacts from treatment, cost of treatment and type of monitoring required. Satellite populations are: difficult to detect, have high priority for treatment (CNAP 2000), require relatively simple treatments, have a low risk of failure, have a low risk of environmental impacts from treatments, are inexpensive to treat and require low-intensity monitoring. Large infestations are the opposite. Therefore, monitoring for satellite populations should emphasize detection, rather than treatment effect, while monitoring for large infestations should focus on determining treatment effectiveness and economic efficiency.

Priorities for weed and restoration monitoring in the Cub Creek watershed are based on management priorities and financial resources. Satellite populations need to be monitored for their presence in order to eradicate them. Large infestations do not need to be monitored for presence, but need to be evaluated for treatment success in order to prevent spending money on unsuccessful treatments or restoration. Therefore, in order to meet management goals, monitoring for the two types of infestations can be considered of equal importance. Unless sufficient resources are available to accomplish treatment implementation and monitoring for both types of infestations, satellite infestations should be given priority for both treatment and monitoring. Treatment of large infestations should wait until resources are available to implement monitoring as well, so that changes in treatments can be made as quickly as possible.

Monitoring scale and the type of data collected are based primarily on monitoring objectives and financial constraints. Monitoring scale can range from landscape level to sub-population level, while types of data collected include qualitative and quantitative data (Elzinga et al. 1998). Since the primary objective for monitoring of satellite populations is detection, and it is known that they are distributed throughout the watershed, a watershed-scale approach will be required. Also, since this is a preventative tactic, assessment of the full population is desired. This requires locating every individual, and can be very labor-intensive. However, once individuals are detected, a simple qualitative notation of presence will accomplish the monitoring objectives. For large infestations, emphasis is placed on evaluating the effectiveness of treatments, which is reflected by changes in the density or percent cover of target and non-target species. Since these infestations are large, there aren't the resources or the need to monitor the entire infestation. Instead, sub-samples of the larger population can be observed, and that information can be extrapolated to the whole infestation (Elzinga et al. 1998).

Monitoring Protocol

Satellite populations: Areas where new, small infestations are expected or have been previously found will be monitored, such as disturbed areas, travel corridors and riparian areas (Dewey et al. 2003). Temporary transects will be established with distances between them based on terrain, the density of vegetation, the size of target species and the number of technicians available and will be laid out so that all potential areas for weeds can be observed (Dewey 2004). Surveys will be performed at times of the year when target plants are easily identifiable, such as during flowering. Since detection is the most labor-intensive part of treatment for satellite populations, surveys should be made at a time of year when treatment is also appropriate (before seed-set for annual and biennial species and in rosette for some perennials), to allow for efficient treatment. Presence will be indicated by a "point" recorded by global positioning system (GPS) units and stored in a geographic information system (GIS). The actual number of individuals associated with each point should also be recorded to allow for some quantitative analysis, if deemed necessary. Surveys will be performed once every year until 2 years after satellite population presence has no longer been detected in the watershed. After that, surveys will be conducted every 5 years as part of the on-going maintenance for the watershed. If a treatment does not reduce the presence of a particular species by 40-65% in 2 years, alternative treatments will be considered.

Large Infestations: Monitoring for these infestations focuses on detecting changes in a population by tracking density (number of individuals per unit area) or percent cover (aerial cover) of target species and non-target species (including restoration species). Since observation of the entire population for either is not possible or even necessary, the establishment of subpopulation sample units reduces the time and money required to collect accurate data. A minimum of 10 permanent, 1m^2 quadrats will be randomly placed within each treatment type to track changes.

To randomize placement of quadrats, a random number generator, such as those found on scientific calculators, can be used; however, the numbers generated must be between 0 and 1. The random fraction is multiplied by the total amount possible for each selection. For instance, when randomly selecting which infestation each quadrat should be placed in, assign each infestation a sequential number and then multiply the random fraction by the total number of infestations. Round to the nearest whole number and that will be the infestation that receives that quadrat.

To randomly place the quadrat within the infestation, pick a center point within the infestation and multiply a new random fraction by 360. Using a compass, establish a heading from the center point of the infestation, based on this value (Elzinga et al. 1998). Next, estimate the distance from the center point of the infestation to the edge in the direction of the established heading. Multiply this number by a new random fraction and this is the distance from the center point, in the direction of the established compass heading, that the southwest corner of the quadrat is placed.

The use of permanent quadrats requires more time and resources initially; however, they make monitoring in subsequent seasons easier. The use of permanent quadrats will account for variation between and within infestations, and will reduce the total number of sampling units required overall (Elzinga et al. 1998). The disadvantage of using permanent quadrats is that they must be marked for relocation in such a way that does not bias the treatments and affect their ability to represent the larger population (e.g. attract livestock, hinder mowing or prevent drill seeding). A small marker installed at soil level can serve as a locator for one corner of the quadrat. The marker can be relocated using GPS, or if it is metal, it can be buried and located with a metal detector. Once the quadrat has been correctly placed, with the southwest corner on the marker, stem density can be counted fairly quickly and accurately within the quadrat and may be an appropriate activity to assign to volunteers. Percent cover is more subjective and less accurate; however, it may reveal changes that density would not. The use of cover classes at 10% increments will help reduce error (e.g. 11-20%, 21-30%…. etc.). Since both grazing and mowing treatments affect canopy structure, percent aerial cover must be estimated after a sufficient time has passed since the last treatment for the canopy to recover. If the 3-4 week interval recommended for grazing and mowing does not allow for full canopy recovery, it may be necessary to exclude the monitoring plots from treatment for a longer period of time before monitoring. Percent cover for each species present, bare ground, litter and rock should all be included. It is not necessary to include overstory vegetation in these quadrats, such as trees and shrubs, since this monitoring design is scaled to detect changes in herbaceous vegetation.

These same plots can be used to monitor the success of revegetation, as long as each seeding treatement receive a minimum of 10 initial quadrats (see below). Density of desirable species and percent cover are both indicators of the success of the seedings. As stated earlier, less than 2.7 plants/ m^2 (.25 plants/$ft.^2$) is considered poor establishment, while 2.7-5.4 plants/m^2 (.25-.5 plants/$ft.^2$) is considered fair, 5.4-8.1 plants/m^2 (.5-.75 plants/$ft.^2$) is considered good and 8.1 plants/m^2 (.75 plants/$ft.^2$) or more is considered excellent (Vallentine 1989). However, since management objectives also include the establishment of diverse and healthy plant communities, additional observations and calculations must be completed. Qualitative assessments of soil stability, hydrologic function and biotic integrity, combined with quantitative data that indicate potential causes for changes in condition are considered indicators of rangeland health (Pyke et al. 2002). Of the indicators suggested, the following specific attributes are recommended for observation in quadrats established for the Cub Creek watershed: presence of rills, bare ground, wind scour, litter amount and litter movement. Two of these, bare ground and litter amount have already been addressed; however, including notations that describe the presence and extent of rills, wind scour and litter movement will contribute to the assessment. Interpretation of the results are subjective; however, an increase in the presence of bare ground, rills, wind scour or litter movement and a decrease in the amount of litter present indicates a decreasing trend in range health.

Diversity is measured based on the number species, and the relative contribution of species and can be compared using a number of different indices (Chambers and Brown 1983). A commonly used index is Shannon's Diversity Index-H', which is calculated as follows:

$$H' = -\sum_{i=1}^{s} p_i \log p_i$$

where p_i is equal to species contribution and can be compared in terms of density, biomass or percent cover, for which data is already being collected. Values range from 0 to 1, with 1 indicating the most diversity. Revegetated areas are generally compared to reference sites; however, for the Cub Creek watershed, one has not been established. Therefore, statistical analysis is problematic, except for comparison with baseline data or between seeding treatments. Informal analysis can be done by averaging values from all quadrats and creating an overall value for all revegetation areas. A subjective evaluation of success can be made based on the range of values for the diversity index. A value of 0 indicates no establishment, and, therefore, no diversity. A value of 1 indicates maximum diversity, while .5 indicates moderate diversity.

The number of quadrats required to accurately determine the changes associated with treatments are based on the following factors: detection limits, variability of results, correlation between pre and post-treatment data, percentage of the whole population sampled and professional judgment (Elzinga et al. 1998). Since weed managers are primarily interested in treatments that will show major changes, capturing subtle differences is not necessary, which reduces the number of sample units required. The use of permanent quadrats also reduces the number of samples required. Unfortunately, the actual number of sample units required cannot be calculated until data have been collected after the first year of treatment. Therefore, 10 initial permanent quadrats for each treatment will be considered sufficient, and after data have been collected at the end of the first season of treatment, the following equation will be used to ensure that an adequate number of quadrats have been established (Elzinga et al. 1998):

$$n = S^2 8.5/.2C$$

n= number of quadrats required.

S= standard deviation between baseline data and post-treatment data

C= sample mean of baseline data

Both type I and type II error levels have been set at 10% and minimum detectable change has been set at 20%. If it is determined that additional quadrats are required, they should be established following the same procedure as the original quadrats and sampled immediately, so that they can be included with the other data gathered during that same period.

Baseline data will need to be collected once before treatments are implemented, for comparison. Afterwards, data will be collected only near the end of each treatment season, before the target plants go dormant, but after they have recovered from the last defoliation event. It is important to note that over time the large infestations will become a series of smaller infestations and may eventually be considered satellite populations. Whether DINO decides to change the management goals for these satellite populations will depend on priorities and available resources.

Data Interpretation

Changes in the number of satellite populations can be expected to be evident after the first year of treatment, as the number of populations present in the GIS database for each target species declines. Some populations represent many individuals and may require multiple treatments before they are eradicated. If the number of populations for a species does not show a sharp decline, it may be necessary to do more in-depth analysis and calculate if there is a reduction of individuals within each population. For each population, the first count of individuals can be compared to counts after treatment to generate a percent change in individuals. These can be averaged across populations of the same species to generate a mean value for a particular treatment against a particular species. In general, if the resulting percent reduction of individuals is less than 40-65%, an alternative treatment may be justified.

The larger infestations use the same technique to normalize data and create averages of treatment effectiveness across differences within and between infestations. For each quadrat, percent change from the baseline data will be calculated and then averaged among quadrats within each treatment. These averages can be compared across treatments to gauge the effectiveness of the various treatments. For selective grazing and mowing treatments, a moderate (35-75%) density or percent cover reduction compared to the baseline data warrants repeating the treatment the following year. If the density or percent cover reduction is high (75-100%), the treatment should be replaced with herbicide the following year and revegetation should be implemented. A low (0-35%) reduction in density or percent cover may be acceptable for the first year, since the initial depletion of the root reserves of Russian knapweed may take time to have an effect. As mentioned earlier, initial stem densities may actually increase after mowing and grazing treatments due to decrease in apical dominance; however, within 2-3 seasons of repeated treatments a decrease in stem density should become apparent. If not, changing to an herbicide treatment may be desired. Herbicide treatments can be expected to result in 90-100% reduction in the first year (Benz et al. 1999); however, there may be less with wick applications. Glyphosate may also be less effective than clopyralid or clopyralid+2,4-D, especially on drier sites. In general, less than 60% reduction of density or percent cover would warrant the use of an alternate herbicide, unless proximity to water requires the use of *glyphosate (Aquamaster). In this case, as low as 20-30% reduction in density or percent cover may be acceptable, since no other options exist. Follow-up treatments would be required for several years to complete treatment. It is important to note that other factors besides the results of monitoring will help to decide what treatments to use, including economics, logistics and public feedback.*

There is no need for formal statistical analysis for data gathered from the monitoring of satellite populations. Since the entire population is being censused, there is no chance of sampling error and any changes observed are real (Elzinga et al. 1998). It is possible to run formal statistical analysis on the data gathered from the permanent quadrats in the large infestations; however, there are some considerations. The first is that the informal analysis based on average percent change of density or percent cover among quadrats described above is probably adequate for making most weed management decisions. The second is that since the quadrats have been spread randomly among the infestations within areas that receive each treatment, there has been no stratification among differences in initial density or percent cover. Given the variation in infestations in the Cub Creek watershed, this will likely produce a very large standard deviation among the baseline data and a formal statistical test such as a T-test would only detect large changes. This would be problematic except that as mentioned earlier, weed managers generally are only interested in large changes, so it may not be a problem. If it were a problem, one solution would be to establish an equal number of randomly placed "control" quadrats in untreated areas. These quadrats would not receive treatments and would be assumed to represent natural variation in density or percent cover from season to season. The percent change could be compared to treated quadrats to show formal statistical differences to density and percent cover resulting from treatments. This, of course, is problematic since leaving patches of target species untreated for comparison would interfere with management objectives.

Monitoring Summary

Topic	Satellite Populations	Large Infestations
Monitoring objective	detection of whole population	effect of treatments
Scale	whole population distributed throughout the watershed	sub-population
Sampling unit	temporary transect	permanent quadrat
# of sample units	enough to cover all potential sites	at least 10 per treatment
Data type	presence (qualitative)	density, % cover, rills, wind scour, litter movement and diversity (quantitative and qualitative)
Sample frequency and timing	once/year, before treatment, then every five years after treatment has been completed	once before treatment implementation, then once/year after treatment
Required for treatment?	yes, to locate for treatment	yes, to assess results of treatment
Statistical analysis	none	optional (T-test)

Work Summary

(see text for important details and alternative treatments)

	Treatments:		
Species	**Mechanical**	**Chemical**	**Cultural**
Burdock .04ha(.1ac)	Spudding (before seed-set) .04ha(.1ac)	Glyphosate -2% (veg. growth) 2,4-D-.18-.72 L/ha(.08-.3 Q/ac) .04ha(.1ac)	
Houndstongue .3ha(.85ac)	Spudding (before seed-set) .3ha(.85ac)	2,4-D-1.12 kg/ha(1 lb/ac) (early spring) .3ha(.85ac)	
Yellow sweetclover 5ha(12.8ac)	Spudding (before seed-set) 2.8ha(7ac)	Glyphosate-2% 2,4-D-2.4-4.8 L/ha(2-4pts/ac) 2.2ha(5.7ac)	Revegetation Zone B: .4ha(1ac)
Bull thistle .8ha(1.9ac)	Spudding (before seed-set) .8ha(1.9ac)	2,4-D-.16kg/ha(.15 lbs/ac) (spring) .8ha(1.9ac)	
Musk thistle <.04ha(<.1ac)	Spudding (before seed-set) <.04ha(<.1ac)	2,4-D-.24kg/ha(.22 lbs/ac) (spring) <.04ha(<.1ac)	
Scotch thistle <.04ha(<.1ac)	Spudding (before seed-set) <.04ha(<.1ac)	2,4-D-.32kg/ha(.29 lbs/ac) (before bolting) <.04ha(<.1ac)	
Diffuse knapweed .04ha(<.1ac)	Pulling (3X/yr.) .04ha(<.1ac)	Glyphosate-2% (active growth) 2,4-D- 1-1.5 kg/ha(.9-1.4 lbs/ac) (active growth) .04ha(<.1ac)	
Saltcedar 7.8ha (19.3ac)	Cutting 7.8ha (19.3ac)	Glyphosate or triclopyr-100% 7.8ha (19.3ac)	
White Poplar (area unknown)	Cutting (area unknown)	Glyphosate or triclopyr-100% (area unknown)	

	Treatments:		
Species	**Mechanical**	**Chemical**	**Cultural**
Russian olive <.04ha (<.1ac)	Cutting <.04ha (<.1ac)	Glyphosate or triclopyr-100%-<.04ha (<.1ac)	
Hoary cress <.04ha(<.1ac)		2,4-D- .32-.48 kg/ha(.32-.44 lbs/ac) (pre-bloom) Imazapyr (Habitat-near water)- .02L/ha(.08-.16 Q/ac) (pre-bloom)- <.04ha(<.1ac)	
Perennial pepperweed <.04ha(<.01ac)		Glyphosate-2% or 1.75L/ha (4 Q/ac) (flowerbud phase)- <.04ha(<.1ac)	
Canada thistle 4.3ha(10.8acr)		Glyphosate-2.5-4% (fall rosette) Clopyralid or Clopyralid +2,4-D -.56 kg/ha(.5 lbs/ac) or .028+.112 kg/ha(.025+.1 lb/ac) (June or fall)- 4.3ha(10.8acr)	Revegetation Zone A: 1.6ha(4ac)
Russian knapweed – point infestations 10.8ha(27ac)		Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-10.8ha(27ac)	Revegetation Zone B: 1.6ha(4ac)
Infestation #1 .24ha(.6ac)	Mowing (every 3-4 weeks from June-October)-.24ha(.6ac)	Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-.24ha(.6ac)	Revegetation Zone A: .24ha(.6ac)
Infestation#2 1.6ha(4ac)	Mowing (every 3-4 weeks from June-October)-1.6ha(4ac)	Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-1.6ha(4ac)	Revegetation Zone A: 1.6ha(4ac)
Infestation#3 9.6ha(24ac)	Mowing (every 3-4 weeks from June-October)- 1.6ha(4ac)	Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-9.6ha(24ac)	Grazing-100% utilization every 3-4 weeks (June-Oct.)- 8ha(20ac) Revegetation Zone A: 9.6ha(24ac) Drill-seeding: 5.6ha(14ac)

Infestation#4 1.4ha(3.6ac)	Mowing (every 3-4 weeks from June-October)- .7ha(1.8ac)	Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-1.4ha(3.6ac)	Grazing-100% utilization every 3-4 weeks (June-Oct.).7ha(1.8ac) Revegetation Zone B: 1.4ha(3.6ac)
Infestation#5 3ha(7.3ac)		Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-3ha(7.3ac)	
Infestation#6 1.4ha(3.6ac)	Mowing (every 3-4 weeks from June-October)- .7ha(1.8ac)	Glyphosate- 2% (June or Aug) Clopyralid-.32 kg/ha(.29 lbs/ac) [+2,4-D-+1.65 kg/ha(1.6lb/ac)] (July, Aug ,Oct)-1.4ha(3.6ac)	Grazing-100% utilization every 3-4 weeks (June-Oct.)-.7ha(1.8ac) Revegetation Zone A: 1.4ha(3.6ac)
Quackgrass (area unknown)	Mowing repeatedly (area unknown)	Glyphosate-1.5kg/ha(1.38 lbs/ac) or 5% Sethoxydim-3L/ha(1.3 Q/ac) or 1.5% (area unknown)	Burning (area unknown)
Cheatgrass (area unknown)	Mowing (during boot stage) (area unknown)	Glyphosate-.2-.4kg/ha(.18-.37 lbs/ac) (active growth) Sethoxydim-n/a (active growth) (area unknown)	Grazing (during boot stage) (area unknown)
Total	Spudding: 4ha(10ac)	Cut & Paint herbicide application:7.8ha(19.4ac)	Grazing: 9.4ha (23.6 acres)
	Mowing: 4.8ha(12.2ac)	Wick or Spot-spray application: 36ha(90ac)	Revegtation ZoneA: 14.5ha (36.2ac) ZoneB: 3.4ha (8.6ac) Drill-seeding: 5.6ha(14ac)

Proposed Work Schedule

Season 1

May	June	July	August	September	October	November

|---------------T&E surveys------------------|

|Post interpretive signs-|

|-Survey and apply herbicide to perennial satellite populations-|

|-Treat biennial satellite populations -||-Treat woody species-|

|---------See Note 1 ---------| |- See Note 2-|

|-Consult with grazing contractor-||---collect baseline data for monitoring--|

|---------Collect seed----------|

|-Establish seeding trials-|

Note 1: Apply herbicide to large perennial infestations in the ABSENCE of listed plant species.

Note 2: Apply herbicide to large perennial infestations in areas where listed plants are PRESENT; also an effective time to treat same infestations regardless of listed plant presence depending on chemical used.

Season 2

May	June	July	August	September	October	November

|-----------------T&E surveys----------------|

|---Prepare for grazing---| |----grazing and mowing treatments-----|

|-monitor treatments-| |-seed-|

|-follow-up survey and treat satellite populations-|

|---------See Note 1 ---------| |- See Note 2-|

Season 3

Repeat as necessary.

Monitoring Data Form

Project Title:		Location:			Page___ of ___
Date:	Quadrat #:	GPS coordinates: N E		Treatment:	Recorder:
Quantitative Measurements					
Species	Density (individuals/plot)		Species:	% Cover (in increments of 10%)	

Qualitative Measurements

	none	slight	moderate	extreme	comments:
Rills					
Wind scour					
Litter movement					

Notes:

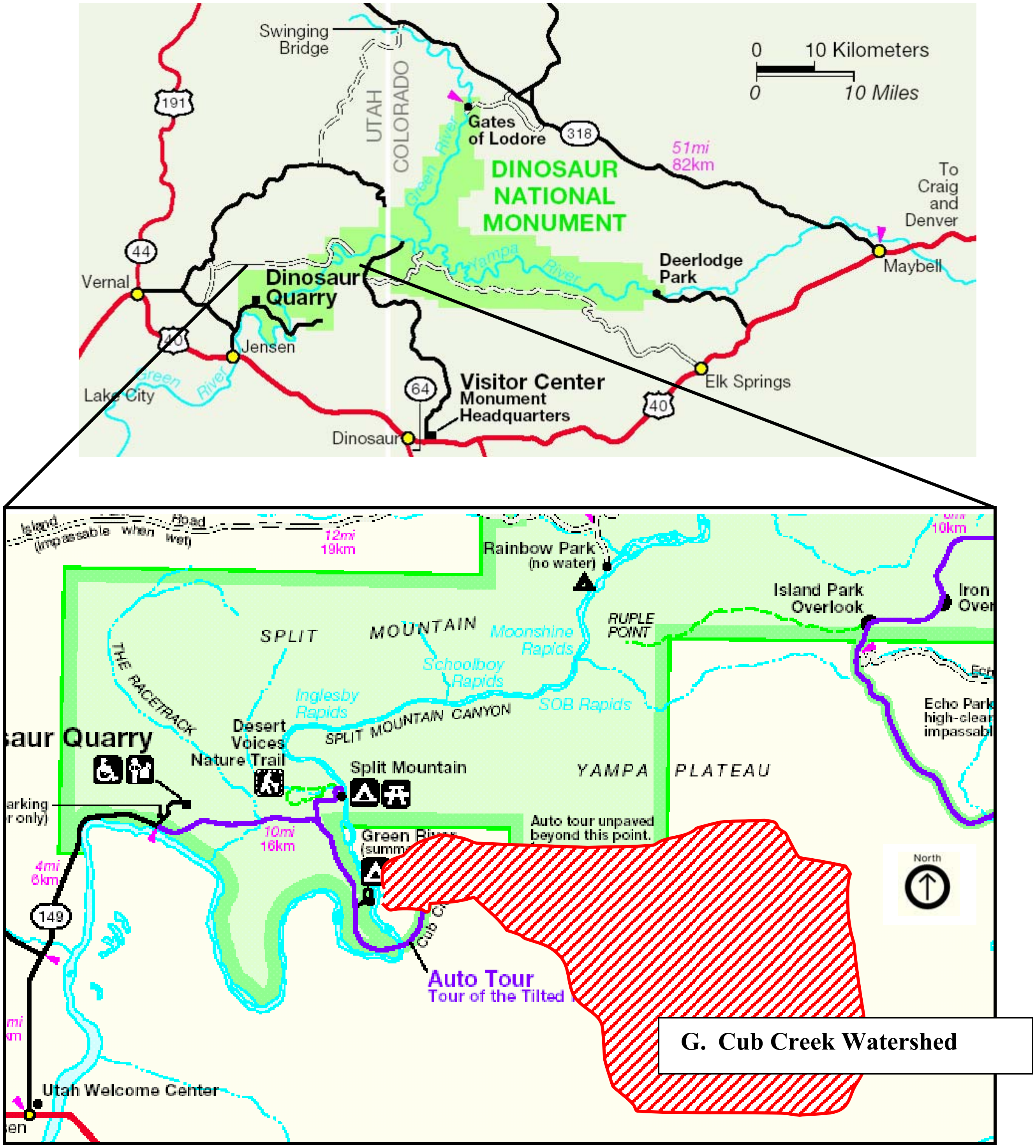

Figure 1. Map of the Cub Creek watershed and surrounding areas.

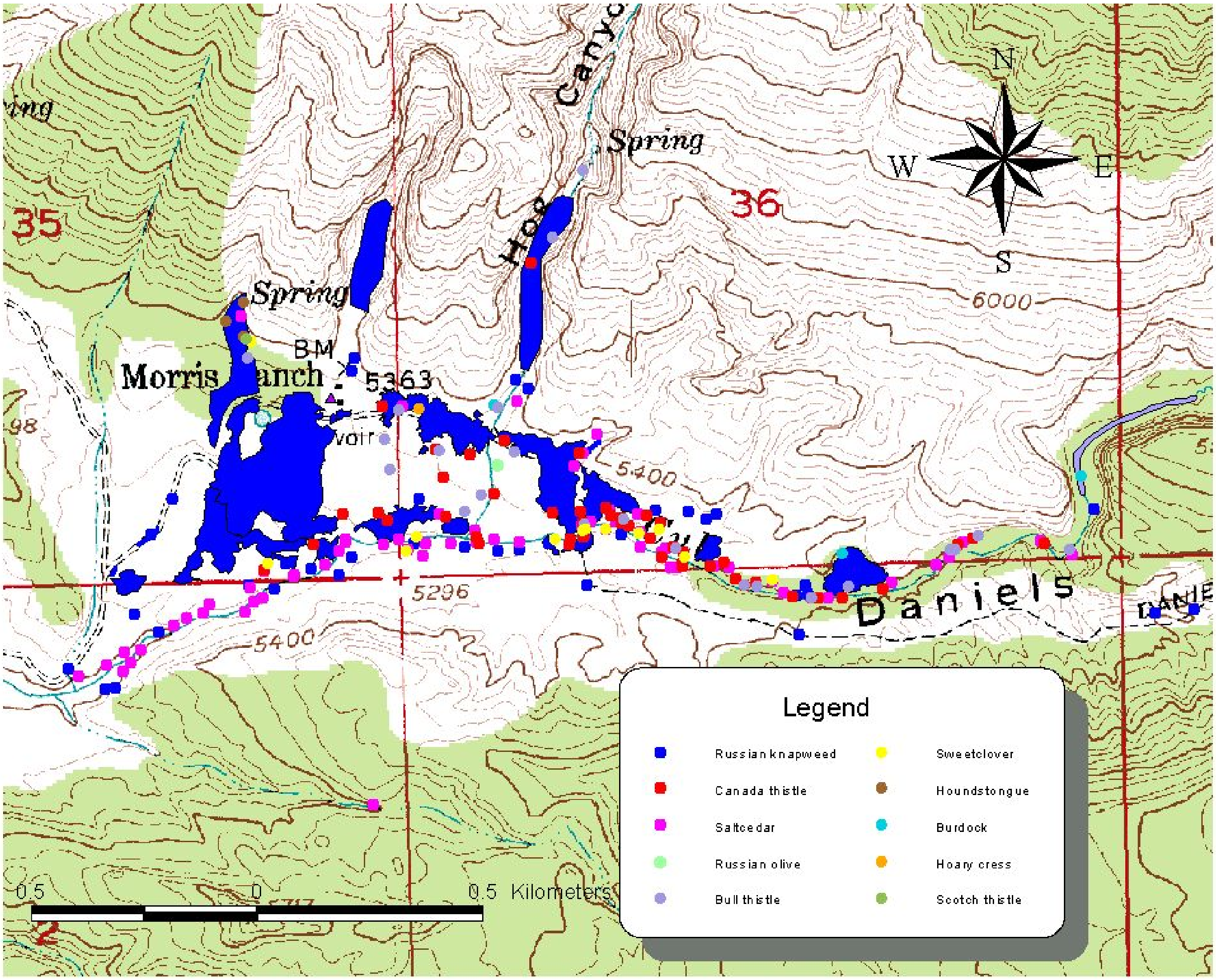

Figure 2. Distribution of weeds targeted for control in the vicinity of the Josie Morris homestead.

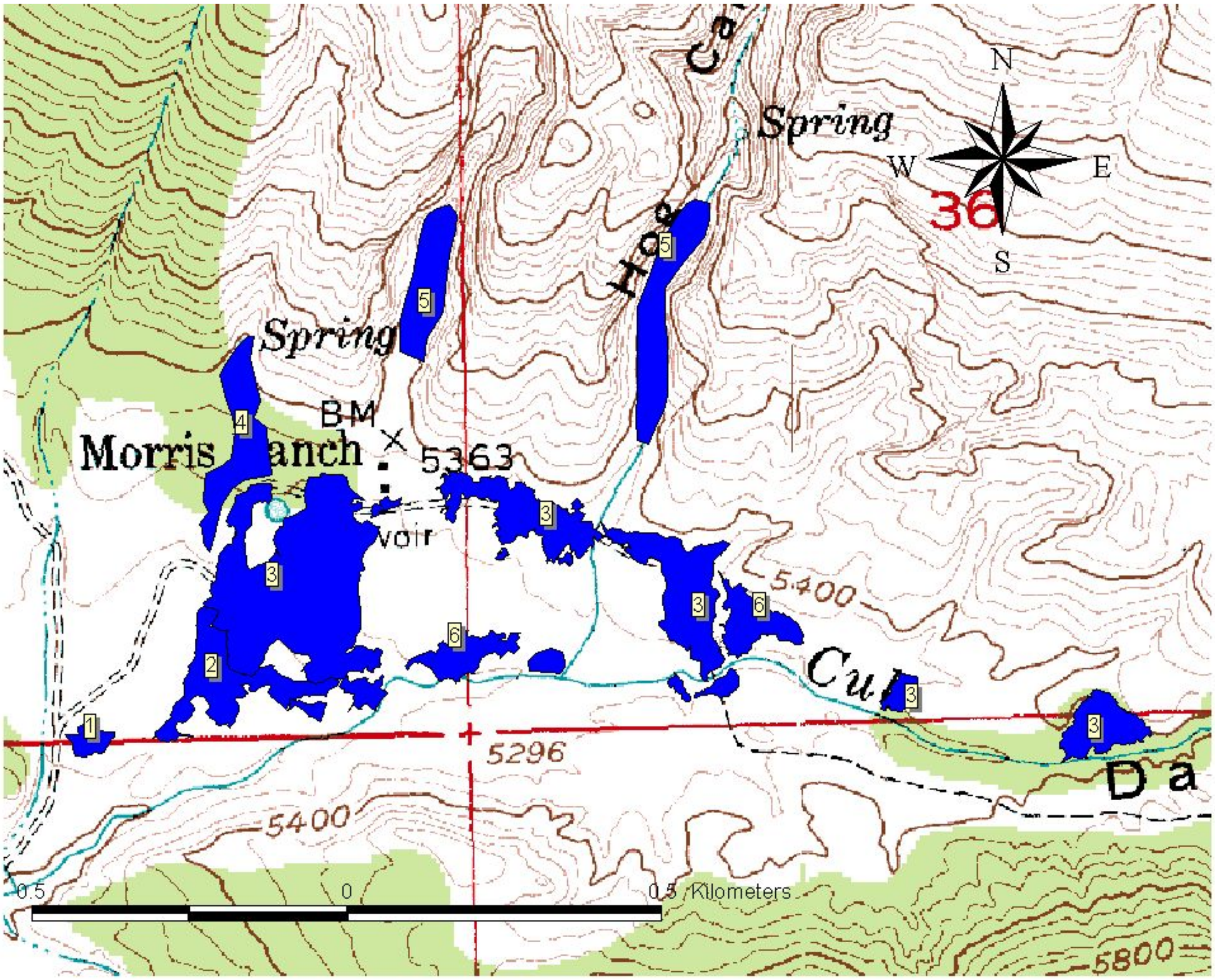

Figure 3. Russian knapweed infestations that have been prescribed special treatment due to their size, in order to reduce potential negative impacts.

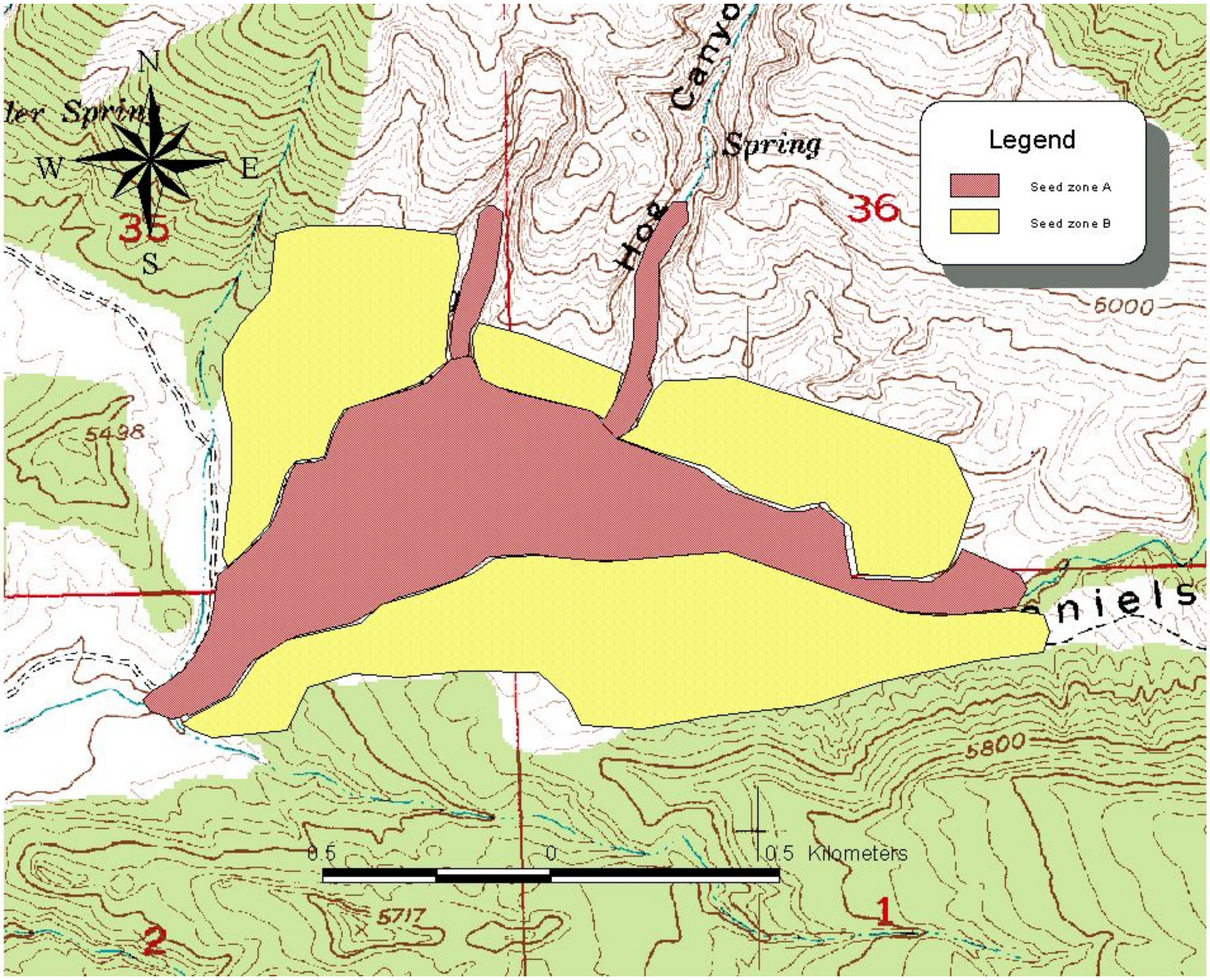

Figure 4. Distribution of proposed seed mixes for use in revegetation of weed infestations in the vicinity of the Josie Morris homestead.

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Appendix D:

Land Use and Park Operations Best Management Practices (BMPs) for Invasive Plant Prevention

Dinosaur National Monument

October 2004

The most effective, economical, and ecologically sound approach to managing invasive plants is to prevent their invasion in the first place. Often, land managers direct limited resources into fighting firmly established infestations. By that stage, management is expensive and eradication is probably impossible. Certainly it is necessary to manage infestations to limit spread of invasive plants into non-infested areas. However, limited resources might be spent more efficiently on proactive weed management that controls existing weed infestations but also focuses on prevention or early detection of new invasions (CIPM 2003).

The following practices are adapted and compiled from multiple land management organization experienced field personnel that have identified invasive plant prevention as a priority practice in their overall strategy to manage invasive species. This list incorporates many suggested practices under many types of land management operation types and is designed to allow managers to pick and choose those practices that are most applicable and feasible to individual park operations as staffing and budgets allow.

Invasive Plant Prevention: Lands

Site-Disturbing Projects and Maintenance Programs

Project Planning

- Environmental analyses for projects and maintenance programs should assess weed risks, analyze high-risk sites for potential weed establishment and spread, and identify prevention practices.
- Determine site-specific restoration and monitoring needs and objectives at the onset of project planning.
- Learn to recognize desirable plants as well as weeds.
- Before ground-disturbing activities begin, inventory and prioritize weed infestations for treatment in project operating areas and along access routes. Identify what weeds are on site or within the vicinity and do a risk assessment accordingly. Control weeds as necessary.
- Begin project operations in non-infested areas. Restrict movement of equipment and machinery *from* weed-contaminated areas *to* non-contaminated areas. This includes machinery used for or by park operations construction, recreation, agriculture, forestry, oil and gas exploration and production, utility companies, and tourism.
- Locate and use weed-free project staging areas. Avoid or minimize travel through weed-infested areas, or restrict travel to periods when spread of seed or propagules is least likely.

- Identify sites where equipment can be cleaned. Remove mud, dirt, and plant parts from project equipment before moving it into a project area. Seeds and plant parts should be collected and incinerated when practical.
- Coordinate project activities with nearby herbicide applications to maximize cost effectiveness of weed treatments.
- Evaluate options to regulate the flow of traffic on sites where desired vegetation needs to be established or maintained.
- Inspect materials on origination site to ensure that they are weed-free before transport and use. Only material from certified weed-free inspected and approved pit sources will be used, unless the material is heat treated to 300°F to kill weed seeds. If in-house sources of sand, gravel, and fill are infested, eradicate weeds, then strip and stockpile the contaminated material for several years, if possible, checking regularly for weed re-emergence.
- When material from a weed-infested but treated source is used in a project, inspect and document the project area annually for at least three years to ensure that any weeds transported to the site are promptly detected and controlled.
- Maintain stockpiled, non-infested material in a weed-free condition.
- Maintain equipment storage and staging areas in weed-free condition.
- Use local seeding guidelines to determine procedures and appropriate seed mixes. A certified seed laboratory needs to test each lot according to Association of Seed Technologists and Analysts (AOSTA) standards (which include an all-state noxious weed list) and provide documentation of the seed inspection test. Check state and federal lists to see if any local weeds need to be added prior to testing. Non-certified seed should be tested before use.

Project Implementation

- Minimize soil disturbance.
- If a disturbed area must be left bare for a considerable length of time, cover the area with weed barrier until revegetation is possible.
- When working in vegetation types with relatively closed canopies, retain shade to the extent possible to suppress weeds and prevent establishment and growth.
- Retain native vegetation and topsoil in and around project activity as much as possible.

Post-project Follow-up

- Clean all equipment before leaving the project site if operating in weed infested areas.
- Inspect, remove, and properly dispose of weed seed and plant parts found on clothing and equipment. Proper disposal means bagging and incinerating seeds and plant parts or washing equipment in an approved containment area.
- Revegetate disturbed soil where appropriate to optimize plant establishment for that specific site. Define for each project what constitutes disturbed soil and objectives for revegetation.
- Revegetation may include topsoil replacement, planting, seeding, fertilization, and weed-free mulching as necessary. Use native material where appropriate and feasible. Use known or certified weed-free or weed-seed-free mulch where certified materials are required or available.

- Monitor sites where seed, hay, straw, or mulch has been applied. Eradicate weeds before they seed. In contracted projects, contract specifications can require that the contractor maintain the site weed-free for a specified time.
- Where practical, stockpile weed-seed-free topsoil and replace it on disturbed areas (for example, road embankments or landings).
- Inspect and document all ground-disturbing operations in noxious weed infested areas for at least three growing seasons following completion of the project. For ongoing projects, continue to monitor until reasonably certain that no weeds have appeared. Plan for follow-up treatments based on inspection results.

Roads and Utilities

Pre-project Planning

- Communicate with contractors, local weed districts or weed management areas about projects and best practices for prevention.
- Fill materials brought into the park from commercial or other sources shall come from borrow pits that have been inspected by the NPS (or with prior consultation, County weed management staff) and approved as free of invasive non-native plants. Fill material includes, but is not limited to, gravel, sand, road base, pit run, crusher fines, or any similar materials that will be transported into the monument from outside sources. Inspect gravel pits and fill sources annually to ensure weed-free status.
- Remove mud, dirt, and plant parts from project equipment before moving it into a project area. Seeds and plant parts should be collected and incinerated when practical, or washed off in an approved containment area.
- Restrict transportation of non-certified weed-free forage and hay on through roads.
- Avoid acquiring water for road dust abatement where access to water is through weed-infested sites.
- Treat all seed-bearing invasive weeds on travel right-of-ways at least 1 month before construction equipment moves into a relatively weed-free area.
- Schedule and coordinate blading or pulling of noxious weed-infested roadsides or ditches in consultation with the local weed specialist. When it is necessary to blade noxious weed-infested roadsides or ditches, schedule activity when seeds or propagules are least likely to be viable and spread.

Project Implementation

- Retain shade to suppress weed by minimizing the removal of trees and other roadside vegetation during construction, reconstruction, and maintenance; particularly on south aspects.
- Do not blade or pull roadsides and ditches infested with noxious weeds unless doing so is required for public safety or protection of the roadway. If the ditch must be pulled, ensure weeds remain on-site. Blade from least infested to most infested areas.

Post-project

- Clean all equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts before leaving the project site if operating in areas infested with weeds. Seeds and plant parts should be collected and incinerated when practical.

- Where re-seeding has been specified for construction, reconstruction, and maintenance activities, seed all disturbed soil (except travel route) within 7 days of work completion at the site.
- Use a seed mix fit for local environmental conditions that includes fast, early-growing (preferably native) species that is certified weed-free to provide quick revegetation. Consider the following options to assist in successful germination: applying weed-free mulch with seeding.
- Periodically inspect roads and rights-of-way for noxious weeds. Train road maintenance staff and utility truck operators to recognize weeds and report locations to the local weed specialist. Inventory weed infestations and schedule them for treatment.
- Treat weeds in road decommissioning and reclamation projects before roads are made impassable. Re-inspect and follow up based on initial inspection and documentation.
- To avoid weed infestation, build and maintain healthy plant communities whenever possible, including utility rights of way, roadsides, highway landscaping projects, rest area construction, scenic overlooks, and entrances.

Routine Roadside Maintenance

- Consider planting low maintenance (preferably native) vegetation on problem roadside areas (e.g. where frequent ditching or grading is required to maintain proper drainage). This may reduce the need for mowing, ditching, grading – all of which contribute to weed introduction and spread.
- Mow roadsides when target weed(s) will be most impacted but desirable vegetation will be least damaged (e.g. when cheatgrass is in the “red” color stage).

Wilderness Recreation

- Inspect and clean mechanized trail vehicles of weeds and their seeds.
- Wash boots and socks before hiking into a new area. Inspect and clean packs, equipment, and bike tires.
- Avoid hiking through weed infestations whenever possible. Wearing gators when hiking in weedy areas can greatly reduce the chance of picking up weed seeds in socks and shoelaces.
- Keep dogs and other pets free of weed seeds. Weeds often grow along trails; leash dogs when weeds are in seed.
- Avoid picking unidentified "wildflowers" and discarding them along trails or roadways.
- Maintain trailheads, campgrounds, visitor centers, boat launches, picnic areas, roads leading to trailheads, and other areas of concentrated public use in a weed-free condition. Consider high-use recreation areas as high priorities for weed eradication.
- Provide containers at parking lots, campgrounds, trailheads, and river access points for visitors to deposit removed seeds.
- Sign trailheads and access points that are not scheduled for treatment to assist in educating visitors on the consequences of their activities.
- In areas susceptible to weed infestation, limit vehicles to designated, maintained travel routes. Inspect and document travel corridors for weeds and treat as necessary.

Invasive Plant Prevention: Water

Aquatic Recreation

- Maintain l00-foot weed-free clearance around boat launches and docks.
- As part of the permit, require boats/trailers and other boating equipment to be cleaned prior to arriving at the launch site.
- Inspect boats, trailers, and other boating equipment and remove any visible plants, animals, or mud before leaving any waters or boat launching facilities.
- Wash and dry boats, tackle, float tubes, waders, nets, downriggers, anchors, floors of boats, axles, trailers, and other boating equipment to remove or kill harmful species not visible at boat launch before transporting to new waters. Use hot (40°C / 104°F) clean water or a high-pressure sprayer, or allow boat and equipment to dry for a minimum of five days.
- Avoid running personal watercraft through aquatic plants near boat access locations.
- Promptly post signs if aquatic invasives are found. Confine infestation; where prevention is infeasible or ineffective, close facility until infestation is contained.
- Wash or dry watercraft before transporting to another body of water.
- Learn to recognize aquatic invasive species.
- Share prevention measures and practices with state fish and game departments, counties, and other adjacent agencies.

Watershed Management

- Frequently and systematically inspect and document riparian areas and wetlands for noxious weed establishment and spread. Eradicate new infestations before they become established since effective tools for riparian-area management are limited.
- When possible, maintain conditions that sustain desired riparian plant systems that compete effectively with weeds.
- Promote dense growth of desirable vegetation in riparian areas (where appropriate) to minimize the availability of landing and germination sites for weed seeds and propagules that might be produced upstream.
- Address noxious weed risks in watershed restoration projects and water quality management plans.

Invasive Plant Prevention: Animals

Grazing Management

- Consider prevention practices and cooperative management of weeds in grazing allotments. Prevention practices may include (see below for detail recommendations):
    - Altering season of use
    - Exclusion
    - Weed control methods
    - Revegetation
    - Education
    - Activities to minimize ground disturbance
    - Preventing weed seed transportation
    - Maintaining healthy vegetation
    - Inspection
    - Reporting

- Except on private in holdings or in emergency situations as permitted, no supplemental feed of livestock allowed in the monument. In situations where supplemental feed is allowed, certified weed free hay/feed is required within monument boundaries.
- Provide certified weed-free supplemental feed in a designated area so new weed infestations can be detected and treated immediately. Pelletized feed is unlikely to contain viable weed seed.
- If livestock may contribute to seed spread in a weed-infested area, schedule livestock use for prior to seed-set or after seed has fallen.
- If livestock were transported from a weed-infested area, annually inspect and treat entry units for new weed infestations.
- Consider closing infested pastures to livestock grazing when grazing will either continue to exacerbate the condition or contribute to weed seed spread. Designate those pastures as unsuitable range until weed infestations are controlled.
- Noxious weeds can be introduced through seeds in livestock dung. Keep new livestock (especially livestock that may have been fed poor-quality hay) in a holding field for a minimum of 48 hours before releasing onto open range. Required quarantine periods could be longer depending on prior location of the animals, invasive species present in that area, biology of weed seeds and length of time required for animals to pass them, or at the request of the allotment permittee.
- Manage the timing, intensity (utilization), duration, and frequency of livestock activities to maintain the competitive ability of desirable plants and retain live plant cover and litter. The objective is to manage such that grazers are prevented from selectively removing desirable plant species and leaving undesirable species.
- Manage livestock grazing on restoration areas to ensure that desired vegetation is well established. This may involve exclusion for a period of time. Consider practices to also minimize wildlife grazing on the areas, if necessary.
- Reduce ground disturbance, including damage to biological soil crusts. Consider changes in the timing, intensity, duration, or frequency of livestock use; location and changes in salt grounds; restoration or protection of watering sites; and restoration of yarding/loafing areas, corrals, and other areas of concentrated livestock use.
- Inspect areas of concentrated livestock use for weed invasion. Especially focus on watering locations and other resource-rich environments that may be particularly susceptible to invasion. Inventory and manage new infestations.
- Defer livestock grazing in burned areas until vegetation has successfully reestablished, usually after 2 growing seasons.

Outfitting / Recreation Pack and Saddle Stock Use

- No supplemental feed of pack or livery is allowed in monument. In situations where supplemental feed is allowed by lease or concessionaire agreements, certified weed free hay/feed is required within monument boundaries.
- Noxious weeds can be introduced in pack or livery stock dung. Feed pack and saddle stock only weed-free feed for several days before traveling into the backcountry.
- Inspect, brush, and clean animals (especially hooves and legs) before entering public land. Inspect and clean tack and equipment.
- Regularly inspect trailheads and other staging areas for backcountry travel. Bedding in trailers and hay fed to pack and saddle animals may contain weed seed or propagules.
- Tie or hold stock in ways that minimize soil disturbance and avoid loss of desirable native species.
- Authorized trail sites for tying pack animals should be monitored several times per growing season to quickly identify and eradicate new weeds. Trampling and permanent damage to desired plants are likely. Tie-ups should be located away from water and in shaded areas where the low light helps suppress weed growth.
- Educate outfitters to look for and report new weed infestations.

Wildlife

- Periodically inspect and document areas where wildlife concentrate in the winter and spring that might result in overuse or soil scarification.
- Use weed-free materials for all wildlife management activities.
- Incorporate weed prevention into any wildlife habitat improvement project design.

Invasive Plant Prevention: Fire

Fire Management Plans

- Prescribed fire burn plans will include pre-burn invasive weed inventory and risk assessment components as well as post-burn mitigation components.
- Integrate prescribed fire and other weed management techniques to achieve best results. This may involve post-burn herbicide treatment or other practices that require careful timing.
- Include weed prevention and follow-up monitoring in all prescribed fire activities. Include in burn plans the possibility that post-burn weed treatment may be necessary.
- Implementation Plans for Wildland Fire for Resource Benefit will include considerations and mitigation measures for control of weed establishment and spread.

Incident Planning

- Increase weed awareness and weed prevention by providing training to new and/or seasonal fire staff in invasive weed identification and prevention BMPs.
- Provide weed ID aids, such as *Uintah County Noxious Weeds* pocket guides*, Noxious Weeds: A Biological Wildfire* video, *Explosion in Slow Motion: Weeds on Western Lands* video, and *Leave No Weeds* laminated cards.
- For prescribed burns, inventory the project area and evaluate potential weed spread with regard to the fire prescription. Areas with moderate to high weed cover should be managed for at least 2 years prior to the prescribed burn to reduce the number of weed seeds in the soil. Vigilant weed management will be necessary after the burn.
- Ensure that a weed specialist is included in a Fire Incident Management Team when wildfire or prescribed operations occur in or near a weed-infested area. Include a discussion of weed prevention operational practices in all fire briefings.
- Use operational practices to reduce weed spread (for example, avoid weed infestations when locating fire lines).
- Locate and treat weeds in practice areas.
- Identify and periodically inspect potential helispots, staging areas, incident command posts/base camps, etc. in advance of fire incidents camps and staging areas and keep them in a weed-free condition. Encourage network airports and helibases to do the same.
- Provide dispatch with information on known weed infestation areas; update annually.
- Develop a burned-area integrated weed management plan, including a monitoring component to detect and eradicate new weeds early.
- Provide weed documentation forms to be included with the Initial Attack Incident Commander, Prescribed Fire Monitor and Engine Boss kits.
- Utilize incident resources for weed mitigation as opportunities arise.

Fire-fighting

DINO Resources

- Ensure that all equipment (including borrowed or rental equipment) is free of weed seed and propagules before entering incident location.
- When possible, use fire suppression tactics that reduce disturbances to soil and vegetation, especially if creating fire lines.
- Use wet or scratch-lines where possible instead of fire breaks made with heavy equipment.
- Avoid moving water buckets from aquatic-weed-infested bodies of water to bodies that are not infested. There is no hazard in using water infested with aquatic weeds on terrestrial sites.
- Given the choice of strategies, avoid ignition and burning in areas at high risk for weed establishment or spread.
- Hose off vehicles on site if they have traveled through infested area.
- Inspect clothing for weed seeds if foot travel occurred in infested area.
- Where possible, establish incident bases, fire operations staging areas, and aircraft landing zones in areas that have been inspected and are verified to be free of invasive weeds
- If placement of operations facilities in weed-infested areas cannot be avoided, mow areas of concentrated activity if weeds are not yet in seed stage. If weeds are producing seeds, designate travel routes on weed-free paths.
- Cover weed infested cargo areas and net-loading areas with tarps if weeds exist and can't be removed or avoided.
- Flag off high-risk weed infestations in areas of concentrated activity and show weeds on facility maps.
- If fire operations involve travel or work in weed infested areas, a power wash station will be staged at or near incident base and helibase. Wash all vehicles and equipment upon arrival from and departure to each incident. This includes fuel trucks and aircraft service vehicles.
- Direct field personnel to report potential conflicts between weed prevention and fire management activities.

Interagency Resources

- Clean vehicles and equipment prior to entering Dinosaur National Monument, or during check-in at incident base or staging area, prior to assignment.
- All DINO vehicles and equipment sent off the monument for fire assistance will be cleaned before returning home or immediately upon returning home.
- Smoke jumpers will inspect gear and clothing for weed seeds and plant parts before coming onto the monument and before leaving the monument.
- Provide non-monument personnel with weed identification aids.

Post-fire / Rehabilitation

- Request that a weed specialist review burned area rehabilitation reports to ensure proper and effective weed prevention and management is addressed.
- Thoroughly clean the undercarriage and tires of vehicles and heavy equipment before entering a burned area.
- Treat weeds in burned areas. Weeds can recover as quickly as 2 weeks following a fire. Schedule recon 1 month and 1 year post-fire to identify and treat infestations. Eradicate or contain newly emerging infestations.
- Restrict travel to established roads to avoid compacting soil that could hinder the recovery of desired plants.
- Inspect and treat weeds that establish at equipment cleaning sites after fires.
- Determine soon after a fire whether revegetation is necessary to speed recovery of a competitive plant community, or whether desirable plants in the burned area will recover naturally. Consider the severity of the burn and the proportion of weeds to desirable plants on the land before it burned. In general, more severe burns and higher pre-burn weed populations increase the necessity of revegetation. Consider revegetating an area if the desired plant cover is only 20 to 30%. Use a certified weed-free seed mix.
- Inspect and document weed establishment at fire access roads, cleaning sites, all disturbed staging areas, and within burned areas. Control infestations to prevent spread within burned areas.
- Seed and straw mulch to be used for burn rehabilitation (for wattles, straw bales, dams, etc.) should be inspected and certified that they are free of weed seed and propagules.
- Weed-free or relatively weed-free burned areas should be monitored the following growing season.
- Identify need for possible fire rehab to prevent or mitigate weed invasion during fire incident and apply for funding during the Incident.
- Replace soil and vegetation right side up when rehabing fire line.
- Require certified weed-free mulching materials used in fire rehab operations.
- Require certified weed-free native plant seed when fire rehab plans call for reseeding.
- Monitor and treat weeds at power wash sites, fire access roads, and all areas disturbed by operations activities.

Invasive Plant Prevention: Education and Early Detection

- Contact appropriate personnel in state and county weed agencies on a regular basis to keep informed on the latest threats in the area and to update these guidelines with the current Best Practices for prevention.
- Communicate regularly with neighboring landowners and agencies to stay apprised of invasive threats and to coordinate prevention activities.
- Educate personnel and visitors in weed identification, biology, impacts, and effective prevention measures.
- Maintain proficient weed management expertise on staff. Expertise means that necessary skills are available and institutional knowledge is maintained.
- Develop or adopt weed-awareness programs and a list of simple prevention practices for local residents, concessionaires, fishing and hunting license-holders, outfitters, backcountry campers and other visitors. This should include mention of the important role of robust, undisturbed native vegetation and biotic soil crusts in deterring weed invasions and in facilitating repair and restoration of vegetation.
- Develop incentive programs for personnel and visitors encouraging weed awareness, detection, reporting, and identifying new invaders.
- Treat weeds at administrative sites and visitor centers and use weed prevention practices to maintain sites in a weed-free condition.
- Support the development and distribution of weed-free or weed-seed-free feed, hay, straw, and mulch.
- Develop a guide to assist visitors in self-inspection of vehicles and equipment at park entrance areas. Include a “most wanted” list with sketches or photos of propagules.

These guidelines are adapted and compiled primarily from the following resources:

Center for Invasive Plant Management. 2003. Invasive Plant Prevention Guidelines. Montana State University Publication, Missoula, MT.

Colorado Bureau of Land Management Weed Management Prevention Measures www.co.blm.gov/botony/lolostip.htm

Goodwin, K., R. Sheley, J. Clark. 2002. Integrated Noxious Weed Management After Wildfires. Montana State University Extension Services

USDA USFS 1998. DRAFT Weed Prevention Measures, Lolo National Forest, Bozeman, MT.

Appendix E: United States Fish and Wildlife Service Consultation Documentation

This appendices contains the following documents pertaining to consultation required under Section 7 of the Endangered Species Act:

1. T&E species list request letters to CO & UT USFWS Field Offices
2. Biological Assessment
3. Moffat County, CO and Uintah County, UT T&E species lists
4. USFWS letter of concurrence

United States Department of the Interior

NATIONAL PARK SERVICE
Dinosaur National Monument
4545 Highway 40
Dinosaur, CO 81610

February 11, 2004

Al Pfister
Field Supervisor for Ecological Services
United States Fish and Wildlife Service
764 Horizon Drive, Building B
Grand Junction, Colorado 81506-3904

Dear Mr. Pfister:

We are currently in the initial stages of developing an Invasive Plant Management Plan and Environmental Assessment for Dinosaur National Monument. In accordance with the National Environmental Policy Act, I am requesting a list of all threatened, endangered, and species of special concern for the portion of the monument that lies in Moffat County, CO. The proposed plan if for the monument-wide management of invasive species, which includes the Green and Yampa Rivers and their associated watersheds and uplands. Actions proposed in this plan will consider the presence of these species and their critical habitat.

Please send the list to my attention at the address listed above. Thank you for your assistance.

Sincerely,

/S/

Emily Spencer
Weed Management Planning Specialist
Dinosaur National Monument

United States Department of the Interior

NATIONAL PARK SERVICE
Dinosaur National Monument
4545 Highway 40
Dinosaur, CO 81610

February 11, 2004

Henry Maddux
Field Supervisor for Ecological Services
United States Fish and Wildlife Service
2369 W. Orton Circle
Suite 59
West Valley City, UT 84119

Dear Mr. Maddux:

We are currently in the initial stages of developing an Invasive Plant Management Plan and Environmental Assessment for Dinosaur National Monument. In accordance with the National Environmental Policy Act, I am requesting a list of all threatened, endangered, and species of special concern for Uintah County, UT. Actions proposed in this plan will consider the presence of these species and their critical habitat.

Please send the list to my attention at the address listed above. Thank you for your assistance.

Sincerely,

/S/

Emily Spencer
Weed Management Planning Specialist
Dinosaur National Monument

Invasive Species Management Plan and Environmental Assessment for Dinosaur National Monument

Biological Assessment

National Park Service

May 12, 2005

Prepared by:

Emily Spencer
Weed Management Planning Specialist
Dinosaur National Monument
National Park Service

Reviewed by:

Tamara Naumann
Botanist
Dinosaur National Monument
National Park Service

Cay Ogden
Biologist / T&E Species Coordinator, Intermountain Region
National Park Service

Submitted to:

Al Pfister
Western Slope Field Supervisor for Ecological Services
United States Fish and Wildlife Service
Grand Junction, Colorado

List of Abbreviations

APHIS	Animal and Plant Health Inspection Service
ATV	All Terrain Vehicle
BA	Biological Assessment
BLM	Bureau of Land Management
CE	Categorical Exclusion
DINO	Dinosaur National Monument
DO	Director's Order
EA	Environmental Assessment
ESA	Endangered Species Act
FWS	(United States) Fish and Wildlife Service
IPM	Integrated Pest Management
IWM	Integrated Weed Management
NEPA	National Environmental Policy Act
NPS	National Park Service
USDA	United States Department of Agriculture

Introduction

The purpose of this biological assessment is to determine the likely effects of implementing the preferred alternative of Dinosaur National Monument's (DINO) proposed Invasive Plant Management Plan on 10 federally listed species (endangered, threatened, candidate, and proposed). Director's Order 12 (DO-12), the NPS guidance for Conservation Planning, Environmental Impact Analysis, and Decision-making, requires a NEPA-compliant program for invasive plants management. The objective of this plan, which will serve as programmatic analysis (general guidance), is to provide coordinated, sound integrated weed management guidance to DINO within the framework and requirements of DO-12 and the NEPA process.

The preferred alternative, which proposes to use mechanical, cultural, chemical, biological controls, and expanded early detection and prevention techniques on invasive plants, considers the full range of appropriate IPM techniques available both now and in the future for proactive, adaptive integrated weed management. The other two alternatives analyzed in the plan's environmental assessment (EA) consider a course of action using a more limited range of available techniques and tools (i.e. no chemical or biological controls or expanded prevention/early detection techniques). The preferred alternative's more comprehensive approach is expected to be more economical and successful in treating and preventing unacceptable levels of invasive plants, while posing the least hazard to people, property, and environment.

The preferred alternative also most clearly meets the directive established in DO 77-7 that calls for "IPM procedures to be used to determine when to control pests and whether to use mechanical, physical, chemical, cultural, or biological means…" and allows the most flexibility and creativity in using available techniques to address invasive species infestations. Each infestation or area of infestations would have a treatment implementation plan, which in turn will direct the development of annual operating plans to achieve desired management objectives.

Section 7 of the Endangered Species Act of 1973, as amended, requires federal agencies to use their authorities to carry out programs to conserve endangered and threatened species, and to insure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of listed or proposed species, or result in the destruction or adverse modification of their critical habitats. A Biological Assessment must be prepared for federal actions that are “major construction activities” (defined under NEPA as a project significantly affecting the quality of the human environment) to evaluate the potential effects of the proposal on listed or proposed species. The contents of the BA are at the discretion of the federal agency, and will depend on the nature of the federal action (50 CFR 402.12(f)). The species considered in this assessment/evaluation include:

Common Name	**Scientific Name**	**Status**	**Known/suspected to be present?**	**Suitable habitat present?**	**Determination of Effect and Rationale Under the Preferred Alternative**
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Yes	Yes - winter	Not Likely to Adversely Affect
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Yes	Yes	Not Likely to Adversely Affect
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate for Listing	No	Yes	Not Likely to Adversely Affect
Black-footed Ferret	*Mustela nigripes*	Endangered	No	Yes	Not Likely to Adversely Affect
White-tailed prairie dog[1]	*Cynomys leucurus*	Removed from Consideration	Yes	Yes	Not Likely to Jeopardize Continued Existence or Adversely Modify Habitat
Bonytail chub	*Gila elegans*	Endangered	Yes	Yes	Not Likely to Adversely Affect
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered	Yes	Yes	Not Likely to Adversely Affect
Humpback chub	*Gila cypha*	Endangered	Yes	Yes	Not Likely to Adversely Affect
Razorback sucker	*Xyrauchen texanus*	Endangered	Yes	Yes	Not Likely to Adversely Affect
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	Yes	Yes	Not Likely to Adversely Affect

[1] The status of White-tailed prairie dog was “Petitioned for Listing” when the research and analysis for this document began in January 2004. However the species was removed from consideration on November 9, 2004 because FWS ruled that there was insufficient scientific information to warrant studying whether the species should be placed on the endangered species list. Dinosaur National Monument has chosen to keep all analysis and implement any relevant conservation measures that were completed for the species before its change in status because it provides critical habitat for the endangered Black-footed ferret, therefore making it a species of management concern to monument staff.

Eight additional species (boreal toad, Canada lynx, Clay Reed-mustard, Graham Beardtongue, Horseshoe milkvetch, Shrubby Reed-mustard, Uinta Basin Hookless Cactus, and White River Beardtongue) are listed for Moffat and/or Uintah Counties, however these species do not occur and suitable habitat is not present within the monument boundary. Therefore, the proposed Invasive Plant Management Plan and its actions would have “no effect” and a determination as such has been made for these species and their habitat(s).

The National Park Service is developing direction in DO 77-8 to guide habitat management for Endangered Species. Preparation of a Biological Assessment as part of the NEPA process ensures that Endangered Species receive full consideration in the decision-making process.

Description of the Proposal

Purpose and Need
The purpose of this planning effort is to develop a monument-wide integrated invasive plant management plan for Dinosaur National Monument that is in compliance with Executive Order 13112 (Invasive Species), National Park Service's *Management Policies* (2001), Director's Order 12 – Environmental Impact Analysis, and Director's Order 77-7, which requires that the Service and each park unit use IPM to address pest issues. Three alternatives are analyzed in the EA; the preferred alternative is analyzed in this Biological Assessment (BA).

The proposed plan is needed to achieve the following:

4. Preserve, protect, and restore natural conditions and ecological processes of Dinosaur National Monument by eradicating, significantly reducing, or containing infestations of 24 known invasive plants,
5. Prevent further introductions of invasive species already present in the monument as well as new species introductions by increasing visitor and staff awareness through education, by identifying mechanisms for cooperation among neighboring agencies and landowners, and by implementation of best management practices,
6. Establish decision-making tools and protocols that will guide treatment plan development for routine and project-based weed management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs)

Description of Action Area
The geographic scope of the Invasive Plant Management Plan is confined to the authorized boundary of Dinosaur NM. Therefore, the Invasive Plant Management Plan addresses proposed actions within the 211,141 acres of Dinosaur NM in Colorado and Utah and the EA considers impacts of those actions both within the monument and to adjacent areas that could reasonably be impacted by the Invasive Plant Management Plan.

The spread of invasive plants throughout Utah and Colorado poses a serious environmental and economic threat to public land, ranchland, farmland and private property in Uintah and Moffat counties. The success of a weed management program depends, in part, on the success of similar efforts on adjacent land. Therefore, Dinosaur National Monument has joined with other federal, state and local government agencies, non-profit organizations, and private landowners to develop joint strategies for curbing this silent threat.

The following agencies, organizations, and landowners have had an expressed interest in invasive species in Dinosaur National Monument and have active partnerships with the monument concerning invasive species management:

- Uintah Basin Cooperative Weed Management Area
- Dinosaurland RC&D
- Moffat County, Colorado
- Uintah County, Utah
- Uintah County weed board
- Chew Family Ranch
- U.S. Bureau of Reclamation
- U.S. Bureau of Land Management

- U.S. Fish and Wildlife Service
- Tamarisk Coalition
- The Nature Conservancy
- Outward Bound West (OBW)
- National Outdoor Leadership School (NOLS)
- Sierra Club
- Friends of the Yampa
- Utah State University
- Colorado State University
- Colorado Division of Wildlife
- Colorado State Parks

Examples of existing partnerships and projects include:

- Dinosaur National Monument Weed Warrior Program has worked for 7 years with over 2500 Colorado Outward Bound and National Outdoor Leadership School students removing tamarisk and perennial pepperweed along the Green and Yampa River canyons while exchanging educational and interpretive opportunities concerning national and local invasive species issues and concerns. Friends of the Yampa, a local volunteer group from Steamboat Springs, CO, has volunteered over 1650 hours removing tamarisk in innovative ways from the river canyons in DINO for the last 4 years while advocating for invasive species awareness in local communities.
- Dinosaur National Monument has actively participated in supporting and organizing several Uintah Basin Cooperative Weed Management Area and Dinosaurland RC&D workshops, meetings, and workdays to help focus multi-agency weed education and control efforts in the Uintah Basin.

Potential project partnerships include:

- Cooperative Russian olive and tamarisk removal with the Chew Family on adjacent monument and private land along the Green River in Utah - partners may include cooperative extension services, Uintah County, and other private landowners along the Green River.
- Yampa River Tamarisk and Russian Olive Management Cooperative Initiative, Routt and Moffat Counties, Colorado – proposed to begin in 2005, a comprehensive mapping and control effort will begin in northwest CO with the long-term goal of a tamarisk and Russian olive-free watershed. Partners committed in 2005 include BLM, Moffat and Routt counties, The Nature Conservancy, CO Division of Wildlife, CO State Parks, and several volunteer and service organizations.

Dinosaur National Monument continues to participate in Colorado Weed Management and Utah Weed Control Associations – organizations dedicated to statewide invasive species issues, and remains committed to pursuing new partnerships with interested entities to manage weeds cooperatively in northwestern CO and northeastern UT.

Description of Proposed Treatments

Please refer to Appendix A for a list of invasive plants for both Colorado and Utah.

Mechanical Control

Mechanical techniques for control of weeds in DINO include mowing, cutting/sawing, digging, pulling, spudding (severing of roots below the root crown), discing/plowing and smothering. Mechanical techniques can be especially effective in preventing seed production in annual and biennial forbs and exhausting root reserves in perennial plants (Meunscher 1980), and timing of these controls can be extremely important in determining outcome. For example, mowing cheatgrass in the “red” stage (post-flowering [“green”] but pre-curing [“tan”]) has proven to be very effective in some types of habitats. For perennial plants that reproduce vegetatively from root parts, mechanical treatments are generally not expected to provide complete control, even when repeated. Most often, they can be used as a tool for stressing the plants, making other treatments more effective (Derscheid et al. 1961, Renz and DiTomaso 1998).

The following mechanical controls have been found to be effective on weeds found in Dinosaur National Monument (See Appendix B for details and citations):

Mechanical Control:	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Mowing	X	X		X	X	X	X	X	X		X		X	X		X						
Cutting/sawing			X			X	X	X		X		X			X			X	X		X	X
Smothering									X													
Digging/pulling/ spudding	X						X	X		X	X				X		X				X	
Plowing/discing	X	X			X		X		X					X		X	X			X		

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress
CRUNU musk thistle **CENDI** diffuse knapweed **CENMA** spotted knapweed **CIRAR** Canada thistle **CIRVU** bull thistle
CYWOF houndstongue **ELGAN** Russian olive **ELRE3** quackgrass **EPHES** leafy spurge **HYSNI** black henbane
LEPLA perennial pepperweed **LINDA/LIVU2** Dalmatian toadflax/yellow toadflax **MEUOF** yellow sweet clover
ONRAC Scotch thistle **SONUL** meadow sowthistle **TAARA** tamarisk / saltcedar **ULMPU** Siberian / Chinese elm

NOTE: Some control techniques for control of weeds (mowing, discing/plowing, chemical application, seeding) involve the use of motorized vehicles, such as ATV’s and tractors. Because much of DINO is proposed Wilderness, there is a monument-wide ban on off-road uses of these types of vehicles, including for use in routine park operations. Exceptions may be granted under special circumstances requiring additional scrutiny by monument staff. Weed management is no different than other park operations and use of motorized vehicles for weed control will be considered only under special circumstances and on a project-by-project basis.

Cultural Control

Cultural controls consist of actions that managers can take to indirectly impact weed populations. Cultural controls can often be very cost-effective and therefore useful on large scales. Proposed treatments that have been shown to be effective on weeds in DINO include: prescribed grazing of domestic livestock, prescribed fire and restoration/revegetation.

Land managers can use domestic livestock to selectively overgraze certain weed species to prevent seed set or weaken plant structure. In general, sheep and goats prefer forbs and can be used to graze broad-leaved weeds, while cattle prefer grasses and can be used to manage undesirable grasses (Tu et al. 2001). Both can be effective in reducing litter build-up prior to herbicide applications.

DINO is one of the few units in the NPS that currently has active cattle grazing allotments within its boundaries. *It is important in this document to draw a distinction between prescribed grazing as a tool for weed management and current permitted grazing management operations within the monument.* The plan includes use of all classes of domestic livestock (cattle, sheep, and goats) for weed management purposes only and does not attempt to address or change (with the exception of particular Best Management Practices) current permitted grazing operations as permitted and described in Dinosaur National Monument's founding legislation. The monument recognizes the opportunity for partnerships between the monument and current permittees to utilize cattle for prescriptive grazing to benefit resource management when the goals, objectives, and schedule of the grazing activity are agreeable to both parties. Such opportunities will be considered on a project-by-project basis and will be developed in close coordination and communication with the operator. In 1960, Congress set forth provisions for the systematic phasing out (retiring) of grazing activities within the monument over time, however, this plan seeks to use domestic livestock in a prescriptive manner for weed management regardless of the status of permitted grazing operations on allotments within the monument.

There has been ongoing concern across the West about the presence of domestic goats and sheep within Rocky Mountain bighorn sheep range regarding disease transmission. There is a currently a general recommendation to corral goats and sheep at night to prevent interactions and not allow "free-ranging" grazing during special-use prescribed grazing projects to eliminate the chance of goats and sheep becoming feral and contacting bighorn sheep (Woolever 2004, Wild 2004). In order to ensure the safety and protection of both livestock operations and native ungulates, the NPS wildlife veterinarian (and any additional federal, state, cooperative extension wildlife/large mammal veterinarians as necessary or desired) will be consulted on all proposed prescriptive grazing projects to explore current disease transmission issues and to identify any further required mitigation practices.

Prescribed burning consists of planning, setting, and managing fire to accomplish resource management objectives (CNAP 2000). Fire is sometimes necessary to prompt germination of some plants, but it can also reduce the abundance of some species. The most successful uses of fire for invasive species control result from burns that try to mimic or restore historical (natural) fire regimes, which have been disrupted by land use changes, suppression practices, fire breaks, or development (Tu et al. 2001). Prescribed fire may be used to reduce standing litter prior to herbicide application to enhance effectiveness of herbicides or to reduce the amount of herbicide necessary to accomplish management objectives.

Restoration or revegetation can be defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2002). In the context of this EA, ecosystem damage or degradation refers to the presence of weeds, while the establishment of desirable native vegetation is the ecological recovery that we are trying to assist. Assisting the establishment of desirable vegetation through revegetation practices contributes to the larger goal of restoration as well as the goal of weed management (Jacobs et al. 1998). The establishment of a diverse community of desirable vegetation can prevent weed encroachment by utilizing all or most available resource niches (Sheley et al. 1996). Revegetation practices can include seedbed preparation, broadcast seeding, drill seeding, container planting and sprigging live branches (Roundy 1996).

The following cultural controls have been found to be effective against weeds found in Dinosaur National Monument (see Appendix B for details and references):

Cultural Control	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Prescribed Fire	X			X			X		X			X	X	X							X	
Prescribed Grazing		X			X	X		X	X	X				X		X			X	X		
Revegetation	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress
CRUNU musk thistle **CENDI** diffuse knapweed **CENMA** spotted knapweed **CIRAR** Canada thistle **CIRVU** bull thistle
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Chemical Control

Chemical control in this document refers to the use of herbicides to kill or injure target plants, as well as chemicals applied with herbicides that improve the efficacy of the active ingredient (adjuvants). Herbicides are classified according to their mode of action, or how they affect the target plant. Of the 7 modes of action, three are most relevant to weed management in natural areas – plant growth regulators, amino acid inhibitors, and photosynthesis inhibitors. Plant growth regulators are designed to move from the leaves to the actively growing part of the plant, thereby interfering or completely eliminating plant growth. They are used for control of annual and perennial broadleaf plants and are useful where non-target species are grasses. Amino acid inhibitors also act on actively growing parts of the plant and are used to control annual grasses, cool-season perennial grasses and certain broadleaf plants. They are relatively non-selective and are only effective when applied to foliage, as they rapidly deactivate in soil. Other types of amino acid inhibitors stunt root growth, which in time starves the plant. Photosynthetic inhibitors move upward through the plant, showing symptoms of activity from the bottom to top on plant shoots. For this reason, photosynthetic inhibitor herbicides are used in control of established perennials, since potential control must come from the continued soil uptake and not movement down through the plant from the shoots. These herbicides typically have good soil activity and are used pre and post-emergence on certain annuals and established perennials.

When using synthetic herbicides, three soil characteristics are particularly relevant: percent organic matter, available water capacity, and soil permeability. When incorporated into the soil, part of the herbicide dissolves in the soil water and part is adsorbed onto soil particles (primarily organic matter). The amount of herbicide adsorbed onto soil particles depends on the characteristics of the chemical and on the amount of organic matter and fine material in the soil. Any herbicide that remains in water in the soil is available for uptake by plant roots. However, if the water moves off-site or out of the rooting zone, it takes some of the dissolved herbicide with it. Depending on the distance of travel, the concentration of the herbicide, and type of herbicide used, this herbicide movement can be a problem for susceptible plants and other organisms (USDA-USFS 1996).

All herbicides analyzed here dissolve to some extent in water and can be absorbed fairly readily from soil moisture by susceptible plants. Some of these herbicides can move with water as it moves through the soil. Soil permeability and water-holding capacity determine how much water moves through the soil into ground water or in surface water after rainfall. If the soil retains a large quantity of water in its upper horizons for later use by plants, the water and dissolved herbicide will have little opportunity to move. In contrast, if soil is highly permeable and has little water-holding capacity, water passes through the soil rapidly and carries some of the herbicide with it (USDA-USFS 1996).

The following herbicides are known to be effective on weeds present in Dinosaur National Monument (see Appendix B for specific rates, combinations and references):

Herbicide: (brand name)	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Chlorsulfuron (Telar)					X				X		X					X						
Clopyralid (Reclaim, Transline)		X				X		X	X										X	X		
Fluazifop-p-butyl (Fusilade DX, Fusion, Tornado)	X			X									X									
Glyphosate (Roundup, Aquamaster)	X	X	X	X					X			X	X	X								
Hexazinone (Velpar)			X										X									
Imazapyr (Arsenal, Habitat)		X			X							X	X			X					X	
Imazameth/ Imazapic (Plateau)				X										X								
Metsulfuron (Ally, Escort)			X		X	X					X					X			X			
Sulfometuron-methyl (Oust)					X									X								
Triclopyr (Garlon)												X									X	
2,4-D (Navigate, Weed-pro, Justice)		X	X		X	X	X	X	X	X	X	X		X	X		X	X	X	X		X

(Humburg et al. 1989, Tu et al. 2001)

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress
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Often times, substances are added to herbicides to improve their efficacy. They are collectively called adjuvants. They include surfactants, penetrants, thickening agents, spreaders, anti-foaming agents and dyes (Tu et al. 2001). Some adjuvants are already mixed with commercially available herbicides and some must be added by the user. Herbicide labels generally specify what adjuvants are appropriate. Adjuvants are considered "inert" ingredients and are generally unregulated. However, some have been found to be environmentally harmful (eg. the surfactant in RoundUp). These types of adjuvants are recommended for the following herbicides proposed for use at DINO:

Herbicide:	non-ionic surfactant	crop oil concentrate	methylated seed oil	silicon-based surfactant
Chlorsulfuron	X			
Clopyralid	X			
Fluazifop-p-butyl	X	X		
Imazapyr	X	X	X	X
Imazameth/ Imazapic	X	X	X	X
Metsulfuron	X			
Triclopyr	X		X	
2,4-D	X	X		

(Humburg et al. 1989, Tu et al. 2001)

Biological Control
Biological control can be defined as the deliberate introduction or manipulation of a pest's natural enemies (such as insects and pathogens) with the goal of suppressing the pest population (Wilson and Huffaker 1976). The theoretical framework for the use of biological controls is based on the hypothesis that the success of many non-native invasive weeds is the result of their release from predators or pathogens from their native range when they are introduced in a new range (Cronk and Fuller 1995). By introducing predators or pathogens, usually from the weeds' native range, their success can be curbed, allowing native plants to compete on more equal terms. Bio-control agents are not capable of completely eradicating a weed population, because as the number of host plants declines, so does the population of bio-control agents. However, bio-control can be a useful tool in reducing the initial size or density of a weed infestation, making other treatments more feasible.

To date there has been no known or permitted release of non-native biocontrol agents in Dinosaur National Monument for the control of invasive species. However, one controversial insect species, *Rhinocyllus conicus*, is believed to be present in the park and is suspected to be negatively impacting rare and native thistles, specifically *Cirsium ownbeyi*. It was not intentionally released in the monument but may have dispersed naturally. *R. conicus* was widely released in the U.S. in the 1960s for the control of non-native thistles (such as musk and plumeless thistle) when the threat of non-native thistles was thought to be of a greater risk to ecosystem health than the threat of *R. conicus* to native thistles (which pre-release tests showed it had affinity for). A graduate student from University of Maryland conducted surveys during the summer of 2004 in several *C. ownbeyi* locations within the monument but did not find *R. conicus.* An interim report of his surveys was completed in May 2005. Surveys are planned again in

2005 in coordination with BLM in the Yampa canyon and other sites to determine *R. conicus* presence in the monument, its extent, and any impacts to native vegetation.

The following is a list of APHIS-approved bio-control agents currently available for release in the US and effective against weeds found in DINO. However, the monument does not have plans to release any of these insects simply because of their availability and potential effect on invasive species present within the monument. Release of biocontrol agents will depend on infestation location, size, distribution, abundance, accessibility for follow-up monitoring and restoration (when required), potential effect on non-target species (especially T&E plant species and particularly those related to the target invasive species), and whether or not other control techniques are first capable of or effective in reducing the infestation(s) to acceptable threshold levels.

Bio-control Agent	CENRE	CENDI	CENMA	CIRAR	CIRVU	ELGAN	EPHES	LINDA
Agapeta zoegana		X	X					
Bangasternus fausti		X	X					
Cyphocleonus achates		X	X					
Larinus minutus		X	X					
Metzneria paucipunctella		X	X					
Pterolonche inspersa		X	X					
Sphenoptera jugoslavica		X	X					
Terellia virens		X	X					
Urophora affinis		X	X					
Urophora quadrifasciata		X	X					
Subanguinea picridis	X							
Aceria acroptiloni	X							
Ceutorhynchus litura				X				
Urophora stylata					X			
Tubercularia ulmea						X		
Phomopsis arnoldiae						X		
Phomopsis elaeagni						X		
Lasiodiplodia theobromae						X		
Apthona nigriscutis							X	
Apthona lacertosa							X	
Hyles euphorbia							X	
Oberea erythrocephala							X	
Spurgia esulae							X	
Brachypterolus pulicarius								X
Calophasia lunula								X

CENRE Russian knapweed **CENDI** diffuse knapweed **CENMA** spotted knapweed
CIRAR Canada thistle **CIRVU** bull thistle **ELGAN** Russian olive **EPHES** leafy spurge
LINDA/LIVU2 Dalmatian toadflax/yellow toadflax

Research is currently being done on at least two additional biocontrol agents that could contribute greatly to weed management in DINO. Tamarisk and cheatgrass occupy the most area of any of the 24 invasive species found in DINO. Cheatgrass is so widespread that it has not been mapped in great detail, but it is known to occupy, and in many situations dominate, every native vegetation type in the monument. Current research on a head smut disease caused by the fungus *Ustilago bullata* shows some promise for the control of cheatgrass (Meyer), though no time frame is available for potential release, nor is its approval for release as a management tool guaranteed.

More information is known, however, about tamarisk within the monument. 2002-2004 inventory reports show that that close to 650 acres of riparian habitat is occupied by tamarisk. USDA APHIS is in the final stages of research and approval for a release of a nonindigenous leaf beetle (*Diorahabda elongata)* into 14 western states (CO and UT included). This beetle has shown promise in reducing the density and extent of tamarisk infestations in those areas (USDA APHIS 2003).

D. elongata is a leaf-eating beetle native to the Fukang region of central China. After 10 years of research by APHIS, the Fukang strain of *D. elongata* has been found to be one of the very few tamarisk-affiliated insects that is both host-specific to tamarisk and effective at suppressing tamarisk, and therefore a good candidate for use in a biocontrol program. Simply put, *D. elongata* is expected to control tamarisk by completely defoliating a shrub, preventing it from photosynthesizing and impeding seed production. Tamarisk, native to Asia, appears to be an ideal candidate for classical biocontrol because, unlike most problem plant species in N. America, there are no native plants in the same genus or family and only one related family (Frankeniaceae) in the same order (Tamaricales) as tamarisk. Six species of *Frankenia* occur in the west/southwest U.S. and northern Mexico. One of the six, *Frankenia johnstonii*, is federally listed as endangered (though a proposed rule to delist it was published in the Federal Register by FWS in May 2003). In no-choice-quarantine tests, leaf beetle larvae fed and developed on *Frankenia* as well as on tamarisk, but in multiple-choice selection tests in large outdoor cages, adults were not attracted to *Frankenia* and rarely laid eggs on it. In similar experimental cages at the release site in Pueblo, CO, only slight feeding was observed on Frankenia in spite of the presence of hundreds of starving adults and larvae that had defoliated the tamarisk plants (PEST CABweb 2003). There are no species of Frankenia found in northwest CO / northeast UT and all lab and field tests performed to date have shown the likelihood of the beetle moving off-target to unrelated plants is extremely low or nonexistent. Therefore, Dinosaur National Monument expects no damage to desirable plant species, including the seven listed plants found in and/or adjacent to the planning area.

Additionally, DINO is outside the documented range of the federally endangered Southwest willow flycatcher (*Empidonax trailii extimus*) – the northernmost extent of which reaches into southern CO. Potential loss of SWFL nesting habitat caused by leaf beetle defoliation is a high concern for FWS with regard to the proposed tamarisk biocontrol program because it is known to nest in tamarisk below the 37th parallel. Temporary loss of nesting habitat due to beetle predation on tamarisk is not expected to impact resident or migratory bird populations in/adjacent to the planning area – even for the yellow-billed cuckoo (*Coccyzus americanus*), which to date has not been found in the monument, though suitable habitat does exist (please refer to page 26 for the analysis of effects on the yellow-billed cuckoo). DINO does contain important migratory bird habitat, but its location in the upper basin of the Colorado River system has conferred a certain amount of resistance to tamarisk infestation and much native riparian vegetation still exists.

Proposed *D. elongata* Release Location

Dinosaur N.M. proposes to release *D. elongata* in Echo Park (see enclosed park map), which is located at the near geographic center of the monument and is the confluence of the Green and Yampa Rivers, as early as summer of 2005, pending plan approval. Echo Park was selected as a near-ideal test release location because of its relative isolation (from a plant and animal perspective) due to the steep canyon walls surrounding the area, though it is easily accessible by 4WD vehicle (there is a campground and boat ramp in the area) for pre-and post-release activities, such as monitoring and restoration, as needed. Echo Park has one of the largest, nearly monotypic stands of tamarisk found within the monument, and even though a 1-acre area has been cleared using a combination of mechanical and chemical control measures (primarily for safety purposes to allow easy visitor access to the river in the event of a wildfire in the area), approximately 20 acres of tamarisk remain along the river in the Echo Park area. It is anticipated Echo Park will provide all the necessary features required by *D. elongata* for successful establishment and reproduction – adequate initial food supply, a duff layer for diapause retreat, annual natural flood cycles that will not eliminate reproductive populations, and longer day lengths (14.5 – 15 hours) that are important for successful reproductive, dispersal, and feeding periods (Dinosaur lies at approximately the same latitude [40ºN] as the most successful test site in Lovelock, NV).

From a preventative standpoint, we believe successful establishment of a biocontrol program at the confluence of the Green and Yampa Rivers will arrest the progression of tamarisk (already well established on the Green River) upstream in the Yampa River canyon, where it is just beginning to invade. The Yampa River is unique in that it is the last remaining unregulated major tributary in the Colorado River system and therefore retains a relatively natural hydrologic regime. This, in addition to having a high quality, intact native riparian vegetation community, has slowed tamarisk establishment compared with regulated reaches within the system (such as the Green River), but the Yampa still remains vulnerable to invasion. For tamarisk already established on sand and cobble bars in the rivers at the confluence, other treatment options that can be used elsewhere in the monument, namely mechanical and chemical, are not viable options because of accessibility and because of the importance of those areas as critical spawning habitat for several of the four federally endangered fish that occur in the vicinity. Dinosaur staff are cautiously optimistic that the use of the leaf beetles in this particular area will provide better control of tamarisk than has been achieved thus far in the interest of protecting and restoring critical habitat for listed Colorado River fish as well as migratory songbirds.

Post-release Monitoring

Post-release monitoring in Echo Park is planned for the biocontrol agent (*D. elongata*) and vegetation (tamarisk and native plants). DINO has provided $24,000 to CSU to conduct the monitoring for two years, and is committed to helping secure additional funding to support three additional years of monitoring. Monument staff have coordinated with the Tamarisk Coalition, CSU, BLM, and the Colorado Department of Agriculture to ensure that monitoring protocols used in Echo Park will be consistent with those employed at the Grand Junction release site (Colorado River).

The Tamarisk Coalition, in partnership with the U.S. Bureau of Reclamation (Central Utah Project Completion Act office), has provided funding for four years of breeding bird monitoring in Echo Park to supplement the leaf beetle/vegetation monitoring work. Rocky Mountain Bird Observatory has developed and will implement protocols to document post- release bird nesting patterns. This monitoring program will occur for a minimum of four years beginning in 2005 with the hope of continued funding to extend the study for a total of 5 years.

As the beetle, bird, and vegetation monitoring programs progress and effects are documented, DINO staff is prepared to do work as needed, including active restoration and follow-up treatments, to preserve natural stream dynamics and migratory bird use of riparian habitats.

Finally, the Tamarisk Coalition and CSU will work with DINO to develop educational materials for public use on the western slope biological control program.

<u>Area Coordination and Support</u>
Dinosaur has notified surrounding agencies, landowners, lessees, and concessionaires of its desire to use biocontrol, specifically on tamarisk, as part of an integrated weed management program. Notice of this desire was given in an initial call for comments in late 2003 on the then-proposed monument-wide weed management planning process. Sixteen comments were received and all were in favor of adopting an integrated approach, which includes the use of biocontrol agents. In addition, several agencies have expressed the desire for future coordinated insect releases in the area using the Echo Park "insectary" as a source once it is established. Agencies/organizations in support of the *D. elongata* release and subsequent establishment in northwest CO include Moffat County, CO commissioners and weed coordinator, Uintah County, UT commissioners and weed coordinator, Bureau of Land Management, and USFWS Ouray and Brown's Park National Wildlife Refuges.

Dinosaur National Monument staff recognizes that the use of biocontrol will not achieve rapid or total control of tamarisk - we do not know yet how many times or years a mature plant must be repeatedly defoliated before the plant succumbs. Rather, biocontrol agents are expected to, at a minimum, prevent annual seed set (a mature plant can produce an estimated 600,000 windborne seeds per year) over the long term and, at best, kill tamarisk plants. Dinosaur National Monument will not rely solely on biocontrol agents for tamarisk control - tamarisk in other parts of the monument will continue to be actively removed using mechanical and/or chemical methods.

Prevention
IPM also includes actions that don't directly impact weed populations and don't require environmental analysis (and thus are not analyzed in the analysis of effects), but are an integral part of a successful weed management plan. These actions include prevention and early detection of weed introductions and spread, inventory, monitoring, and education.

History of Invasive Species and their Management in Dinosaur National Monument
The area of what is now Dinosaur National Monument can be described as a sort of 'hub' where several ecoregional provinces converge, making Dinosaur's cold desert flora particularly rich in localized endemic species; over 600 plant species native to the area have been documented within the monument. Great diversity of geologic substrates combines with extreme topographic variation within the monument to produce plant communities that are nearly all transitional to some degree.

Early settlers to the area arrived in the mid 1800s and established homesteads and ranches, introducing some of the first non-native plants to the area for livestock forage or human food. Later, the development of roads, campgrounds, trails, boat ramps, picnic areas, visitor centers, etc. to accommodate increased visitation in the 1960s further contributed to the establishment of non-native species. Today, 75 of the

687 species of flora known in the monument are non-native, primarily imported accidentally by livestock, maintenance and construction activities, and even visitors.

Dinosaur National Monument began managing for invasive species because of three concerns: threats to native plant communities and the wildlife that depend on them; threats to natural river processes and aquatic resources; and from agricultural producers downstream on the Green River who were concerned about the increased invasion of perennial pepperweed and Russian knapweed into irrigated pastures (Naumann 2003).

The first systematic invasive species inventory occurred in 1996. Approximately 300 affected acres of six target species (perennial pepperweed, Russian olive, tamarisk, Russian knapweed, Canada thistle, and leafy spurge) were identified and mapped in the Yampa and Green River corridors and along roads and around campgrounds, housing, and headquarter areas. In 1997, the Weed Warrior program was initiated, with funding provided by a grant from Canon USA, Inc. through the National Park Foundation. That year, the Weed Warrior program reached 500 volunteers, who pulled tamarisk and perennial pepperweed along the river corridors and in campgrounds (Naumann 2003).

Sierra Club, Outward Bound West (OBW), and National Outdoor Leadership School (NOLS) volunteers put in 500 hours in 1996 and 1000 hours in 1997 mechanically removing perennial pepperweed and tamarisk using their hands, saws, and shovels. Some limited chemical spot-treatment using clopyralid was performed in 1997 by Moffat County, CO and Uintah County, UT certified applicators on Russian knapweed in the four housing areas and along Cub Creek road. Additional spot applications are performed occasionally by staff in those same areas. No formal monitoring of invasive treatments has been established, though all weed management activities performed in the monument since 1996 were evaluated internally for NEPA compliance (Naumann 2003). Downstream agricultural producers, county governments, and both the commercial and private boating communities continue to be the largest advocates of weed management in the monument.

Species Considered and Their Status

On February 11, 2004, a list of threatened, endangered and candidate species that may be present in the action area was requested from the U.S. Fish & Wildlife Service Colorado and Utah Field Office. The list for Uintah County, Utah was received by mail on February 20, 2004. Louanne McMartin of the FWS Grand Junction field office delivered the list for Moffat County, Colorado on April 9 during a visit to Dinosaur National Monument for a regional / proposed weed plan orientation and field trip.

The following list includes threatened, endangered, candidate, and proposed species located in Uintah County, UT and Moffat County, CO. A pre-field review was conducted of available information to assemble occurrence records, describe habitat needs and ecological requirements, and determine whether field reconnaissance is needed to complete the Biological Assessment. Sources of information included Dinosaur National Monument records and files, the State Natural Heritage Program database, state wildlife agency information, and published research (Giroir 2003, Dewey 2003, Naumann 2002).

Common Name	**Scientific Name**	**Status**	**State(s) Listed**	**Known/ suspected to be present?**	**Suitable habitat present?**	Rationale if not carried forward for analysis
Bald eagle	*Haliaeetus leucocephalus*	Threatened	CO / UT	Yes	Yes - winter	

Common Name	Scientific Name	Status	State(s) Listed	Known/ suspected to be present?	Suitable habitat present?	Rationale if not carried forward for analysis
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	CO / UT	Yes	Yes	
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate for Listing	CO / UT	No	Yes	
Black-footed ferret	*Mustela nigripes*	Endangered	CO / UT	No	Yes	
Canada lynx	*Lynx canadensis*	Threatened	CO / UT	No	No	DINO does not contain suitable habitat
White-tailed prairie dog	*Cynomys leucurus*	Removed from Consideration	CO / UT	Yes	Yes	
Bonytail chub	*Gila elegans*	Endangered	CO / UT	Yes	Yes	
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered	CO / UT	Yes	Yes	
Humpback chub	*Gila cypha*	Endangered	CO / UT	Yes	Yes	
Razorback sucker	*Xyrauchen texanus*	Endangered	CO / UT	Yes	Yes	
Boreal toad	*Bufo boreas*	Candidate for Listing	CO / UT	No	No	DINO does not contain suitable habitat
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	CO / UT	Yes	Yes	
Clay Reed-mustard	*Schoenocrambe argillacea*	Threatened	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence
Graham Beardtongue	*Penstemon grahamii*	Candidate for Listing	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence
Horseshoe milkvetch	*Astragalus equisolensis*	Candidate for Listing	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence
Shrubby Reed-mustard	*Schoenocrambe suffrutescens*	Endangered	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence
Uinta Basin Hookless Cactus	*Sclerocactus glaucus*	Threatened	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence
White River Beardtongue	*Penstamon scariosus var. albifluvis*	Candidate for Listing	UT	No	No	though endemic to the Uinta Basin, range does not extend into DINO; 2002-2003 rare plant survey confirms its absence

III. Consultation History

On April 9, 2004 Louanne McMartin of the FWS CO Western Slope Field Office in Grand Junction, CO visited Dinosaur National Monument to become familiar with the area and project and to informally discuss the monument-wide weed plan with regards to proposed (cut stump) chemical treatments for tamarisk (*Tamarix* sp.) removal along the river corridors and its potential impacts to the four endangered fish (Bonytail chub, Colorado pikeminnow, Humpback chub, and Razorback sucker) present in the Green

& Yampa River systems. Ms. McMartin agreed that conservation practices we proposed would be sufficient in protecting existing populations of these fish. These conservation measures are outlined in Section V – Analysis of Effects.

In addition, Emily Spencer and park botanist Tamara Naumann met with the northwest Colorado Level 1 team on September 17, 2004 in Steamboat Springs, CO to review and discuss the first draft of this biological assessment (A Level 1 team is the core component of the streamlined consultation process as called for by an August 2000 memorandum of agreement signed by USDA Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Marine Fisheries Service committing to working closer together to improve the interagency consultation process under the Endangered Species Act. Level 1 teams are composed of biologists and botanists designated by their respective agencies as team members whose role is to assist land management agencies in designing programs and activities to avoid jeopardizing and to promote the recovery of listed and proposed species, as well as to promote the recovery of other species of concern.). Their comments and suggestions are reflected in this document.

Because Dinosaur National Monument spans two states, the monument is technically responsible for consulting on T&E species in both CO and UT. During the Level 1 team meeting in Steamboat Springs Cay Ogden (Wildlife Ecologist T&E Species Coordinator for NPS Intermountain Region) suggested seeking permission from both UT and CO FWS State Field Supervisors to have one FWS office designated as the lead office for consultation. On September 20, 2004 Al Pfister, FWS Western CO Field Supervisor, agreed with Henry Maddux, FWS UT Field Supervisor, via email exchange that Colorado would be the lead state for Dinosaur National Monument's informal consultation process for the Invasive Species Management Plan.

On September 24, 2004 Heather Barnes, botanist for the UT FWS field office, called with minor comments regarding the draft biological assessment. Several of her comments are also reflected in this document.

Finally, on December 21, 2004 Emily Spencer consulted with Louanne McMartin again regarding the recent change in status for the White-tailed prairie dog (*Cynomys leucurus*), determined by FWS on November 9, 2004. Ms. McMartin confirmed via email correspondence that DINO no longer had to include analysis for the species in the biological assessment as it did prior to the status change since FWS ruled that there was insufficient scientific information to warrant studying whether the species should be listed. However, the monument has chosen to keep all analysis completed before the change in status in the final document because the prairie dog habitat is potential habitat for the endangered Black-footed ferret, therefore making it a species of management concern to monument staff.

IV. Analysis of Effects – Federally Listed and Proposed Species

Bald Eagle *Haliaeetus leucocephalus*

Affected habitat description and status within the planning area

Bald eagle surveys have found no nests within the planning area boundary to date. Reports in 2002 and 2003 of suspected immature and mature bald eagles during the summer months in the areas of Rainbow Park (UT) and Deerlodge Park (CO) resulted in late April 2004 informal nest surveys in those areas. Two mature bald eagles were observed on a large nest in a cottonwood tree just outside the monument boundary on the Yampa River near Deerlodge Park. Follow-up surveys at the same site revealed that the nest was abandoned for an unknown reason within a week of the initial observation and was taken over by a Canada goose pair. No bald eagle activity was observed in the Rainbow Park area during April and May of 2004. This eagle activity in the area identifies the possibility of future eagle nesting.

Bald eagles are known to winter along portions of the Yampa and Green Rivers within the planning area and are generally present from mid-November to mid-April. Large mature cottonwood trees along the Yampa and Green Rivers are used as roosting and perching sites and these waterways provide the main food sources of fish and waterfowl. Upland habitats adjacent to these waterways are used as scavenging areas primarily for winter killed mule deer and elk.

Analysis of effects

Direct Effects

The preferred alternative would result in no direct effects to bald eagles. Bald eagles are known to winter within the planning area from mid-November to late April. Mechanical and chemical control of riparian species does not occur during this time period because of inhospitable weather conditions and effectiveness of control at that time. Prescribed fires for invasive species control will not be conducted within riparian zones because of likely damage to desirable vegetation (cottonwoods, willows). Grazing does occur in the monument during bald eagle wintering, but is not expected to affect roosting or feeding in any way. Any biological control agents released for control of invasive species will likely be inactive during the winter months and therefore not affect wintering bald eagles.

Indirect Effects

There is the potential for short-term and indirect impacts to wintering and nesting bald eagles associated with chemical control and use of prescribed fire (for weed management) that occurs during fire season (generally April through September). Misuse or accidental spills/drift of certain herbicides for weed control can kill or damage established beneficial riparian vegetation that bald eagles may use for roosting and nesting (or upland vegetation that prevents excessive soil erosion) and could result in localized fish kills that could reduce forage for bald eagles. Misuse or accidental spills/drift of fire retardants or foams used in prescribed fire management (which also contain chemicals more toxic to certain fish) could also have similar negative impacts for foraging eagles. Presence of staff or volunteers performing weed control nearby during certain periods could disrupt normal behavior of any nesting bald eagles, possibly resulting in nest abandonment or failure.

Conservation Measures

In order to minimize effects, both direct and indirect, of modification of winter roost sites and to potential nesting bald eagles the following conservation measures are incorporated into the project plans:

- No vegetative treatments within 500m of active bald eagle nest sites between February 1 (adult courtship) and July 31 (nestling fledge) or between November 1 and March 1 for wintering eagles.
- All chemical applications will be performed according to product label specifications and equipment used for application will be appropriately matched to scale of project work to reduce chance of accidental spills and drift that adversely affects non-target vegetation and aquatic resources. For example, use of herbicides that are known to be toxic to fish but are deemed the most effective on invasive species in riparian areas will be used during post-flood season and will be applied in spot applications using a backpack applicator or wick to eliminate chemical drift or leaching into the water table. No aerial application of retardant /foam will occur within 300 feet of any water body, including lakes, rivers, streams, and ponds whether or not they contain aquatic life.

Determination of Effect and Rationale

No direct effects are anticipated to occur to bald eagles. However, there is the potential for indirect/short and long-term impacts. Chemicals, both herbicides and fire retardants, may temporarily affect fish populations - a prime food source for wintering bald eagles. Misuse of herbicides or accidental spills may kill or damage cottonwoods eagles use for nesting and roosting. Vegetation treatments in close proximity to nesting or roosting eagles may alter normal behavior, resulting in missed foraging opportunities or failed/abandoned nests. The conservation measures should adequately reduce or eliminate any negative impacts. Implementation of the Invasive Plant Management Plan is expected overall to improve bald eagle habitat (both nesting and wintering) over the long term primarily by removing invasive species that impede normal cottonwood and willow regeneration. Therefore, implementation of the Invasive Species Management Plan with the conservation measures **may affect, but is not likely to adversely affect the bald eagle.**

Black-footed Ferret ***Mustela nigripes***

Affected habitat description and status within the planning area

The original range of the black-footed ferret in Colorado closely approximated the range of prairie dogs, as black-footed ferrets prey on these animals and use their burrows for living quarters and as nursery dens to rear their young (Fitzgerald 1994). Although black-footed ferrets have not been documented within the planning area, reintroduction efforts with the goal of reestablishing naturally breeding, self-sustaining populations of black-footed ferrets in northwest CO and northeast UT occur on other federal lands surrounding the monument boundaries. Over the past 3 years, 149 black-footed ferrets have been released into two of the three management areas near DINO, which include Wolf Creek (south east of monument boundaries between Elk Springs and Massadona along Highway 40) and Coyote Basin (south of monument boundaries between Dinosaur and Rangely west of Highway 64, extending into Utah). More releases were planned for October 2004 in Wolf Creek and Coyote Basin, though the exact number of ferrets released is not known. The third management area, Little Snake, is north and east of the monument boundary between Browns Park and Maybell. No ferrets have been released in this area because prairie dog population levels are not suitable, though breeding and conditioning pens are located here.

Two populations of white-tailed prairie dogs are known in Dinosaur National Monument. Acreages were estimated using aerial imagery in areas of known historical occupancy. FWS guidelines establish a minimum area of 200 acres of white-tailed prairie dogs towns are needed to support a black-footed ferret. In Colorado, an estimated 20-acre colony is present on West Cactus Flat. The closest release area (Wolf Creek) is approximately 7-9 miles from this colony. Most of the expected ferret habitat is south of Highway 40, however, white-tailed prairie dog colonies extend north of the highway. The colony on West Cactus Flat is considerably smaller than the 200 acres needed for ferret occupancy and the terrain between the Wolf Creek release area and this colony is dominated by a pinyon pine-juniper community, presenting a considerable obstacle for prairie dog habitat expansion at this time. Therefore, it is unlikely that a linkage of these two colonies that would provide suitable ferret habitat would occur in the foreseeable future.

The other white-tailed prairie dog colony is an approximately 300-acre grouping of colonies that exists southeast of the Quarry on the Utah side of the monument. Although ferrets are likely not currently present in the monument, the probability of them moving into the area in the near future is high (Zwetzig, personal communication). Ferrets have been released every year since 1999 in Utah and successful reproduction has been documented every year since 2000 in and around the Coyote Basin management area. They have now expanded on their own outside the original release areas. BLM biologists believe there are enough suitable white-tailed prairie dog colonies between documented ferret occupation in Utah and the prairie dog complex within the monument to provide ferrets with a corridor for continued movement towards monument boundaries and probable establishment. Supplemental black-footed ferret releases on BLM land in northeast Utah, south of DINO, are planned for the next several years (Zwetzig, personal communication).

Analysis of effects

Direct Effects

No direct impacts are anticipated to black-footed ferrets, primarily because of their nocturnal nature and their ability to avoid any direct contact with people, equipment, or other animals by escaping into prairie dog burrows. There are no invasive species of management concern in the two areas where white-tailed prairie dogs occur (and where ferrets would occur, if present), therefore no weed management activities are planned for those areas at this time or in the foreseeable future.

Indirect Effects

Should weed management activities occur in ferret-occupied habitat, ferret's primary prey species in this area (white-tailed prairie dogs) may be reduced if desirable vegetation that is used as food by prairie dogs is temporarily reduced or eliminated if herbicide control treatments are improperly performed. Also, use of vehicles in the area for treatments could compact or destroy burrow entrances.

Conservation Measures

In order to minimize potential impacts, both direct and indirect, to this species, the following conservation measures are incorporated into project plans:

- Any herbicide treatment performed within the monument will be done according to label direction.

- Burrow mounds/entrances will be avoided by any vehicles (ATV/tractor/ truck) required in control activities.
- Tools appropriate in scale for the control work will be used to avoid unnecessary trampling or disturbance to habitat.

Determination of Effect and Rationale

No direct effects are anticipated to black-footed ferrets. There is the potential for short-term damage to burrow entrances by vehicles used in weed control or for a short-term reduction in their primary food source if desirable vegetation (for white-tailed prairie dogs) is damaged or eliminated by misuse of chemical weed treatments. The conservation measures should adequately reduce any adverse impacts to black-footed ferrets and their potential habitat should weed control become necessary in occupied habitat. No ferrets are known to be present within the monument at this time. It is anticipated that the black-footed ferret will benefit overall from the implementation of the Invasive Plant Management Plan due to overall improvement of native vegetation composition, diversity, abundance, and health that supports active and healthy white-tailed prairie dog communities. Therefore, it is the determination that the proposed implementation of the Invasive Plant Management Plan with the conservation measures **may affect but is not likely to adversely affect the black-footed ferret.**

Mexican Spotted Owl ***Strix occidentalis lucida***

Affected habitat description and status within the planning area

Mexican spotted owls nest in steep canyons with dense stands of large ponderosa pine or pinyon-juniper with Douglas-fir, and in mature to old-growth mixed-conifer forest with high canopy closure. Favored stands generally are multi-storied, with snags and downed logs. The owls nest in tree cavities or on cliff ledges. Members of this subspecies are nonmigratory, although individuals sometimes move to lower elevations in winter (Beidleman 2000). Within the Colorado Plateau region in Colorado they are known to inhabit only the Mesa Verde National Park area, however there is a documented account in two consecutive years in the late 1990s of a lone male calling in the same remote, unnamed area north of the Yampa River in the vicinity of Outlaw Park within monument boundaries during surveys by Mexican spotted owl researchers from Northern Arizona University. No nesting activity has been confirmed in the monument. This documentation represents a significant northern disjunction from the generally recognized range of the species (southern CO and UT, AZ, NM, west TX, and Mexico).

Analysis of effects

Direct Effects

No direct effects are anticipated to this species. The Mexican spotted owls that were heard in the monument occupy a relatively inaccessible region where only few people (mostly researchers) seldom visit. No known invasive species infestations occur in that area or in the few other areas with similar required habitat. No weed management activities, including prescribed fire, are planned for that area at this time or in the near future.

Indirect Effects

The primary indirect threat within the monument is the loss of mature conifer stands by stand-replacement fires, especially in steep canyons and riparian zones (FWS 1995). However, no prescribed fires are planned for invasive species management purposes in the few regions that have suitable habitat.

Conservation Measures

- None required

Determination of Effect and Rationale

No direct or indirect effects are anticipated to occur to this species. It is anticipated that the Mexican spotted owl will benefit overall from the implementation of the Invasive Plant Management Plan as invasive species spread and introduction is expected to decrease when the full range of integrated pest management techniques is used, thereby improving critical habitat over the long term. Therefore, it is the determination that the proposed implementation of the Invasive Species Management Plan **may affect but is not likely to adversely affect the Mexican spotted owl or its habitat.**

Ute Ladies'-tresses ***Spiranthes diluvialis***

Affected habitat description and status within the planning area

The Ute ladies-tresses orchid inhabits riparian and subirrigated meadow communities below 6,500 feet in elevation, although it may occur up to 7,000 feet, in areas such as Utah's Uinta Basin, Colorado's Front Range, southeastern and central Wyoming, and southwestern Montana. Apparently an early to mid-seral species, the typical fluviogeomorphic structures occupied by the orchid include abandoned channels, meander scars, vegetated channel banks, vegetated floodplains, and point bars. It likes to have its "feet" wet for at least a portion of the growing season (late July to September depending on elevation and location) in a seasonally flooded to saturated hydrologic regime. Flowering and seed set occur well after the peak flow stages and flooding (Crane 1995).

There are many populations of this orchid in the monument (see enclosed park map). The most comprehensive distribution survey in the monument to date occurred in 1998 by Judy Ward and monument botanist Tamara Naumann on the Green and Yampa Rivers. In 2002, a few additional populations were found along Cub Creek by Utah State University seasonal mapping crews (also included on park map).

Analysis of effects

Direct and Indirect Effects

There is the possibility that treatment of invasive species in riparian habitat (such as for Canada thistle, leafy spurge, Russian olive, and tamarisk) could directly and indirectly impact *Spiranthes* by trampling, soil disturbance, grazing pressure, herbicide mortality/damage, or by off-target damage of biological control agents.

Conservation Measures

In order to minimize potential impacts, both direct and indirect, to this species, the following conservation measures will be followed:

- To the degree possible, weed control treatments will occur pre-emergence or post-seed set for *Spiranthes diluvialis*.
- IPM crews will consult with the monument botanist before control to correctly identify *Spiranthes* and be advised of its known and potential locations.
- Tools appropriate in scale for the control work will be used to avoid unnecessary trampling or disturbance to habitat.
- If herbicide use is deemed necessary, it will be applied in a manner that uses the smallest amount deemed effective under extant site conditions with carefully applied spot treatments.
- No biocontrol agents will be intentionally released by the monument for use on an invasive plant species of the same family as a threatened, endangered, or rare plant that occurs inside or adjacent to the monument.

Determination of Effect and Rationale

Direct and indirect adverse effects to *Spiranthes diluvialis* could inadvertently result from a number of invasive species control techniques, including trampling, grazing, and off-target damage caused by herbicides or biocontrol agents. The conservation measures should adequately reduce any adverse direct and indirect impacts to *S. diluvialis* and its habitat. It is anticipated that *S. diluvialis* will benefit overall from the implementation of the Invasive Plant Management Plan as competition from other riparian invasive species is reduced or eliminated and, in the case of tamarisk removal, natural stream geomorphology and channel characteristics that support *S. diluvialis* are restored. Therefore, it is the determination that the proposed implementation of the Invasive Plant Management Plan with the conservation measures **may affect but is not likely to adversely affect *Spiranthes diluvialis* populations or its habitat**.

Colorado pikeminnow	***Ptychocheilus lucius***
Razorback sucker	***Xyrauchen texanus***
Bonytail chub	***Gila elegans***
Humpback chub	***Gila cypha***

Affected habitat description and status within the planning area

These four fish species historically occur in the Upper Colorado River Basin, including the Green and Yampa Rivers. These fish require a diversity of habitats within the Colorado River, particularly during certain life stages. Low velocity side channels, backwaters, oxbows, sloughs, and flooded bottom lands are all important habitats for both young and adult fish. Several important spawning bars occur in or near the monument – all are threatened by tamarisk invasion and one is vulnerable to Russian olive invasion.

The decline of these fishes is mainly attributed to changes in the Colorado River resulting from the impoundment of large portions of the main stem and its tributaries. Controlled rivers have resulted in losses of habitat and natural function, such as cottonwood and willow regeneration and flooding and the resulting rearrangement of channel and floodplain morphology. Finally, irrigation, commercial and domestic water use, and dams have dewatered, cooled, and altered much of the river system. In addition to losses of habitat, many of these changes in the river system have resulted in more favorable conditions for non-native fishes. Non-native fishes, which are now common, compete for resources including food, space, cover, and physical habitat, and are known to prey on native fishes.

Analysis of effects
Overall, these fish species should benefit from the implementation of the Invasive Plant Management Plan. Removal of riparian invasive plant species, especially tamarisk, will assist in improving habitat for these species by preserving cobble bars and maintaining naturally occurring alluvial sediment deposit dynamics and features that create slower moving water. Erosion within the Green and Yampa River basin has always played a factor in the maintenance of habitats important to these fishes. In addition, ongoing studies (Schmidt and Larson 2003) within the monument are showing where invasive species management in riparian environments are likely to be successful in protecting long-term stream habitat complexity that can benefit instream biodiversity and listed species habitat.

Direct Effects
Direct effects from invasive species treatments will be localized, short-term, and minimal to these fishes. However, there is the possibility that the use of herbicide and fire retardant used in prescribed fire activities adjacent to or within tributaries of the Green and Yampa Rivers could result in direct negative impacts.

Indirect Effects
Indirect effects to these fish would be localized, minimal, and short-term. There is the potential for erosion due to removal of soil stabilizing vegetation on banks, bars, and islands associated with the Yampa and Green Rivers. Loss of vegetation could result in temporary increases in surface water runoff. However, these fish are well adapted to the high silt load conditions of the Green and Yampa Rivers. Potential increases in sediment resulting from the implementation of the Invasive Plant Management Plan would have negligible effects to these fishes or designated critical habitats, and could be beneficial by limiting productivity of non-native fishes that are not adapted to high silt conditions and by maintaining or restoring unvegetated spawning and nursery habitat, especially in the lower Yampa River channel.

Conservation Measures
To reduce potentially negative effects, both direct and indirect, the following conservation measures will be incorporated into the plan:

- Rivers, streams, and ponds will be avoided in the event fire suppressants (foams) need to be used for prescribed fire control.
- Chemical controls will only be used in the vicinity of aquatic habitats only if it is deemed that other weed management techniques are infeasible or would cause undue disturbance to fish or their critical habitat. All restrictions outlined on herbicide labels will be followed.
- Herbicides that are toxic to aquatic species and/or have high mobility in soils and/or persist in the environment will not be applied to soils or sprayed on foliage in standing water. If a particular herbicide is deemed necessary for control of the target species, it will be applied in spot applications (cut stump or wick) using hand equipment (backpack sprayer) during the post-flood stage in low-wind situations when it's potential for accidental drift or contact with surface water is at a minimum.

- No herbicide applications will be made along the major river corridors within 6 months prior to the earliest peak flow date (May 15) to ensure an adequate breakdown time for active ingredients before any likelihood of inundation of treated areas due to flood events.
- Biological control of tamarisk is proposed for Echo Park, which contains compromised nursery habitat (due to tamarisk invasion of the river channel). This strategy would minimize herbicide use in critical fish habitat and will (we hope) slow or stop tamarisk invasion upstream into more critical habitat areas on the Yampa River.

Determination of Effect and Rationale

There is the potential for direct and indirect short-term, localized impacts. Chemicals, both herbicides and fire retardants, can be toxic to fish in general and may affect populations. The conservation measures should adequately reduce likelihood of negative impacts. It is anticipated that these native Colorado River fish will benefit overall from the implementation of the Invasive Plant Management Plan, as there are situations in the monument where particular riparian invasive species (namely tamarisk and Russian olive) grow up to the water's edge and within channel and indirectly threaten critical habitat for riparian and aquatic T&E species. Research has demonstrated that tamarisk contributes to channel narrowing and alters fluvial sediment deposition processes, which in turn degrades reproductive habitat for these fish by converting cobble bars used for spawning into unusable sandbars. Removal of these invasive species is expected to contribute towards the overall restoration of stream geomorphology and channel characteristics, which may promote and contribute to recovery efforts of these fish species. Therefore, it is the determination that the proposed implementation of the Invasive Species Management Plan with the conservation measures **may affect but is not likely to adversely affect these four endangered fish or their habitat.**

White-tailed Prairie dog *Cynomys leucurus*

Affected habitat description and status within the planning area

In western Colorado and north-eastern Utah, white-tailed prairie dogs are most often found in semi-desert shrublands to elevations over 10,000 feet, though most records are from below 8,500 feet. They feed on a wide variety of grasses, forbs, and woody plants such as sage, saltbush, winterfat, and rabbitbrush (Fitzgerald et al. 1994). They frequently occur in loosely organized colonies that may occupy hundreds of hectares on favorable sites. Two populations of white-tailed prairie dogs are known in Dinosaur National Monument. In Colorado, an estimated 20-acre colony is present on West Cactus Flat. An approximate 300-acre grouping of colonies exists southeast of the Quarry on the Utah side of the monument. Acreages were estimated using aerial imagery in areas of known historical occupancy.

A survey for invasive species occurred in both of these areas in 2002 and 2003. No invasive species of concern were identified in the immediate vicinity of either white-tailed prairie dogs colony. Therefore, no weed control is planned in these areas at this time unless future surveys find species of management concern in those areas.

Analysis of effects

<u>Direct Effects</u>

No direct impacts are anticipated to white-tailed prairie dogs, primarily because of their ability to avoid any direct contact with people, equipment, or other animals by escaping to their burrow system. There are no invasive species of management concern in the two areas where white-tailed prairie dogs occur, therefore no weed management activities are planned for those areas at this time or in the foreseeable future.

Indirect Effects

Should weed management activities occur in occupied habitat, potential indirect impacts may include temporary displacement of animals above ground by some types of treatment techniques. Desirable vegetation that is used as food for this species may be adversely affected if herbicide treatments are not done according to label direction. Use of vehicles in the area for treatments could compact or destroy burrow entrances.

Conservation Measures

In order to minimize potential impacts, both direct and indirect, to this species, the following conservation measures are incorporated into project plans:

- Any herbicide treatment performed within the monument will be done according to label direction.
- Burrow mounds/entrances will be avoided by any vehicles (ATV/tractor/ truck) required in control activities.
- Tools appropriate in scale for the control work will be used to avoid unnecessary trampling or disturbance to habitat.

Determination of Effect and Rationale

No direct effects to white-tailed prairie dogs are anticipated, however some weed control techniques may indirectly result in temporary displacement (underground) or adversely affect above ground burrow structures or vegetation. The conservation measures should adequately reduce any adverse indirect impacts to white-tailed prairie dogs and their habitat should weed control become necessary in occupied habitat. It is anticipated that the white-tailed prairie dog will benefit overall in the long term from the implementation of the Invasive Plant Management Plan through the overall improvement of native vegetation composition, diversity, abundance, and health that supports active and healthy prairie dog communities. Therefore, it is the determination that the proposed implementation of the Invasive Plant Management Plan with the conservation measures **is not likely to jeopardize continued existence or adversely modify proposed critical habitat of the white-tailed prairie dog.**

Yellow-billed Cuckoo ***Coccyzus americanus***

Affected habitat description and status within the planning area

This species' habitat consists of old-growth riparian cottonwood-willow galleries with dense understories (Kingery 1998). Yellow-billed cuckoo historically occurred in portions of western Colorado, however, it was likely never common and only a few pairs have been recently confirmed to nest along the Yampa, Colorado, and Uncompahgre rivers (Kingery 1998). Though potential suitable habitat does exist for yellow-billed cuckoos in the monument, surveys performed by Rocky Mountain Bird Observatory in 2001 and 2002 did not detect cuckoos within monument boundaries (Giroir 2003). The Colorado Breeding Bird Atlas (1998) reports only one confirmed breeding occurrence on the Western Slope – in cottonwoods along the Yampa River near Hayden, CO (Routt County). Neither

Glenn Giroir nor Rich Levad, both of Rocky Mountain Bird Observatory, have record of more recent confirmed nesting in northwest Colorado (Giroir and Levad 2004), though a confirmed observation of a presumed migrant was recorded in Loudy-Simpson Park in Craig, CO in August, 2002 (Luke 2004).

Analysis of effects

Implementation of the invasive species management plan should have negligible long-term or direct impacts to this species. No western yellow-billed cuckoos are known to nest within monument boundaries, though suitable habitat may be present along small, scattered portions of the Yampa River and vegetated tributaries.

Direct Effects

No direct impacts to yellow-billed cuckoos or their habitat is anticipated through the implementation of the invasive plant management plan. Prescribed fires for invasive species control will not be conducted within riparian zones because of likely damage to desirable vegetation (cottonwoods, willows). Grazing does occur in the monument but is not expected to impact nesting or foraging success in any way.

Indirect Effects

There is the possibility that weed management treatments in close proximity to riparian areas could have short and long-term indirect impacts to yellow-billed cuckoos. The presence of staff and volunteers performing weed control activities and use of some types of mechanized equipment, such as chainsaws, in close proximity to occupied habitats (should occupation ever occur) could disrupt normal behavior of nesting cuckoos, possibly resulting in nest abandonment or failure. Though cuckoos in Colorado are documented most frequently nesting in cottonwood woodlands, biological control agents released for tamarisk control may cause the temporary loss of nesting habitat available to this and other migratory bird species. Misuse or accidental spills/drift of certain herbicides for weed control that can kill or damage established beneficial riparian vegetation (cottonwoods) that cuckoos prefer for nest sites and foraging can have long-term indirect impacts for cuckoo nesting success.

Conservation Measures

In order to minimize indirect effects the following conservation measures are incorporated into the project plans:

- Invasive species treatments in occupied yellow-billed cuckoo habitat will be timed so as not to displace cuckoos during the general nesting period between May 1 and July 31.
- All chemical applications will be performed according to product label specifications and equipment used for application will be appropriately matched to scale of project work to reduce the chance of accidental spills and drift that adversely affects non-target riparian vegetation. For example, herbicides will be applied in spot applications using a backpack applicator or wick to reduce chemical drift or leaching into the water table.
- Active restoration and follow-up treatments will occur where appropriate in areas where biocontrol activity has killed or denuded tamarisk stands in order to preserve migratory bird use of riparian habitats.

Determination of Effect and Rationale

No direct effects are anticipated to occur to yellow-billed cuckoos. However, there is the potential for indirect/short and long-term impacts. Misuse of herbicides or accidental spills may kill or damage cottonwoods cuckoos use for nesting. Vegetation treatments in close proximity to nesting yellow-billed cuckoos may alter normal behavior, resulting in missed foraging opportunities or failed/abandoned nests. The conservation measures should adequately reduce any adverse impacts to yellow-billed cuckoos and their potential habitat. No birds are known to nest within the monument. Implementation of the Invasive Plant Management Plan is expected overall to improve yellow-billed cuckoo habitat over the long term primarily by removing invasive species and allowing native cottonwoods and willow to recolonize riparian corridors and allow greater diversity and perhaps abundance of insects eaten by cuckoos. Therefore, implementation of the Invasive Species Management Plan with the conservation measures **may affect but is not likely to adversely affect the yellow-billed cuckoo.**

VI. Responsibility for a Revised Biological Evaluation

This Biological Assessment was prepared based on presently available information. If the action is modified in a manner that causes effects not considered, or if new information becomes available that reveals that the action may impact endangered, threatened, proposed, or sensitive species in a manner or to an extent not previously considered, a new or revised Biological Assessment will be required.

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Appendix A –Invasive Plants of Colorado and Utah

This table is a compilation of the state noxious weed lists for Colorado and Utah. **Bolded** species have been identified as the top ten prioritized weed species for the state of Colorado and are recognized to be the most widespread and to cause the greatest economic impact in the state. Species that are both ***bolded and italicized*** make up the State of Colorado's 'A List' and carry a state-mandated eradication order. Watch list species are invasive species that are not currently known to occur in the monument, but are present either in and/or adjacent to Moffat or Uintah counties. Also included in the list are non-native species that are found in Dinosaur NM that are not recognized as being invasive in nature and therefore are not listed by either Colorado or Utah.

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Absinth wormwood (*Artemisia absinthium*)		CO		
African mustard *(Malcomia africana)*	**yes**			
African rue (Peganum harmala)		CO		
Annual wheatgrass *(Eremopyrum triticeum)*	**yes**			
Asperagus *(Asperagus officinalis)*	**yes**			
Baby's breath (*Gypsophilia paniculata)*		CO	●	
Bassia (*Bassia hyssopifolia)*	**yes**			
Bermudagrass (*Cynodon dactylon*)		UT		
Black henbane (*Hyoscyamus niger*)	**yes**	CO		**yes**
Black medic *(Medicago lupulina)*	**yes**			
Black nightshade (*Solanum nigrum*)		CO		
Blue mustard (*Chorispora tenella*)	**yes**	CO		
Bouncingbet (*Saponaria officinalis*)	**yes**	CO		
Broad-leaf plantain *(Plantago major)*	**yes**			
Bulbous bluegrass *(Poa bulbosa)*	**yes**			
Bull cottonthistle (*Onopordum tauricum*)		CO		
Bull thistle (*Cirsium vulgare*)	**yes**	CO		**yes**
Bur buttercup *(Ranunculus testiculatus)*	**yes**			
Camelthorn (Alhagi pseudalhagi)		CO		
Canada bluegrass *(Poa compressa)*	**yes**			
Canada thistle (*Cirsium arvense*)	**yes**	CO, UT		**yes**
Catnip *(Nepeta cataria)*	**yes**			
Cheatgrass (*Bromus tectorum)*	**yes**	CO		**yes**
Chicory (*Cichorium intybus*)	**yes**	CO		
Chinese clematis (*Clematis orientalis*)		CO		
Clasping peppergrass *(Lepidium perfoliatum)*	**yes**			
Coast tarweed (*Madia sativa*)		CO		

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Common burdock (*Arctium minus*)	**yes**	CO		**yes**
Common crupina (Crupina vulgaris)		CO		
Common dandelion (*Taraxacum officinale)*	**yes**			
Common groundsel (*Senecio vulgaris*)		CO		
Common mullein (*Verbascum thapsus*)	**yes**	CO		
Common St. Johnswort (*Hypericum perforatum*)		CO		
Common tansy (*Tanacetum vulgare*)		CO		
Common teasel (*Dipsacus sylvestris*)		CO	●	
Crested wheatgrass *(Agropyron cristatum)*	**yes**			
Curly dock (*Rumex crispus)*	**yes**			
Cut-leaf water parsnip *(Berula erecta)*	**yes**			
Cypress spurge (Euphorbia cyparissias)		CO		
Dalmatian toadflax – broadleaf (*Linaria dalmatica*)	**yes**	CO		**yes**
Dalmatian toadflax – narrowleaf (*Linaria genistifolia*)	**yes**	CO		**yes**
Dame's rocket (*Hesperis matronalis*)		CO	●	
Desert alyssum (*Alyssum desertorum*)	**yes**			
Diffuse knapweed (*Centaurea diffusa*)	**yes**	CO, UT		**yes**
Dyers woad (Isatis tinctoria)		CO, UT	●	
Eurasian watermilfoil (*Myriophyllum spicatum*)		CO		
False flax *(Camelina microcarpa)*	**yes**			
Field bindweed (*Convolulus arvensis*)	**yes**	CO, UT		
Flixweed (*Descurainia sophia*)	**yes**	CO		
Giant salvinia (Salvinia molesta)		CO		
Green foxtail (*Setaria viridis*)		CO		
Hairy nightshade (*Solanum sarrachoides*)		CO		
Hairy whitetop *(Cardaria pubscens)*	**yes**			
Halogeton (*Halogeton glomeratus*)	**yes**	CO		
Hoary cress (*Cardaria draba*)	**yes**	CO, UT		**yes**
Houndstongue (*Cynoglossum officianale*)	**yes**	CO		**yes**
Hydrilla (Hydrilla hydrilla)		CO		
Jagged chickweed *(Holosteum umbellatum)*	**yes**			
Japanese brome *(Bromus japonicus)*	**yes**			
Johnsongrass (*Sorghum halepense*)		CO, UT		
Jointed goatgrass (*Aegilops cylindrica*)	**yes**	CO		**yes**
Kentucky bluegrass (*Poa pratensis*)	**yes**			

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
Kochia (*Kochia scoparia*)	**yes**	CO		
Leafy spurge (*Euphorbia esula*)	**yes**	CO, UT		**yes**
Mayweed chamomile (*Anthemis cotula*)		CO		
Meadow fescue *(Festuca pratensis)*	**yes**			
Meadow foxtail (*Alopecrus pratensis*)	**yes**			
Meadow knapweed (Centaurea pratensis)		CO	●	
Meadow / perennial sowthistle *(Sonchus uliginosus)*	**yes**			**yes**
Mediterranean sage (Salvia aethiopis)		CO		
Medusahead rye (Taeniatherum caput-medusae)		CO,UT		
Moth mullein (Verbascum blattaria)		CO		
Musk thistle (*Carduus nutans*)	**yes**	CO, UT		**yes**
Myrtle spurge (Euphorbia mysinites)		CO		
Oakleaf goosefoot *(Chenopodium glaucum)*	**yes**			
Orange hawkweed (*Hieracium aurantiacum*)		CO		
Orchard grass (*Dactylis glomerata*)	**yes**			
Oxeye daisy (*Chrysanthemum leucanthemum*)		CO	●	
Perennial pepperweed (*Lepidium latifolium*)	**yes**	CO, UT		**yes**
Perennial sorghum *(Sorghum halepense L. & Sorghum almum)*		UT		
Plumeless thistle (*Carduus acanthoides*)		CO	●	
Poison hemlock (*Conium maculatum*)		CO		
Prickly lettuce *(Lactuca serriola)*	**yes**			
Prostrate knotweed *(Polygonum aviculare)*	**yes**			
Puncturevine (*Tribulus terrestris*)		CO		
Purple loosestrife (Lythrum salicaria)		CO, UT	●	
Quackgrass (*Agropyron repens*)	**yes**	CO, UT		**yes**
Rabbitfoot grass *(Polypogon monspeliensis)*	**yes**			
Red fescue *(Festuca rubra)*	**yes**			
Redstem filaree (*Erodium cicutarium*)		CO		
Redtop (*Agrostis stolonifera*)	**yes**			
Rush skeletonweed (Chondrilla juncea)		CO		
Russian knapweed (*Centaurea repens*)	**yes**	CO, UT		**yes**
Russian olive *(Elaeagnus angustifolia)*	**yes**	CO, listed as		**yes**

NON-NATIVE/INVASIVE SPECIES	PRESENT IN DINOSAUR NATIONAL MONUMENT	STATE LISTED	WATCH LIST SPECIES	CONSIDERED FOR ACTIVE MANAGE-MENT
		noxious by Uintah County, UT		
Russian thistle (*Salsola collina*)		CO		
Russian thistle-prickly (*Salsola iberica*)	**yes**	CO		
Saltcedar, tamarisk (*Tamarix ramosissima x parviflora*)	**yes**	CO, proposed for listing in UT and listed as noxious by Uintah County, UT		**yes**
Saltmarsh sandspurry *(Spergularia marina)*	**yes**			
Scentless chamomile (*Matricaria perforata*)		CO		
Scotch thistle (*Onopordum acanthium*)	**yes**	CO, UT		**yes**
Sericea lespedeza (Lespedeza cuneata)		CO		
Shepherd's purse *(Capsella bursa-pastoris*)	**yes**	CO		
Siberian elm *(Ulmus pumila)*	**yes**			**yes**
Slenderweed *(Hutchinsia procumbens)*	**yes**			
Smooth brome (*Bromus inermis*)	**yes**			
Spotted knapweed (*Centaurea maculosa*)	**yes**	CO, UT		**yes**
Spurred anoda (Anoda cristata)		CO		
Squarrose knapweed (*Centaurea virgata*)		CO, UT	●	
Sulfur cinquefoil (*Potentilla recta*)		CO		
Swainsonpea (Sphaerophysa salsula)		CO		
Tall fescue *(Festuca arundinacea)*	**yes**			
Tansy ragwort (Senecio jacobaea)		CO		
Tumble mustard *(Sisymbrium altissimum)*	**yes**			
Velvetleaf (*Abutilon theophrasti*)		CO		
Venice mallow (*Hibiscus trionum*)		CO		
Water plantain (*Alisma plantago-aquatica*)	**yes**			
Water speedwell *(Veronica anagallis-aquatica)*	**yes**			
Watercress *(Nasturtium officinale)*	**yes**			
White clover *(Trifolium repens)*	**yes**			
White sweetclover (*Melilotus alba*)	**yes**			
Wild caraway (*Carum carvi*)		CO		
Wild mustard (*Brassica kaber*)		CO		

NON-NATIVE/INVASIVE SPECIES	**PRESENT IN DINOSAUR NATIONAL MONUMENT**	**STATE LISTED**	**WATCH LIST SPECIES**	**CONSIDERED FOR ACTIVE MANAGE-MENT**
Wild oats (Avena fatua)		CO		
Wild proso millet (*Panicum miliaceum*)		CO		
Willow weed *(Polygonum lapathifolium)*	**yes**			
Yellow foxtail (*Setaria glauca*)		CO		
Yellow nutsedge (*Cyperus esculentus*)		CO		
Yellow salsify *(Tragopogon dubious)*	**yes**			
Yellow starthistle (Centaurea solstitialis)		CO, UT	●	
Yellow sweetclover (*Melilotus officianalis*)	**yes**			**yes**
Yellow toadflax (*Linaria vulgaris*)	**yes**	CO		**yes**

Sources:
State of Colorado Department of Agriculture website:
http://www.ag.state.co.us/DPI/weeds/mapping/NoxiousWeedLists.html

State of Utah Department of Agriculture and Food website:
http://ag.utah.gov/plantind/nox_utah.html

Appendix B: Review of Scientific Literature Pertaining to Weed Species Proposed for Control at DINO

Scientific Name (ITIS Code)	Common name	Growth form	Scientific Literature Pertaining to Weed Control:
Acroptilon repens (CENRE)	Russian knapweed	perennial forb with creeping root system	**Cutting/mowing**: 3x/year (Carpenter and Murray 2003) **Cultivation/discing/plowing:** Every two weeks (Derscheid et al. 1961) **Grazing:** Goats intensive (pers. com Benz) **Chemical:** Picloram(.28 kg ai/ha) July, August or October (Bottoms and Whitson 1998, Benz et al. 1999, Benz. et al. 1999) Clopyralid(.32 kg ai/ha) +2,4-D(1.65 kg ai/ha) July, August or October (Bottoms and Whitson 1998, Benz et al. 1999, Benz. et al. 1999) Glyphosate (1.1 kg ai/ha) June and August(Bottoms and Whitson 1998, Benz et al. 1999, Benz. et al. 1999) **Bio-control:** *Subanguinea picridis* (climate dependant) (Rees et al. 1996) *Aceria acroptiloni*-noticibly stunted(Carpenter and Murray 2003) **Revegetation:** Thickspike wheatgrass, western wheatgrass, streambank wheatgrass (Bottoms and Whitson 1998, Benz. et al. 1999)

Aegilops cylindrica (AEGCY)	jointed goatgrass	annual grass	**Plowing:** Before seed-set (Donald and Ogg 1991) **Mowing/pulling:** Before seed-set (Meunscher 1980) **Fire:** August (Donald and Ogg 1991) **Chemical:** Glyphosate (.3 kg/ha)(Donald and Ogg 1991) *(.2-.5 kg/ha, depending on vigor)-March or April, at lower rates glyphosate didn't affect perrenial grasses (Beck et al. 1995)* Fluazifop (Donald and Ogg 1991) Sethoxydim (Donald and Ogg 1991)
Arctium minus (ARFMI)	*common burdock*	biennial forb	**Cutting:** Before seed-set (Meunscher 1980) **Chemical:** 2,4-D amine(.18-.72kg/ha) during rapid vegetative growth(Dunham 1970) Metsulfuron (.004-.02 L/ha) (Whitson et al. 2000) Glyphosate (.14-1.88L/ha) (Whitson et al. 2000) Hexazinone(.00013kg/ha/yr.) (Whitson et al. 2000)
Bromus tectorum (BROTE)	cheatgrass	annual grass	**Mowing:** Every 3 weeks (Ponzetti 1997) **Grazing:** not recommended?-same as mowing? (Carpenter and Murray 2004a) **Fire:** June (Carpenter and Murray 2004a) **Chemical:** Glyphosate (.028-.032 kg/ha)(Blackshaw 1991) *(.2-.4 kg/ha) –low rates of glyphosate had limited effect on warm-season perennial grass. (Beck et al. 1995)* Imazameth (.04-.12 kg/ha)- doesn't affect some perennial grasses (Carpenter and Murray 2004a) Fluazifop-p-butyl (.16-.24kg/ha) (Carpenter and Murray 2004a) Sethoxydim (Carpenter and Murray 2004a)

			Revegetation: Idaho fescue (*Festuca idahoensis*)(Nasri and Doescher 1995)
Cardaria draba (CADDR)	hoary cress, whitetop	perennial forb with creeping root system	**Mowing:** Mildly effective-(Selleck 1965, O'Brien and O'Brien 1994) **Discing/plowing/cultivation:** Every 5 days for 6-8 weeks, than less frequent into Oct.(Hulbert et al. 1934) Repeated cultivation (Barr 1942, Kott 1966) Within 10 days of re-emergence(Miller and Callihan 1991) **Grazing:** Sheep-(Scurfield 1962) **Chemical:** *2,4-D lv ester or amine (.32-.48 kg/ha) before flower bud stage (William et al. 2002)* Amitrol (1.2kg/190L water) for spot treatment (William et al. 2002) 2.2kg/ha.(Lyons 2004) *Chlorsulfuron (.02L ai/ha) prebloom to bloom or fall rosette (William et al. 2002)* *Metsulfuron (.007L ai/A) ai/ha prebloom to bloom or fall rosette (William et al. 2002)* Sulfometuron Methyl (0.21-0.35 kg/ha) (Hall 1992)
Carduus nutans (CRUNU)	musk thistle	annual or biennial forb	**Cutting/mowing:** Mowing within 2 days of first anthesis greatly reduces seed production (McCarty and Hatting 1975) Cutting at root crown just after anthesis (Heidel 2004) **Grazing:** Goats-during flowering will eat flowers only (Davidson 1990) **Chemical:** 2,4-D (.24kg/ha) April 30 (Feldman et al. 1968) Picloram (.08kg/ha) April-June (Feldman et al. 1968) (.14 kg/ha) spring & fall rosette, bolting plants (Roeth 1979) Clopyralid (Whitson et al. 2000) Metsulfuron(Whitson et al. 2000)

Centaurea diffusa (CENDI)	diffuse knapweed	annual, biennial or short-lived perennial forb	**Notes:**Plant is thought to contain a carcinogenic compound (Carpenter and Murray 2004b) **Cutting:** Repeated for several years; before seed-set(Carpenter and Murray 2004b) **Pulling:** Before seed-set, 3x annually (Carpenter and Murray 2004b) **Plowing:** *Deep (seeds don't germinate below 3 cm.)(Watson and Renney 1974, Zimmerman 1997)* **Fire:** Produces strong grass regrowth (Watson and Renney 1974, Zimmerman 1997) **Chemical:** Picloram (.04-.08 kg/ha) (Beck 1997) Wait 9-12 months before reseeding w/ grasses (Harris and Cranston 1979) Dicamba (.08-.16 kg/ha) (Beck 1997) 2,4-D (1.0 and 1.5 kg/ha) (Watson and Renney 1974) **Bio-control:** *Agapeta zoegana*, *Bangasternus fausti, Cyphocleonus achates, Larinus minutus, Metzneria paucipunctella, Pterolonche inspersa, Sphenoptera jugoslavica, Terellia virens,Urophora affinis, Urophora quadrifasciata*
Centaurea maculosa (CENMA)	spotted knapweed	biennial or short-lived perennial forb	**Mowing/cutting:** Only slightly effective due to persistant seedbank(Mauer et al. 2004) **Pulling:** Effectiveness limited by soil disturbance and seedbank(Mauer et al. 2004) **Grazing:** *Sheep-(5 yearlings/.1ha-never exposed to spotted knapweed before) reduced about %50 (Olson et al. 1997)* **Chemical:** Picloram (.4-.6 kg/ha)(Harris and Cranston 1979) (.28 kg/ha) Spring, Fall, bolt or flower bud stages(Sheley et al. 2000) *Picloram + 2,4-D (.1-1.12 L/ha) spring, before bloom or late summer or fall (Whitson et al. 2000)* Clopyralid (.12-.24 L/ha) during actrive growth (Whitson et al. 2000) *Clopyralid + 2,4-D (.21kg/ha +1.12kg/ha) Spring, Fall, bolt, bud and*

			flower stages (Sheley et al. 2000) **Bio-control:** *Agapeta zoegana, Bangasternus fausti, Cyphocleonus achates, Larinus minutus, Metzneria paucipunctella, Pterolonche inspersa, Sphenoptera jugoslavica, Terellia virens, Urophora affinis, Urophora quadrifasciata*(Rees et al. 1996)
Cirsium arvense (CIRAR)	Canada thistle	perennial forb with creeping root system	**Notes:** Drought decreases chemical efficacy, but increases mechanical impact (Johnson 1912, Hansen 1918, Haderlie et al. 1987) **Mowing:** Every 21 days and leaving 20 cm of stem (Hunter et al. 1985, Nuzzo 2003) Does not improve efficacy of herbicides(Beck and Sebastian 2000) **Grazing:** Goats repeatedly (Drlik et al. 2000) **Tilling, plowing, cultivating:** 7-10 cm deep every 21 days (Hodgson 1968) **Smothering:** Boards, sheet metal or tarpaper (Spence and Hurlbert 1935) **Fire**: mid-July to mid-August (Smith 1985) **Chemical:** Clopyralid + 2,4-D (.028+.112 kg/ha) June (Donald 1993) Clopyralid (Fall at .56 kg/ha) to rosette (Miller and Lym 1998, Nuzzo 2003) Glyphosate (low concentrations 2.5-4% depending on ecotype, higher concentrations not more effective) (Boerboom and Wyse 1988) *Fall application to rosette is most effective (Darwent et al. 1994)* Chlorsufuron-spring, effective in 2-5 years (Donald and Prato 1992) **Biocontrol:** *Ceutorhynchus litura* (Rees et al. 1996) **Revegetation:** *Pascopyrum smithii*(Wilson and Kachman 1999)*Leucantheum vulgare, Achillea millefolium & Reseda lutea* (Edwards et al. 2000)
Cirsium	bull thistle	biennial	**Pulling/cutting/digging:**

vulgare (CIRVU)		forb	*Before seed production; has a short-lived seed bank(Beck 1991, Doucet and Cavers 1996)* **Grazing:** Goats-during flowering, will eat flowers only (Davidson 1990) **Chemical:** 2,4-D (.16 kg/ha) spring (Beck 1991) **Bio-control:** *Urophora stylata* (Rees et al. 1996)
Cynoglossum officinale (CYWOF)	houndstongue	biennial or short-lived perennial forb	**Pulling:** Before seed-set (Meunscher 1980) **Mowing:** *Before seed-set (June 23, in Montana);resulted in %60 control (Dickerson and Fay 1982)* **Spudding:** Fall or spring rosettes (Meunscher 1980) **Chemical:** Metsulfuron (.006-.02 L/ha) (Whitson et al. 2000) Picloram (.56-1.12 kg/ha) Spring, Summer or Fall (Upadhyaya and Cranston 1991) Chlorsulfuron (.07 kg/ha) May-June (Montana) (Dickerson and Fay 1982) (.04 kg/ha) (Upadhyaya and Cranston 1991) 2,4-D amine (1.12 kg/ha)-May 29 (in Montana) (Dickerson and Fay 1982, Upadhyaya and Cranston 1991)
Elaeagnus angustifolia (ELGAN)	Russian olive	tree	**Mowing/Cutting**: Repeated (Stannard et al. 2002) **Girdling**: (Stannard et al. 2002) **Chemical:** *2,4-D ester, 2,4-D + Tryclopyr (foliar or basal bark-w/ diesel), Tryclopyr (basal bark-w/diesel), Imazapyr (hack &squirt), Glyphosate (hack & squirt) (Stannard et al. 2002)* Imazapyr-seedlings(Edelen and Crowder 1997) **Shading**: (Stannard et al. 2002)

			Fire: Requires follow-up treatment(Stannard et al. 2002) **Bio-control:** *Tubercularia ulmea, Phomopsis arnoldiae, Phomopsis elaeagni, Lasiodiplodia theobromae*.-effectiveness?(Stannard et al. 2002)
Elytrigia repens (ELRE3)	quackgrass	perennial grass	**Mowing:** Before flower (FEIS 1996) ***Chemical:*** *Chemicals labeled for control/suppression: Fluazifop, Glyphosate, Hexazinone, Imazapyr*
Euphorbia esula (EPHES)	leafy spurge	perennial forb with creeping root system	**Mowing:** Starting before leaves fully develop, repeated(Derscheid et al. 1985) **Cultivation:** Overlapping Duckfoot,10cm. deep, 14 day intervals (Derscheid et al. 1985) **Fire:** *Removes litter and forces seedbank & synchronizes phenology, which contributes to herbicide efficacy(Biesboer 2004)* **Grazing:** Goats (12/acre for 1 month)(Walker et al. 1994, Merritt et al. 2002b) Sheep (4/acre for 1 month)-once acclimated to the taste(Merritt et al. 2002b) **Chemical:** Picloram (.16-.32 kg/ha) –flowering or fall regrowth (Lym et al. 2002) Imazapic (.02-.036 L/ha) early to mid-Sept.(Lym et al. 2002) Glyphosate (.12 kg/ha) after July1 to activeley growing plants (Lym et al. 2002) Glyphosate + 2,4-D (.06+.63 kg/ha) seed set or fall growth (Lym et al. 2002) *Picloram +2,4-D (.04-.08 +.16kg/ha flower growth or fall regrowth (Lym et al. 2002)* Sulfometuron Methyl (.032-.048 kg/ha) (Masters and Nissen 1998) **Bio-control:** *Apthona nigriscutis, A. lacertosa, Hyles euphorbia, Oberea erythrocephala, Spurgia esulae* (Rees et al. 1996, Merritt et al. 2002a) **Revegetation:** *Pascopyrum smithii* (Lym and Tober 1997) Pseudoroegneria spicata and

			Thinopyrum ponticum (Whitson et al. 1989)
Hyoscyamus niger (HYSNI)	black henbane	annual or biennial forb	**Cutting or digging**: Before seed-set (Meunscher 1980, Lorenz and Dewey 1988) **Chemical:** 2,4-D (1.12-1.24 kg/ha) (Morishita 1991) Picloram (.28-.56 kg/ha) next year's germinating seeds(Morishita 1991, Upadhyaya and Cranston 1991)
Lepidium latifolium (LEPLA)	perennial pepperweed	perennial forb with creeping root system	**Mowing:** At flowerbud stage and applying herbicide after recovery to flowerbud stage or at bolting stage every 14 days (Renz 2003) **Discing:** Fall, followed by spring mowing and herbicide(reduced quantity required) (Renz 2003) **Grazing**: Sheep, cattle, goats(Young et al. 1997, Renz 2003) **Chemical:** Chlorsulfuron (.11kg/ha) June -at flowerbud stage (Young 1998) Imazapyr (.28-.42 kg/ha) flowerbud stage (Renz 2003) Metsulfuron methyl (.021-.042 kg/ha) flowerbud stage (Renz 2003)
Linaria dalmatica/ Linaria vulgaris (LINDA/ LIVU2)	Dalmatian toadflax/ yellow toadflax	perennial forb with creeping root system	**Pulling:** Consistently for 10-15 yrs. (Vujnovic and Wein 1997) **Discing/ plowing/ cultivation:** Sweep-type cultivator every 7-10days in first year and 4-5 times 2^{nd} year (Vujnovic and Wein 1997) **Chemical:** Picloram (.09-1.14 L/ha), Picloram +2,4-D (.38-.76 L/ha)(Whitson et al. 2000) **Bio-control:** *Brachypterolus pulicarius, Calophasia lunula* (Rees et al. 1996)
Melilotus officinalis (MELOF)	yellow sweet clover	annual or biennial forb	**Mowing/cutting:** Before seed-set (Meunscher 1980) **Chemical:**

			2,4-D (.42 kg/ha)-not as effective 2nd year (Greenshields and White) Most broad-leaved herbicides (Goplen and Gross 1977)
Onopordum acanthium (ONRAC)	Scotch thistle	biennial forb	**Cutting/mowing:** Before seed-set (Meunscher 1980, Beck 1991) **Grazing:** *Goats spring and summer (24-119 cm tall plants) 24/ha (Dellow et al. 1988, Mcgregor et al. 1990)* During flowering -will eat flowers only(Davidson 1990) **Chemical**: Picloram (.005-.32 kg/ha) June, 6inch rosettes (Young and Evans 1969) *(.5-3qt./A) spring or late summer &fall, avoid hot conditions(Whitson et al. 2000)* Metsulfuron (.006-.02 L/ha) (Whitson et al. 2000) Clopyralid (.13-.25 L/ha) (Whitson et al. 2000) 2,4-D (.32 kg/ha) spring before bolting (Beck 1991) 2,4-D + Picloram (.04+ .02 kg/ha) spring before bolting or fall (Beck 1991)
Sonchus uliginosus (SONUL)	meadow sowthistle	perennial forb with creeping root system	**Cultivation/plowing/discing:** In rosette stage, w/ 7-9 leaves (Downard and Morishita 1995) **Grazing:** Sheep or cattle (Downard and Morishita 1995) **Chemical:** *Late rosette to bud stage , assumed to respond to herbicide the same as perennial sowthistle (Sonchus arvensis) (Downard and Morishita 1995)* 2-4,D (.32 kg/ha) bud stage and regrowth 8-10in high (William et al. 2002) Amitrol (.64 kg/ha) bud stage (William et al. 2002) Clopyralid + 2,4-D amine (.38-1.9 L/ha) prior to bud stage (William et al. 2002)
Tamarix ramosissima (TAARA)	tamarisk, saltcedar	tree	**Cutting:** Below root crown (Naumann 2003) **Hand-pulling:** Small (Carpenter 2003) **Burning**:

			Needs herbicide follow-up(Carpenter 2003) **Chemical:** Tryclopyr (cut-stump) fall (Neill 1987, Sudbrock 1993) Picloram (cut-stump) (Neill 1987) Tryclopyr (basal-bark application) (Carpenter 2003) Imazypyr (1% v/v or + glyphosate .5% +.5%) -Foliar spray(Duncan 1994) **Revegetation:** Populus fremontii, salix spp. –sprigs (2.5-10 cm diam.) (Sudbrock 1993) Sprigs should be cut from dormant trees and placed with one end at the depth of the water table (Swenson and Mullins 1985)
Ulmus pumila (ULMPU)	Siberian elm	tree	**Chemical:** Picloram+ 2,4-D during rapid growth (Dunham 1970)

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Appendix F

Relative Aquifer Vulnerability Evaluation (RAVE)

In the field of wildland weed management, there is very little literature available to guide herbicide application near water. This is a concern because of the potential impacts from herbicides to water quality and its effects on public health and safety and environmental impacts (Tu et al. 2001). Herbicide labels may provide some direction and are heavily relied on, however there is need for independent evaluation of riparian herbicide application guidelines. The Montana Department of Agriculture in cooperation with Montana State University have developed the Relative Aquifer Vulnerability Evaluation (RAVE) system to help those in involved in agriculture guide their pesticide use in relation to risks to water quality (DeLuca and Johnson 2004). A number of federal land management agencies have adapted it to help guide their herbicide use on non-agricultural lands, including the US Forest Service and Rocky Mountain National Park (NPS 2003).

The RAVE score card can be filled out fairly quickly to determine if water quality is at risk from herbicide application on a particular site. The following factors have been included used to evaluate the risk to water quality:

- Depth to groundwater: the vertical distance below the soil surface to the water table.
- Distance to surface water: the horizontal distance from the application site to the nearest flowing or stationary surface water.
- Percent organic matter: the amount of decayed plant material present in the soil. Organic matter can bind with herbicides, preventing their movement in the soil and their ability to contaminate water. This information can be obtained from soil analysis tests or soil surveys.
- Herbicide application frequency: the number of times, per year that herbicides are applied to the site.
- Herbicide application method: whether the herbicide is applied foliarly or to the soil.
- Herbicide mobility: a relalative ranking of the potential of an herbicide to move in soils and contaminate groundwater. This is based on herbicide persistence, sorptive potential and solubility. The following scores are given for herbicides proposed for use at DINO:

Herbicide	Soil mobility	Herbicide	Soil mobility
Amitrol	medium	Imazameth/ Imazapic	high
Chlorsulfuron	high	Metsulfuron	high
Clopyralid	high	Picloram	high
Fluazifop-p-butyl	medium	Sethoxydim	high
Glyphosate	low	Sulfometuron-methyl	low
Hexazinone	high	Triclopyr	high
Imazapyr	high	2,4-D	high

(Humburg et al. 1989, Tu et al. 2001, DeLuca and Johnson 2004)

- Topographic position: the location of the herbicide application site within the landscape can greatly affect the potential for the herbicide to move off-site. Included are: flood plain (river or lake valley), alluvial bench (lands immediately above a lake or river valley), foot hills (rolling upplands near mountains) and upland plains (plains not immediately near open water or mountains).

<u>Directions for use of the RAVE scorecard:</u>
Each site where herbicide is being considered for use should be evaluated for risk to water quality using the RAVE system. For each site assign a value to each of the factors on the card below and add up the scores to attain a total RAVE score.

The Rave Scorecard:

Depth to groundwater:			% Soil organic matter:		
2-10 ft.*	20		0-1%	5	
10-25 ft.	12		1-3%**	3	
25-50 ft.	5		>3%	2	_____
>50 ft.	0	_____			
Distance to surface water:			Herbicide application frequency:		
1-100 ft.	5		>once/yr.	5	
100-500 ft.	3		Once/year	2	_____
>500 ft.	2	_____			
Topographic position:			Herbicide application method:		
floodplain	15		Soil applied	5	
alluvial bench	10		Foliar applied	2	_____
foothills	5				
upland plain	2	_____			
Soil texture:			Herbicide mobility:		
Gravelly	15		High	20	
Sandy	15		Medium	10	
Loamy	10		Low	5	_____
Clayey	5	_____			
			Total Rave Score:		_______

*Herbicides not registered for aquatic use should not be applied.
**Default, if unknown.

<u>Interpretation of Rave Score:</u>
RAVE scores range from 30 to 100. A higher score indicates a higher risk to water quality from herbicide contamination at a particular site. Scores 30-44 indicate a low risk to water quality from herbicide application. Scores of 45-79 indicate a medium risk to water quality, while scores of 80 and above indicate that herbicide should not be applied at this site.

RAVE Score Card Interpretation Scale:

|--|

30 45 80 100

Low Med. High

RAVE scores can be reduced by changing the herbicide used and the method of application. In all situations carefull handling, label instructions and carefull disposal of herbicides should be followed to reduce risks to water quality.

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Appendix G: Adjuvants approved for use by the State of California

Adjuvant Category	Product Name	Producer	Notes
Nonionic Surfactant	ACTIVATE PLUS	Agriliance LLC	
Nonionic Surfactant	ACTIVATOR 90	Loveland Products, Inc.	Low foaming
Nonionic Surfactant	AD-HERE XL	Plant Health Technologies	Speeds wetting for more uniform coverage
Methylated or Ethylated Vegetable Oil, Nonionic Surfactant and Buffering Agent or Acidifier	AERO DYNE-AMIC	Helena Chemical Co.	Provides pH reduction and buffering, NIS and oil blend
Nonionic Surfactant	B-85	Britz Fertilizers	Spreader-sticker
Organo-Silicone Surfactant and Nonionic Surfactant	CADENCE	KALO, Inc.	Approved for use with Regiment herbicide.
Nonionic Surfactant	DRI NONIONIC SURFACTANT	KALO, Inc.	Dry formulation
Methylated or Ethylated Vegetable Oil, Nonionic Surfactant and Organo-Silicone Surfactant	DYNE-AMIC	Helena Chemical Co.	
Nonionic Surfactant	INDUCE	Helena Chemical Co.	Non-flammable
Nonionic Surfactant and Buffering Agent or Acidifier	INTENSIFY	Britz Fertilizers	Penetrating surfactant, provides pH reduction and buffering
Nonionic Surfactant and Buffering Agent or Acidifier	LI-700	Loveland Products, Inc.	An acidifying penetrating surfactant with drift reducing properties
Nonionic Surfactant and Deposition (Drift Control) and/or Retention Agent and Methylated or Ethylated Vegetable Oil	LIBERATE	Loveland Products, Inc.	Penetrant, depostition aid and shear stable drift control agent
Nonionic Surfactant and Organo-Silicone Surfactant	QUARK	Plant Health Technologies	Nonionic organosilicone wetting agent designed for use in certain agricultural and horticultural uses where a nonionic surfactant is recommended.

Nonionic Surfactant	R-11	Wilbur-Ellis Company	Premium spreader activator
Nonionic Surfactant and Buffering Agent or Acidifier	SUPER SPREAD 7000	Wilbur-Ellis Company	
Nonionic Surfactant	X-77	Loveland Products, Inc.	
Crop Oil (Petroleum) Concentrate	AGRI-DEX	Helena Chemical Co.	Corn oil derived emulsifiers
Crop Oil (Petroleum) Concentrate	CROP OIL CONCENTRATE	Plant Health Technologies	Blend of surfactant and nonphytotoxic oil for use with postemergence herbicides as well as desiccants, defoliants, and other pesticides.
Crop Oil (Petroleum) Concentrate	CROP OIL CONCENTRATE	Helena Chemical Co.	
Crop Oil (Petroleum) Concentrate	O/S BLEND	Britz Fertilizers	
Crop Oil (Petroleum) Concentrate and Deposition (Drift Control) and/or Retention Agent	PENETRATOR	Helena Chemical Co.	
Crop Oil (Petroleum) Concentrate and Deposition (Drift Control) and/or Retention Agent And Buffering Agent or Acidifier	PENETRATOR PLUS	Helena Chemical Co.	Includes buffering component
Methylated or Ethylated Vegetable Oil	MSO CONCENTRATE OIL	Loveland Products, Inc.	Highly effective 100% nonionic-organosilicone wetter / spreader / surfactant.
Methylated or Ethylated Vegetable Oil and Organo-Silicone Surfactant	PHASE	Loveland Products, Inc.	Unique blend of refined and modified spray oil and nonionic organosilicone.
Methylated or Ethylated Vegetable Oil and Organo-Silicone Surfactant	SYL-TAC	Wilbur-Ellis Company	
Organo-Silicone Surfactant	BREAK-THRU	Plant Health Technologies	Highly effective 100% nonionic-organosilicone wetter / spreader / surfactant.
Methylated or Ethylated Vegetable Oil and Organo-Silicone Surfactant	FASTSTRIKE	Plant Health Technologies	Unique blend of refined and modified spray oil and nonionic organosilicone.

Organo-Silicone Surfactant	FREEWAY	Loveland Products, Inc.	
Organo-Silicone Surfactant	KINETIC	Helena Chemical Co.	Co-surfactant blend contains evaporation reducing agents
Organo-Silicone Surfactant	SILWET L-77	Helena Chemical Co.	
Organo-Silicone Surfactant	SYLGARD 309	Wilbur-Ellis Company	100% active product

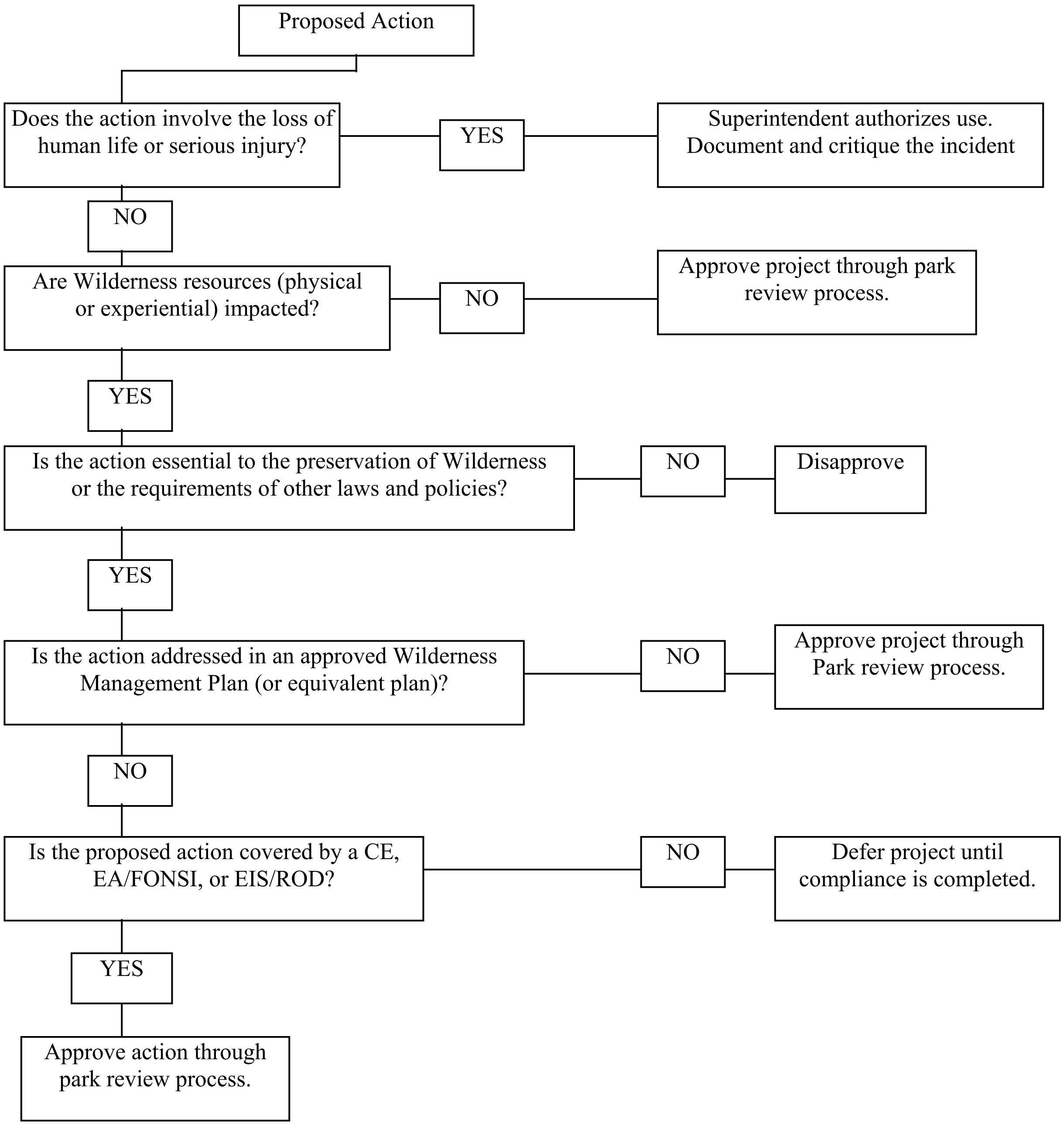
(CDPR 2004, Young 2004)

References

CDPR. 2004. California Department of Pesticide Regulation. http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods. 5/17

Young, B. 2004. Compendium of Herbicide Adjuvants. Southern Illinois University. http://www.herbicide-adjuvants.com/index-7th-edition.html. 6/04

Appendix H: Minimum Tool Analysis Decision Tree for use in Dinosaur National Monument's Recommended and Potential Wilderness Areas



Appendix I: Pesticide Handling

Pesticide Purchase
NPS 77 allows NPS personnel to purchase the amount of pesticide authorized for use during the year of approval. Larger amounts can be purchased only when the smallest amount available for purchase is larger than the amount necessary for the project. If an approved pesticide is unavailable, any substitutions with different active ingredients will require approval through the same pesticide use request and approval process.

Pesticide Storage
Pesticide storage facilities must be locked, fireproof, and ventilated; proper warning signs must be posted. Pesticides must be stored separately from all other substances, and the directions provided on the labeling must be followed. In addition, each type of pesticide must be stored on separate shelves. Any structure used for storage of pesticides should be posted, and copies of labels, material safety data sheets (MSDSs), and inventories should be kept in a locked container outside the storage facility.

Disposal of Pesticides
Only the amount of pesticide required for the treatment area should be mixed to limit the amount of excess pesticide generated during treatment. However, small remaining quantities of mixed pesticides and any rinsate from the container or spray equipment may be applied to the treatment area. If pesticides cannot be disposed of in this manner, they may be given to another agency or disposed of according to state laws and regulations. Donation of surplus chemicals should be documented and records kept for 3 years.

Pesticide Safety
Procedures for handling pesticides are provided on the pesticide label. These directions must be followed. The following precautions should also be followed.

Unless the label specifies otherwise, applicators should wear protective goggles or face shields, rubber or neoprene gloves, an impervious cap with a brim and drip guard, long pants, a long-sleeved shirt, and rubber boots during mixing, loading, application, and cleanup. Depending on the formulation of the pesticide, the applicator should use a respirator approved for the type of pesticide being applied. Mixers and loaders should take the additional precaution of wearing an impervious apron.

When spraying liquids overhead, sleeves should be tucked inside the gloves. However, pants should never be tucked inside of rubber boots.

Pesticide application equipment should never be worn home or washed in home laundry facilities.

Pesticides should never be transported inside the cab or passenger compartment of a vehicle. Instead, they should be removed or placed in containers. They should never be stored in containers used for food preparation or other food service purposes.

Copies of the label and MSDSs should be at the site where pesticides are being applied.

In addition to the safety of the applier, the safety of park visitors and others not involved with the application of pesticides must be considered. Many pesticide labels specify the minimum periods before unprotected individuals may enter treated areas, or they specify that treated areas must be posted. If the label specifies a reentry period, treated areas must be posted with signs warning visitors and others not to enter the treated area. The signs should indicate that the area has been treated with a pesticide, what materials were used, and the name and telephone number of a contact person.

Contracted Pest Management Services
Some practices may require the services of an exotic plant management firm or pest control operator. Contract specifications should describe what is permitted and what is not permitted on the NPS property. Specification should include exotic plant identification, monitoring on a regular basis, and no pesticide application unless action thresholds have been met.

Sample contract language may include the following points:

1. Contractor to arrive at the job site with factory sealed containers.
2. Contractor to mix and apply the pesticide under the observation of a NPS representative.
3. No surplus pesticide(s) will be disposed of on NPS owned or managed lands.
4. If the applicator has arrived at the job site, but is unaware of these contract criteria and has not read them, no work will be permitted until all contractual language has been read and understood and contractual compliance is in order.

Appendix J: Wildlife of Dinosaur National Monument

The following species have been documented in or near Dinosaur National Monument through various research, diaries, journals, and collected specimens.

FISH

Scientific Name	Common Name	Status Notes
Catostomus discobolus	bluehead sucker	native but not endemic
Catostomus latipinnis	flannelmouth sucker	endemic to CO River Basin
Catostomus commersoni	white sucker	introduced to CO River Basin
Catostomus platyrhynchus	mountain sucker	native but not endemic
Xyrauchen texanus	razorback sucker	endemic to CO River Basin
Lepomis cyanellus	green sunfish	introduced to CO River Basin
Lepomis macrochirus	bluegill	introduced to CO River Basin
Micropterous dolomieu	smallmouth bass	introduced to CO River Basin
Micropterous salmoides	largemouth bass	introduced to CO River Basin
Pomoxis nigromaculatus	black crappie	introduced to CO River Basin
Cottus bairdi	mottled sculpin	native but not endemic
Cyprinus carpio	common carp	introduced to CO River Basin
Ptychocheilus lucius	Colorado pikeminnow	endemic to CO River Basin
Semotilus atromaculatus	creek chub	introduced to CO River Basin
Pimephales promelas	fathead minnow	introduced to CO River Basin
Gila elegans	bonytail chub	endemic to CO River Basin
Gila robusta	roundtail chub	endemic to CO River Basin
Gila cypha	humpback chub	endemic to CO River Basin
Gila atraria	Utah chub	introduced to CO River Basin
Cyprinella lutrensis	red shiner	introduced to CO River Basin
Notropis stramineus	sand shiner	introduced to CO River Basin
Richardsonius balteatus	redside shiner	introduced to CO River Basin
Rhinichthys osculus	speckled dace	native but not endemic
Ctenopharyngodon idella	grass carp	introduced to CO River Basin
Fundulus kansae	plains killfish	introduced to CO River Basin
Culaea inconstans	brook stickleback	introduced to CO River Basin
Esox lucius	northern pike	introduced to CO River Basin
Ictalurus melas	black bullhead	introduced to CO River Basin
Ictalurus punctatus	channel catfish	introduced to CO River Basin
Stizostedion vitreum	walleye	introduced to CO River Basin
Salmo trutta	brown trout	introduced to CO River Basin
Oncorhynchus clarki	cutthroat trout	introduced to CO River Basin
Oncorhynchus mykiss	rainbow trout	introduced to CO River Basin
Prosopium williamsoni	mountain whitefish	native but not endemic

HERPTILES

Scientific Name	Common Name	Status Notes
Ambystoma tigrinum	tiger salamander	
Spea intermontana	Great Basin spadefoot	
Bufo woodhousei	Woodhouse's toad	
Pseudacris triseriata	Western chorus frog	probable occurrence
Rana catesbeiana	American bullfrog	
Rana pipiens	Northern leopard frog	
Phrynosoma hernandesi	short-horned lizard	

Scientific Name	Common Name	Status Notes
Sceloporus graciosus	sagebrush lizard	
Sceloporus undulatus	Plateau lizard	
Urosaurus ornatus	tree lizard	
Uta stansburiana	side-blotched lizard	
Cnemidophorus tigris	Western whiptail	
Coluber constrictor	Eastern racer	
Elaphe emoryi	Great Plains ratsnake	
Heterodon nasicus	Western hognose snake	probable occurrence
Lampropeltis triangulum	milk snake	
Liochlorophis vernalis	smooth green snake	probable occurrence
Masticophis taeniatus	striped whipsnake	
Pituophis caetnifer	gopher snake, bull snake	
Thamnophis elegans	Western terrestrial garter snake	
Crotalus viridis concolor	midget faded rattlesnake	
Crotalus viridis viridis	prairie rattlesnake	
Charina bottae	rubber boa	probable occurrence

MAMMALS

Scientific Name	Common Name	Status Notes
Sorex merriami	Merriam shrew	
Sorex monticolus	montane shrew	
Sorex preblei	Preble's shrew	Unconfirmed
Sorex nanus	dwarf shrew	Probably present
Myotis californicus	California myotis	
Myotis ciliolabrum	Western small-footed myotis	
Myotis evotis	long-eared myotis	
Myotis lucifugus	little brown bat	
Myotis thysanodes	fringed myotis	
Myotis volans	long-legged myotis	
Myotis yumanensis	Yuma myotis	
Lasionycteris noctivagans	silver-haired bat	
Lasiurus cinereus	hoary bat	
Pipistrellus hesperus	Western pipistrelle	
Eptesicus fuscus	big brown bat	
Euderma maculatum	spotted bat	
Corynorhinus townsendii	Townsend's big-eared bat	
Antrozous pallidus	pallid bat	
Tadarida brasiliensis	Brazilian (Mexican) free-tailed bat	
Nyctinomops macrotis	big free-tailed bat	
Sylvilagus audubonii	desert cottontail	
Sylvilagus nuttallii	Mountain (Nuttall's) cottontail	
Lepus californicus	black-tailed jackrabbit	
Lepus townsendii	white-tailed jackrabbit	
Neotamias dorsalis	cliff chipmunk	
Neotamias minimus	least chipmunk	
Neotamias rufus	Hopi chipmunk	
Marmota flaviventris	yellow-bellied marmot	
Spermophilus elegans	Wyoming ground squirrel	
Spermophilus lateralis	golden-mantled ground squirrel	
Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
Spermophilus variegatus	rock squirrel	
Cynomys leucurus	white-tailed prairie dog	Recently (11/04) removed from

Scientific Name	Common Name	Status Notes
		consideration for listing under the Endangered Species Act
Tamiasciurus hudsonicus	red squirrel	
Thomomys talpoides	Northern pocket gopher	
Perognathus fasciatus	olive-backed pocket mouse	
Perognathus parvus	Great Basin pocket mouse	
Dipodomys ordii	Ord's kangaroo rat	
Castor canadensis	beaver	
Reithrodontomys megalotis	Western harvest mouse	
Peromyscus crinitus	canyon mouse	
Peromyscus maniculatus	deer mouse	
Peromyscus truei	pinyon mouse	
Onychomys leucogaster	Northern grasshopper mouse	
Mus musculus	house mouse	unconfirmed
Neotoma cinerea	bushy-tailed wood rat	
Microtus longicaudus	long-tailed vole	
Microtus montanus	montane vole	
Lemmiscus curtatus	sagebrush vole	
Ondatra zibethicus	muskrat	
Erethizon dorsatum	porcupine	
Canis latrans	coyote	
Canis lupus	gray wolf	extirpated from monument
Vulpes vulpes	red fox	
Urocyon cinereoargenteus	gray fox	
Ursus americanus	black bear	
Ursus arctos	grizzly bear	extirpated from monument
Bassariscus astutus	ringtail	
Procyon lotor	raccoon	
Mustela frenata	long-tailed weasel	
Mustela vison	mink	
Mustela nigripes	black-footed ferret	unconfirmed
Taxidea taxus	badger	
Spilogale gracilis	Western spotted skunk	
Mephitis mephitis	striped skunk	
Lutra canadensis	river otter	
Felis concolor	mountain lion	
Lynx rufus	bobcat	
Cervus elaphus	elk (wapiti)	
Alces alces	moose	
Odocoileus hemionus	mule deer	
Antilocapra americana	pronghorn	
Bison bison	bison	extirpated from monument
Ovis canadensis	Rocky Mountain bighorn sheep	

BIRDS

Scientific Name	Common Name	Status Notes
Gavia immer	Common Loon	Present in Monument
Podilymbus podiceps	Pied-billed Grebe	Present in Monument
Podiceps nigricollis	Eared Grebe	Present in Monument
Aechmophorus occidentalis	Western Grebe	Present in Monument
Pelecanus erythrorhynchos	American White Pelican	Present in Monument
Phalacrocorax auritus	Double-crested Cormorant	Present in Monument
Ardea herodias	Great Blue Heron	Present in Monument

Scientific Name	Common Name	Status Notes
Egretta thula	Snowy Egret	Present in Monument
Nycticorax nycticorax	Black-crowned Night-Heron	Present in Monument
Plegadis chihi	White-faced Ibis	Present in Monument
Cathartes aura	Turkey Vulture	Present in Monument
Chen caerulescens	Snow Goose	Present in Monument
Branta canadensis	Canada Goose	Present in Monument
Anas strepera	Gadwall	Present in Monument
Anas americana	American Wigeon	Present in Monument
Anas platyrhynchos	Mallard	Present in Monument
Anas discors	Blue-winged Teal	Present in Monument
Anas cyanoptera	Cinnamon Teal	Present in Monument
Anas clypeata	Northern Shoveler	Present in Monument
Anas acuta	Northern Pintail	Present in Monument
Anas crecca	Green-winged Teal	Present in Monument
Aythya valisineria	Canvasback	Present in Monument
Aythya americana	Redhead	Present in Monument
Aythya collaris	Ring-necked Duck	Present in Monument
Aythya affinis	Lesser Scaup	Present in Monument
Clangula hyemalis	Oldsquaw	Present in Monument
Bucephala albeola	Bufflehead	Present in Monument
Bucephala clangula	Common Goldeneye	Present in Monument
Bucephala islandica	Barrow's Goldeneye	Present in Monument
Mergus merganser	Common Merganser	Present in Monument
Oxyura jamaicensis	Ruddy Duck	Present in Monument
Pandion haliaetus	Osprey	Present in Monument
Haliaeetus leucocephalus	Bald Eagle	Present in Monument
Circus cyaneus	Northern Harrier	Present in Monument
Accipiter striatus	Sharp-shinned Hawk	Present in Monument
Accipiter cooperii	Cooper's Hawk	Present in Monument
Accipiter gentilis	Northern Goshawk	Present in Monument
Buteo swainsoni	Swainson's Hawk	Present in Monument
Buteo jamaicensis	Red-tailed Hawk	Present in Monument
Buteo regalis	Ferruginous Hawk	Present in Monument
Buteo lagopus	Rough-legged Hawk	Present in Monument
Aquila chrysaetos	Golden Eagle	Present in Monument
Falco sparverius	American Kestrel	Present in Monument
Falco columbarius	Merlin	Present in Monument
Falco mexicanus	Prairie Falcon	Present in Monument
Falco peregrinus	Peregrine Falcon	Present in Monument
Alectoris chukar	Chukar	Present in Monument
Phasianus colchicus	Ring-necked Pheasant	Present in Monument
Centrocercus urophasianus	Sage Grouse	Present in Monument
Dendragapus obscurus	Blue Grouse	Present in Monument
Meleagris gallopavo	Wild Turkey	Present in Monument
Callipepla californica	California Quail	Present in Monument
Fulica americana	American Coot	Present in Monument
Grus canadensis	Sandhill Crane	Present in Monument
Charadrius vociferus	Killdeer	Present in Monument
Himantopus mexicanus	Black-necked Stilt	Present in Monument
Recurvirostra americana	American Avocet	Present in Monument
Tringa melanoleuca	Greater Yellowlegs	Present in Monument
Tringa flavipes	Lesser Yellowlegs	Present in Monument

Scientific Name	Common Name	Status Notes
Catoptrophorus semipalmatus	Willet	Present in Monument
Actitis macularia	Spotted Sandpiper	Present in Monument
Numenius americanus	Long-billed Curlew	Present in Monument
Gallinago gallinago	Common Snipe	Present in Monument
Phalaropus tricolor	Wilson's Phalarope	Present in Monument
Larus pipixcan	Franklin's Gull	Present in Monument
Xema sabini	Sabine's Gull	Present in Monument
Sterna forsteri	Forster's Tern	Present in Monument
Columba livia	Rock Dove	Present in Monument
Zenaida macroura	Mourning Dove	Present in Monument
Coccyzus americanus	Yellow-billed Cuckoo	Present in Monument
Otus flammeolus	Flammulated Owl	Present in Monument
Otus kennicottii	Western Screech-Owl	Present in Monument
Bubo virginianus	Great Horned Owl	Present in Monument
Glaucidium gnoma	Northern Pygmy-Owl	Present in Monument
Athene cunicularia	Burrowing Owl	Present in Monument
Strix occidentalis lucida	Spotted Owl	Present in Monument
Asio otus	Long-eared Owl	Present in Monument
Asio flammeus	Short-eared Owl	Present in Monument
Aegolius acadicus	Northern Saw-whet Owl	Present in Monument
Chordeiles minor	Common Nighthawk	Present in Monument
Phalaenoptilus nuttallii	Common Poorwill	Present in Monument
Aeronautes saxatalis	White-throated Swift	Present in Monument
Lampornis clemenciae	Blue-throated Hummingbird	Present in Monument
Archilochus alexandri	Black-chinned Hummingbird	Present in Monument
Stellula calliope	Calliope Hummingbird	Present in Monument
Selasphorus platycercus	Broad-tailed Hummingbird	Present in Monument
Selasphorus rufus	Rufous Hummingbird	Present in Monument
Ceryle torquata	Belted Kingfisher	Present in Monument
Melanerpes lewis	Lewis's Woodpecker	Present in Monument
Melanerpes erythrocephalus	Red-headed Woodpecker	Present in Monument
Sphyrapicus nuchalis	Red-naped Sapsucker	Present in Monument
Picoides pubescens	Downy Woodpecker	Present in Monument
Picoides villosus	Hairy Woodpecker	Present in Monument
Picoides tridactylus	Three-toed Woodpecker	Present in Monument
Colaptes auratus	Northern Flicker (Red-shafted)	Present in Monument
Contopus borealis	Olive-sided Flycatcher	Present in Monument
Contopus sordidulus	Western Wood-Pewee	Present in Monument
Empidonax traillii	Willow Flycatcher	Present in Monument
Empidonax hammondii	Hammond's Flycatcher	Present in Monument
Empidonax oberholseri	Dusky Flycatcher	Present in Monument
Empidonax wrightii	Gray Flycatcher	Present in Monument
Empidonax difficilis	Cordilleran Flycatcher	Present in Monument
Sayornis saya	Say's Phoebe	Present in Monument
Myiarchus cinerascens	Ash-throated Flycatcher	Present in Monument
Tyrannus verticalis	Western Kingbird	Present in Monument
Tyrannus tyrannus	Eastern Kingbird	Present in Monument
Lanius excubitor	Northern Shrike	Present in Monument
Lanius ludovicianus	Loggerhead Shrike	Present in Monument
Vireo vicinior	Gray Vireo	Present in Monument
Vireo solitarius	Plumbeous Vireo	Present in Monument
Vireo gilvus	Warbling Vireo	Present in Monument

Scientific Name	Common Name	Status Notes
Perisoreus canadensis	Gray Jay	Present in Monument
Cyanocitta stelleri	Steller's Jay	Present in Monument
Aphelocoma coerulescens	Western Scrub-Jay	Present in Monument
Gymnorhinus cyanocephalus	Pinyon Jay	Present in Monument
Nucifraga columbiana	Clark's Nutcracker	Present in Monument
Pica pica	Black-billed Magpie	Present in Monument
Corvus brachyrhynchos	American Crow	Present in Monument
Corvus corax	Common Raven	Present in Monument
Eremophila alpestris	Horned Lark	Present in Monument
Tachycineta bicolor	Tree Swallow	Present in Monument
Tachycineta thalassina	Violet-green Swallow	Present in Monument
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Present in Monument
Riparia riparia	Bank Swallow	Present in Monument
Hirundo pyrrhonota	Cliff Swallow	Present in Monument
Hirundo rustica	Barn Swallow	Present in Monument
Parus atricapillus	Black-capped Chickadee	Present in Monument
Parus gambeli	Mountain Chickadee	Present in Monument
Parus inornatus	Juniper Titmouse	Present in Monument
Psaltriparus minimus	Bushtit	Present in Monument
Sitta canadensis	Red-breasted Nuthatch	Present in Monument
Sitta carolinensis	White-breasted Nuthatch	Present in Monument
Sitta pygmaea	Pygmy Nuthatch	Present in Monument
Certhia americana	Brown Creeper	Present in Monument
Salpinctes obsoletus	Rock Wren	Present in Monument
Catherpes mexicanus	Canyon Wren	Present in Monument
Thryomanes bewickii	Bewick's Wren	Present in Monument
Troglodytes aedon	House Wren	Present in Monument
Cinclus mexicanus	American Dipper	Present in Monument
Regulus satrapa	Golden-crowned Kinglet	Present in Monument
Regulus calendula	Ruby-crowned Kinglet	Present in Monument
Polioptila caerulea	Blue-gray Gnatcatcher	Present in Monument
Sialia mexicana	Western Bluebird	Present in Monument
Sialia currucoides	Mountain Bluebird	Present in Monument
Myadestes townsendi	Townsend's Solitaire	Present in Monument
Catharus ustulatus	Swainson's Thrush	Present in Monument
Catharus guttatus	Hermit Thrush	Present in Monument
Turdus migratorius	American Robin	Present in Monument
Dumetella carolinensis	Gray Catbird	Present in Monument
Mimus polyglottos	Northern Mockingbird	Present in Monument
Oreoscoptes montanus	Sage Thrasher	Present in Monument
Toxostoma rufum	Brown Thrasher	Present in Monument
Bombycilla garrulus	Bohemian Waxwing	Present in Monument
Bombycilla cedrorum	Cedar Waxwing	Present in Monument
Sturnus vulgaris	European Starling	Present in Monument
Vermivora celata	Orange-crowned Warbler	Present in Monument
Vermivora virginiae	Virginia's Warbler	Present in Monument
Dendroica petechia	Yellow Warbler	Present in Monument
Dendroica tigrina	Cape May Warbler	Present in Monument
Dendroica coronata	Yellow-rumped Warbler (Audubon's)	Present in Monument
Dendroica nigrescens	Black-throated Gray Warbler	Present in Monument
Dendroica townsendi	Townsend's Warbler	Present in Monument

Scientific Name	Common Name	Status Notes
Dendroica striata	Blackpoll Warbler	Present in Monument
Setophaga ruticilla	American Redstart	Present in Monument
Helmitheros vermivorus	Worm-eating Warbler	Present in Monument
Oporornis tolmiei	MacGillivray's Warbler	Present in Monument
Geothlypis trichas	Common Yellowthroat	Present in Monument
Wilsonia pusilla	Wilson's Warbler	Present in Monument
Icteria virens	Yellow-breasted Chat	Present in Monument
Piranga ludoviciana	Western Tanager	Present in Monument
Pipilo chlorurus	Green-tailed Towhee	Present in Monument
Pipilo erythrophthalmus	Spotted Towhee	Present in Monument
Spizella arborea	American Tree Sparrow	Present in Monument
Spizella passerina	Chipping Sparrow	Present in Monument
Spizella breweri	Brewer's Sparrow	Present in Monument
Pooecetes gramineus	Vesper Sparrow	Present in Monument
Chondestes grammacus	Lark Sparrow	Present in Monument
Amphispiza bilineata	Black-throated Sparrow	Present in Monument
Amphispiza belli	Sage Sparrow	Present in Monument
Calamospiza melanocorys	Lark Bunting	Present in Monument
Passerculus sandwichensis	Savannah Sparrow	Present in Monument
Ammodramus savannarum	Grasshopper Sparrow	Present in Monument
Passerella iliaca	Fox Sparrow	Present in Monument
Melospiza melodia	Song Sparrow	Present in Monument
Zonotrichia querula	Harris's Sparrow	Present in Monument
Zonotrichia leucophrys	White-crowned Sparrow	Present in Monument
Junco hyemalis	Dark-eyed Junco (Oregon)	Present in Monument
Junco hyemalis	Dark-eyed Junco (Slate-colored)	Present in Monument
Junco hyemalis	Dark-eyed Junco (Gray-headed)	Present in Monument
Pheucticus melanocephalus	Black-headed Grosbeak	Present in Monument
Guiraca caerulea	Blue Grosbeak	Present in Monument
Passerina amoena	Lazuli Bunting	Present in Monument
Passerina cyanea	Indigo Bunting	Present in Monument
Agelaius phoeniceus	Red-winged Blackbird	Present in Monument
Sturnella neglecta	Western Meadowlark	Present in Monument
Xanthocephalus xanthocepha	Yellow-headed Blackbird	Present in Monument
Euphagus cyanocephalus	Brewer's Blackbird	Present in Monument
Quiscalus quiscula	Common Grackle	Present in Monument
Molothrus ater	Brown-headed Cowbird	Present in Monument
Icterus galbula	Bullock's Oriole	Present in Monument
Leucosticte arctoa tephrocus	Gray-crowned Rosy-Finch	Present in Monument
Leucosticte arctoa atrata	Black Rosy-Finch	Present in Monument
Leucosticte arctoa australus	Brown-capped Rosy-Finch	Present in Monument
Pinicola enucleator	Pine Grosbeak	Present in Monument
Carpodacus cassinii	Cassin's Finch	Present in Monument
Carpodacus mexicanus	House Finch	Present in Monument
Loxia curvirostra	Red Crossbill	Present in Monument
Carduelis pinus	Pine Siskin	Present in Monument
Carduelis psaltria	Lesser Goldfinch	Present in Monument
Carduelis tristis	American Goldfinch	Present in Monument
Coccothraustes vespertinus	Evening Grosbeak	Present in Monument
Passer domesticus	House Sparrow	Present in Monument
Aix sponsa	Wood Duck	Unconfirmed
Tringa solitaria	Solitary Sandpiper	Unconfirmed

Scientific Name	Common Name	Status Notes
Larus delawarensis	Ring-billed Gull	Unconfirmed
Vireo bellii	Bell's Vireo	Unconfirmed
Vireo olivaceus	Red-eyed Vireo	Unconfirmed
Progne subis	Purple Martin	Unconfirmed
Cistothorus palustris	Marsh Wren	Unconfirmed
Polioptila melanura	Black-tailed Gnatcatcher	Unconfirmed
Ixoreus naevius	Varied Thrush	Unconfirmed
Dendroica coronata	Yellow-rumped Warbler (Myrtle)	Unconfirmed
Mniotilta varia	Black-and-white Warbler	Unconfirmed
Ammodramus bairdii	Baird's Sparrow	Unconfirmed
Melospiza lincolnii	Lincoln's Sparrow	Unconfirmed
Calcarius mccownii	McCown's Longspur	Unconfirmed
Cardinalis cardinalis	Northern Cardinal	Unconfirmed
Pheucticus ludovicianus	Rose-breasted Grosbeak	Unconfirmed
Icterus parisorum	Scott's Oriole	Unconfirmed
Carduelis flammea	Common Redpoll	Unconfirmed
Podiceps auritus	Horned Grebe	Probably Present
Aechmophorus clarkii	Clark's Grebe	Probably Present
Botaurus lentiginosus	American Bittern	Probably Present
Ardea alba	Great Egret	Probably Present
Bubulcus ibis	Cattle Egret	Probably Present
Butorides striatus	Green Heron	Probably Present
Anser albifrons	Greater White-fronted Goose	Probably Present
Cygnus buccinator	Trumpeter Swan	Probably Present
Cygnus columbianus	Tundra Swan	Probably Present
Aythya marila	Greater Scaup	Probably Present
Melanitta fusca	White-winged Scoter	Probably Present
Lophodytes cucullatus	Hooded Merganser	Probably Present
Mergus serrator	Red-breasted Merganser	Probably Present
Bonasa umbellus	Ruffed Grouse	Probably Present
Rallus limicola	Virginia Rail	Probably Present
Porzana carolina	Sora	Probably Present
Pulvialis squatarola	Black-bellied Plover	Probably Present
Charadrius semipalmatus	Semipalmated Plover	Probably Present
Charadrius montanus	Mountain Plover	Probably Present
Bartramia longicauda	Upland Sandpiper	Probably Present
Limosa fedoa	Marbled Godwit	Probably Present
Calidris pusilla	Semipalmated Sandpiper	Probably Present
Calidris mauri	Western Sandpiper	Probably Present
Calidris minutilla	Least Sandpiper	Probably Present
Calidris bairdii	Baird's Sandpiper	Probably Present
Calidris melanotos	Pectoral Sandpiper	Probably Present
Calidris himantopus	Stilt Sandpiper	Probably Present
Limnodromus griseus	Long-billed Dowitcher	Probably Present
Phalaropus lobatus	Red-necked Phalarope	Probably Present
Larus philadelphia	Bonaparte's Gull	Probably Present
Larus californicus	California Gull	Probably Present
Sterna caspia	Caspian Tern	Probably Present
Chlidonias niger	Black Tern	Probably Present
Tyto alba	Barn Owl	Probably Present
Sphyrapicus thyroideus	Williamson's Sapsucker	Probably Present
Tyrannus vociferans	Cassin's Kingbird	Probably Present

Scientific Name	Common Name	Status Notes
Vireo cassini	Cassin's Vireo	Probably Present
Cyanocitta cristata	Blue Jay	Probably Present
Catharus fuscescens	Veery	Probably Present
Anthus spinoletta	American Pipit	Probably Present
Vermivora peregrina	Tennessee Warbler	Probably Present
Vermivora ruficapilla	Nashville Warbler	Probably Present
Seiurus aurocapillus	Ovenbird	Probably Present
Seirus noveboracensis	Northern Waterthrush	Probably Present
Spizella pallida	Clay-colored Sparrow	Probably Present
Zonotrichia albicollis	White-throated Sparrow	Probably Present
Calcarius lapponicus	Lapland Longspur	Probably Present
Plectrophenax nivalis	Snow Bunting	Probably Present
Dolichonyx oryzivorus	Bobolink	Probably Present
Quiscalus mexicanus	Great-tailed Grackle	Probably Present

Appendix K: State-listed Animal and Plant Species of Concern

In addition to the federally listed and candidate species listed on page 3-32, the following species are state of UT and/or CO designated or proposed wildlife species of special concern (SC) or state threatened (ST) that have been documented in or near DINO since 1960 by researchers from various federal and state agencies an universities.

Common Name	Scientific Name	Status in UT	Status in CO
Bluehead sucker	*Catostomus discobolus*	SC	
Flannelmouth sucker	*Catostomus latipinnis*	SC	
Roundtail chub	*Gila robusta*	SC	SC
Colorado River cutthroat trout*	*Oncorhynchus clarki pleuriticus*	SC (conservation agreement)	SC
Midget faded rattlesnake	*Crotalus viridus concolor*		SC
Smooth green snake	*Liochlorophis vernalis*	SC	
Northern leopard frog	*Rana pipiens*		SC
Townsend's big-eared bat	*Corynorhinus townsendii*	SC	SC
Spotted bat	*Euderma maculatum*	SC	
River otter	*Lontra canadensis*		ST
Fringed myotis	*Myotis thysanodes*	SC	
Big free-tailed bat	*Nyctinomops macrotis*	SC	
Northern pocket-gopher	*Thomomys talpoides macrotis*		SC
Northern goshawk	*Accipiter gentilis*	SC (conservation agreement)	
Grasshopper sparrow	*Ammodramus savannarum*	SC	
Short-eared owl	*Asio flammeus*	SC	
Burrowing owl	*Athene cunicularia*	SC	ST
Ferruginous hawk	*Buteo regalis*	SC	SC
Greater sage grouse	*Centrocercus urophaianus*	SC	SC
Mountain plover	*Charadrius montanus*		SC
Peregrine falcon	*Falco peregrinus*		SC
Sandhill crane	*Grus canadensis*		SC
American white pelican	*Pelecanus erythrorhynchos*	SC	
Three-toed woodpecker	*Picoides tridactylus*	SC	

* Species may occur within the project area and are managed under Conservation Agreements/Strategies in the state of Utah. This plan is designed to meet the goals and objectives of this Conservation Agreement.

Sources: Utah Division of Wildlife Resources Sensitive Species List
http://dwrcdc.nr.utah.gov/ucdc/ViewReports/SSL121803.pdf

Colorado Division of Wildlife Listing of Endangered, Threatened and Wildlife Species of Special Concern
http://wildlife.state.co.us/species_cons/list.asp

The following plant species are state of UT and/or CO designated or proposed special status species of concern that occur in or near DINO that have been documented since 1960 by researchers from various federal and state agencies an universities.

Common Name	Scientific Name	Status in UT	Status in CO
southern maiden hair fern	*Adiantum capillus-veneris*		X
Jones blue star	*Amsonia jonesii*		X
park rock cress	*Arabis vivariensis = A. fernaldiana var. fernaldiana = Boechera fernaldiana*	X	X
grass milkvetch	*Astragalus chloodes*	X	X
Duchesne milkvetch	*Astragalus duchesnensis*	X	X
Hamilton milkvetch	*Astragalus hamiltonii = A. lonchocarpus var. hamiltonii*	X	X
Dinosaur milkvetch	*Astragalus saurinus*	X	X
Canyonlands sedge	*Carex curatorum*	X	
Ownbey thistle	*Cirsium ownbeyi*	X	X
Rollins' cat's-eye	*Cryptantha rollinsii = Oreocarya rollinsii*	X	X
erect cryptanth	*Cryptantha stricta = Oreocarya stricta*	X	X
Uinta Basin spring parsley	*Cymopterus duchesnensis*	X	X
Utah Bladderfern	*Cystopteris utahensis*	X	X
juniper draba	*Draba juniperina = D. oligosperma var. juniperina*		X
helleborine	*Epipactis gigantea*	X	X
needle-leaf daisy	*Erigeron nematophyllus*	X	
Wilken fleabane	*Erigeron wilkenii*	X	X
Dinosaur buckwheat	*Eriogonum saurinum = E. lonchophyllum var. saurinum*	X	X
Woodside buckwheat	*Eriogonum tumulosum*	X	X
Duchesne buckwheat	*Eriogonum viridulum = E. brevicaule var. viridulum*		X
Utah greasebush	*Forsellesia meionandra = Glossopetalon spinescens var. meionandrum*	X	X
Orchard snakeweed	*Gutierrezia pomariensis*	X	
alcove bog orchid	*Habenaria zothecina = Limnorchis zothcina*	X	X
Rollins sweetvetch	*Hedysarum boreale var. gremiale*	X	
small-head sunflower	*Helianthella microcephala*	X	

rock hymenoxys	*Hymenoxys lapidicola*	X	
Watsons prickly phlox	*Leptodactylon watsonii*	X	X
Rollins bladderpod	*Lesquerella subumbellata*	X	
Uinta Basin stickleaf	*Mentzelia multicaulis var. multicaulis*	X	X
Thurbers muhly	*Muhlenbergia thurberi*	X	X
compact nama, matted fiddleleaf	*Nama densum var. parviflorum*		X
narrow-leaf evening primrose	*Oenothera acutissima = O. flava var. acutissima*	X	X
Bessey locoweed	*Oxytropis besseyi var. obnapiformis*	X	X
large-flowered breadroot	*Pediomelum megalanthum*		X
Vernal narrowleaf penstemon	*Penstemon angustifolius var. vernalensis*	X	X
Fremont beardtongue	*Penstemon fremontiivar. glabrescens*	X	
Plateau penstemon	*Penstemon scariosus var. cyanomontanus*	X	X
Uintah bahia	*Platyschkuhria integrifolia var. ourolepis*	X	
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	X	X
elegant thelypody	*Thelypodiopsis elegans*	X	
mountain clover	*Trifolium andinum*	X	X
Cisco woody aster, desert daisy	*Xylorhiza venusta*	X	
alcove death camas	*Zygadenus vaginatus = Anticlea vaginatus*	X	X

Sources: *Special Status Plant Species – Dinosaur National Monument*. 2002. Unpublished. Compiled by monument botanist Tamara Naumann.

Colorado Natural Heritage Program
http://www.cnhp.colostate.edu/

Appendix L:

Invasive Plant Management Plan and Monument-wide Inventory Results

These 10 proposed management actions comprise the Invasive Plant Management Plan and are discussed in detail below. The actions are designed to be relevant and applicable in achieving some level of invasive plant control strategy regardless of the alternative selected for implementation in Dinosaur National Monument. Techniques employed or scale of activity may vary among the alternatives according to the constraints of each alternative.

The actions are modeled after and designed to expand upon the six management strategies put forth by the NPS Strategic Plan for Managing Invasive Nonnative Plants in National Parks: Prevent invasion; Increase public awareness; Inventory and monitor nonnative plants; Conduct research and transfer technology; Integrate planning and evaluation; and Manage invasive non-native plants.

1. Prevent new infestations by employing prevention and early detection techniques

The most effective, economical, and ecologically sound approach with zero risk to resources of value in managing invasive species is to prevent their invasion in the first place. Often, managers direct limited resources to fighting firmly established infestations. By that stage, management is expensive and eradication is likely impossible. Certainly it is necessary to manage infestations to limit the spread of invasive plants into non-infested areas. However, limited resources might be spent more efficiently on proactive weed management that contains existing weed infestations but also focuses strongly on prevention or early detection of new invasions (Center for Invasive Plant Management 2003).

In this plan, Dinosaur National Monument proposes to adopt a set of invasive plant prevention guidelines, or Best Management Practices (BMPs), as outlined in Appendix D. These practical and proactive techniques are designed to prevent invasion and permanent establishment of invasive plants during the course of daily or routine activities and operations. Many of these practices will also be the core component of a handbook that the NCPN is in the process of producing entitled *Northern Colorado Plateau Network Handbook for Invasive Plant Prevention and Management* that can be used by all other parks on the Northern Colorado Plateau. General objectives of these BMPs include:

- Incorporating weed prevention and control into project planning
- Avoiding or removing sources of introduction and spread of weed seed and propagules to prevent new weed infestations and the spread of existing weeds
- Avoiding the creation of environmental conditions that promote weed germination and establishment
- Re-establishing vegetation to prevent conditions conducive to establishment of weeds when project disturbances create bare ground.

- Improving the effectiveness of prevention practices through weed awareness and education

Early detection of invading plants minimizes spread, enhances opportunities for eradication, and is most effectively done at the local level by land managers and landowners. DINO will monitor heavily developed or high use areas ("hot spots") such as campgrounds, parking lots, housing and administrative areas, road shoulders, river corridors, and trails and trailheads every one to five years to detect new invasive species establishment.

Dinosaur is also committed to supporting and working cooperatively with the State of Colorado's Early Detection and Eradication Specialist who is charged with adapting and implementing the National Early Detection and Rapid Response framework to Colorado.

2. Educate visitors and staff about invasive plants and their management in Dinosaur National Monument

There are several programs already in place that make connections with the public regarding invasive species. The Weed Warrior program engages hundreds of young adults every year in a program that combines invasive species education followed by a short service project involving mechanical removal of species such as tamarisk and perennial pepperweed. Interpretive staff on both the CO and UT sides of the monument lead visitor and volunteer programs that focus on invasive species in campgrounds and along the river canyons. Several short articles about invasive vs. native species have also been featured in the monument newspaper *Echoes*.

DINO will increase efforts to inform the public and staff about invasive plants and the monument's strategy for managing them. Some ideas for expanding awareness among visitors and staff include:

- Visitor center displays and brochures on invasive species and management in the monument
- Partnering with other neighboring agencies in regional educational awareness efforts
- Developing an invasive species website within the Dinosaur National Monument home page dedicated to current information on monument activities, regional news, and technical information on management
- Initiate staff project days where monument staff can learn about a particular weed problem in the park and then participate in a short work project focusing on a particular goal or species, such as improving rare plant habitat or eradicating a new invader.
- Hold informal annual meetings with grazing permittees and staff (maintenance, fire, other resource management staff) potentially impacted by weed management activities to give updates and discuss effectiveness of treatment techniques and inform of upcoming annual work plan.

3. Inventory invasive plants in Dinosaur National Monument

This action calls for the completion of a base inventory of non-native invasive plants in Dinosaur National Monument. Knowing which invasive species are present, their location, and abundance or distribution is the basic building block in any weed management plan and is the information on which all other efforts hinge. Incomplete information on the location and abundance severely limits the monument's ability to achieve habitat management and restoration goals.

Past and Ongoing Inventory Efforts

The first organized invasive species inventory occurred in 1996. Approximately 300 affected acres of 6 target species (perennial pepperweed, Russian olive, tamarisk, Russian knapweed, Canada thistle, and leafy spurge) were identified and hand-mapped on 7.5-minute USGS quadrangle maps. This inventory effort focused solely on the most likely infested areas within the monument – along river corridors, along roads, around campgrounds, and in employee housing and headquarters areas – because these are of highest-use in the monument.

In 2002, Utah State University was contracted to conduct a more extensive survey of invasive plants over more area using technology and a newly developed protocol that would be compatible both with North American Weed Management Association (NAWMA) standards and NPS's nation-wide invasive species initiative and databases that were currently under development. Using Trimble GPS units, crews surveyed on foot 13,947 acres that year and found 18 of the 27 target species, occupying a total of 1,062 infested acres (Dewey et al. 2004). Areas surveyed in 2002 were primarily in the Utah portion of the monument and include the roads to and regions around the Dinosaur Quarry and Split Mountain, Rainbow Park, the "Racetrack", the Green River and Split Mountain campgrounds, Harper's Corner Road, and the Green River corridor from the UT state boundary to the Split Mountain boat ramp.

USU field crews returned in 2003 to survey additional areas in the Green River district as well as Echo Park, Gates of Lodore, Deerlodge Park, and portions of the 2002 Bear Valley burn on the Colorado portion of the monument. A total of 211 of the 8,015 acres surveyed were found to be infested.

Surveys continued in Colorado in 2004 along the Yampa River corridor from Deerlodge Park to its confluence with the Green River in Echo Park. It also included more remote areas of the monument such as West Cactus Flat, Disappointment Draw, Pearl Park, Vale of Tears, and selected areas of the Yampa bench (Schoonover Pasture, Johnson Canyon, Bull Canyon, Sand Canyon). A total of 156 of the 14,636 acres surveyed were found to be infested in these areas.

Maps at the end of this plan show the results of 2002-2004 inventory efforts. The following chart is a summary of inventory efforts and occupied acreage (A) by species recorded from 2002-2004:

Total Acres Surveyed: 36,598
Total Infested Acres Mapped: 1,429
Percent of Surveyed Areas Infested: 4%

Weed Species	< .25 A	.25 A – 10 A	10 A – 100 A	100+ A
Black henbane	●			
Bur buttercup	●			
Cheatgrass				●
Common burdock			●	

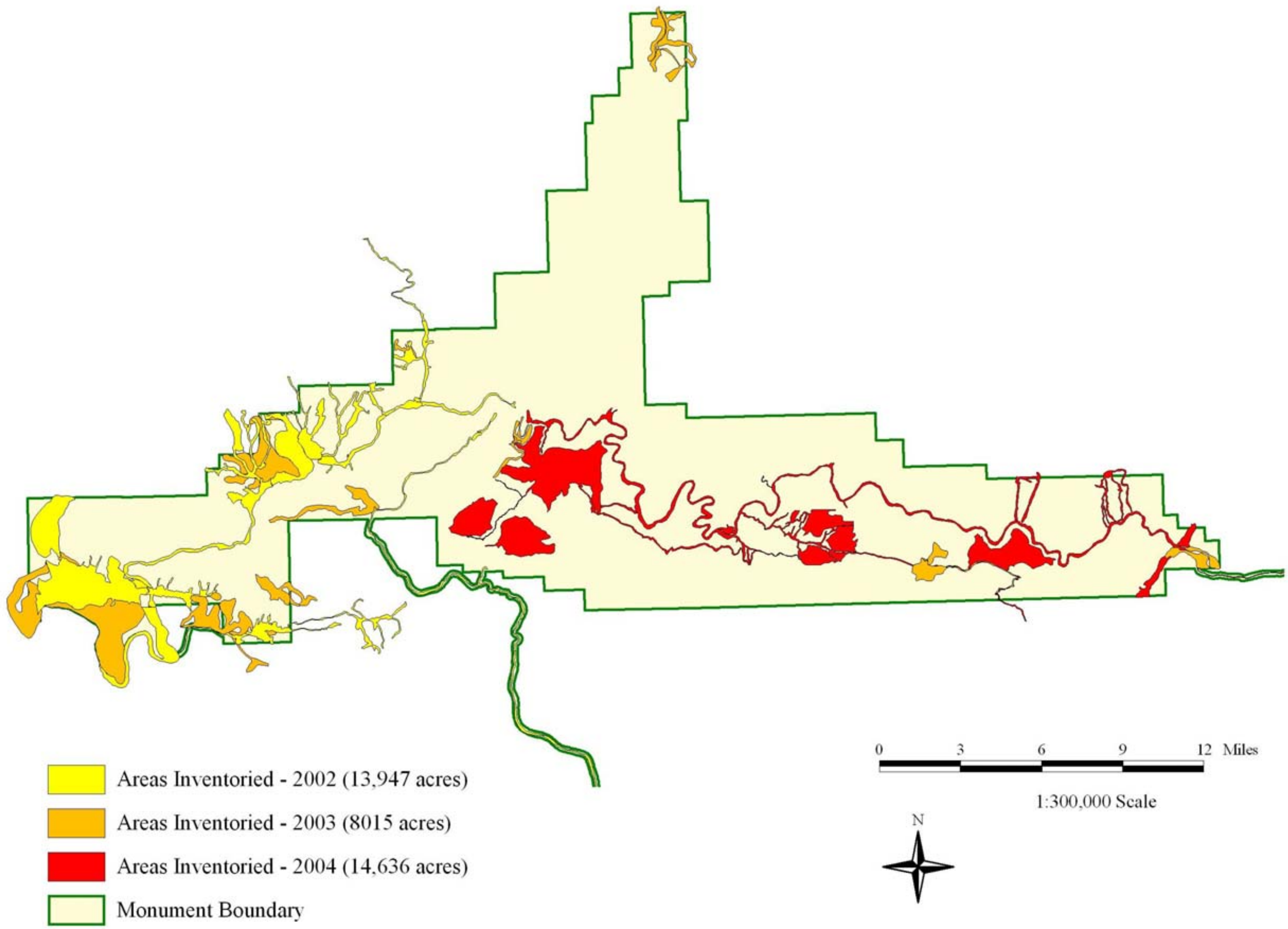
Weed Species	< .25 A	.25 A – 10 A	10 A – 100 A	100+ A
Common mullein		●		
Crested wheatgrass		●		
Field bindweed	●			
Hoary cress		●		
Houndstongue		●		
Jointed goatgrass	●			
Knapweed, Russian				●
Knapweed, spotted	●			
Leafy spurge		●		
Perennial pepperweed				●
Perennial sowthistle		●		
Quackgrass		●		
Russian olive			●	
Tamarisk				●
Thistle, bull			●	
Thistle, Canada				●
Thistle, musk		●		
Thistle, Scotch	●			
Toadflax, Dalmatian	●			
Toadflax, yellow	●			
Tumble mustard		●		
Yellow sweetclover				●

The surveys performed by USU between 2002-2004 clearly show that the overwhelming majority of invasive species problems are concentrated in high-(human)use areas (campgrounds, housing areas, trailheads, visitor centers) and along transportation corridors (river corridors, trails, roads). With the exception of the Morris Ranch (that has a documented history of agriculturally-based invasive species introductions), portions of grazing allotments and more remote areas that have been mapped (Mantle, Island Park, Docs Valley, Green River) do not have significant infestations of high priority invasive species, indicating that permitted agricultural activities and large ungulate movement within the monument are not a significant source or vector for invasive species introduction or spread.

Future Inventory Efforts

This summer (2005) USU will complete the base inventory for the majority of priority areas, including Lodore Canyon, Zenobia Basin and Wild Mountain, within the monument. This will conclude a 4-year effort representing current and valuable information on invasive species in the range of habitats occurring within the monument (over 50,000 acres). Monument staff will then assume responsibility for scaled back re-inventory efforts, focusing on those areas identified as important points of introduction or spread, using a similar data collection protocol every 10-15 years as part of a prevention and early detection program, subject to availability of funds.

Figure 3. Total area inventoried for Invasive Plants in Dinosaur National Monument ifrom 2002-2004.



4. Monitor effectiveness of control efforts

Monitoring is the repeated collection and analysis of information to evaluate progress and effectiveness in meeting resource management objectives (Elzinga et al. 1998) and is an essential part of an integrated weed program. Based on inventory and ranking criteria, a good monitoring program saves time and money by telling managers which control techniques are working and which ones are not. Monitoring programs can range from simple, such as taking photo points, to more complex plot and transect data collection, but all are ongoing processes that will detect useful trends with each year of repetition. Without monitoring, there is no way of knowing whether control efforts are contributing to fulfillment of desired management objectives (CNAP 2000).

The NCPN is currently researching and developing invasive species treatment effectiveness monitoring protocols that will be employed by all NCPN parks, including Dinosaur National Monument, in 2006. A minimum monitoring standard will be established for consistency and comparability of results across NCPN parks. There are few NPS Inventory and Monitoring networks that have network-wide standardized monitoring programs, so it is anticipated that the NCPN protocol may serve as guidance for invasive species monitoring nationwide within NPS. Data generated from the park monitoring programs will be entered into a monitoring module in the forthcoming NCPN invasive species management database described in Proposed Action #5.

5. Track invasive plant management efforts

The NCPN is in the process of developing its own repository for all data collected concerning invasive species management efforts, such as inventory, control, and monitoring. The purpose of this database is to standardize and facilitate any required annual reporting that individual parks do on species, date, location, treatment technique(s) employed, type and amount of chemicals used, and staff time used, etc. It can also be used as part of a treatment effectiveness monitoring program, as it will eventually provide important treatment histories of particular areas that can be selected for more intensive analysis and monitoring efforts. In addition, the database will be able to hold any verified, complete treatment and inventory data collected prior to 2005 (referred to as 'legacy data') that meets the current required reporting fields to further support its use as an effectiveness monitoring tool.

The NCPN database will be designed to support the Alien Plant Control and Monitoring (APCAM) database that is used by all EPMTs for nationwide invasive species control reporting requirements. The network has decided not to use APCAM as a reporting tool for invasive species work on the Colorado Plateau because APCAM is not designed to meet additional inventory, monitoring, and restoration data management needs identified by individual parks. It is expected the new database will be ready for implementation by the time most parks in the NCPN have NEPA-compliant invasive plant management plans in place.

6. Prioritize both invasive plant species and locations to be controlled

Because it is impossible to control every weed, invasive or otherwise, that occurs in Dinosaur National Monument, it makes sense to focus management efforts on those species that have or *could* have the greatest impact to monument resources or neighboring agro/economic activities. Prioritizing management activities both by species and their location will help guide the most efficient use of resources (specifically staff time and budget), according to predetermined weed management objectives.

For the purposes of identifying pest plant species, many states and the USDA have created regulatory noxious weed lists focusing federal and state attention to species that threaten agricultural production and wildlands or natural areas. In some cases, such as in Colorado, the weed lists have been prioritized to guide coordinated state and county efforts and even provide management recommendations for individual species. Colorado's weed list and law can be found at http://www.ag.state.co.us/DPI/weeds/Weed.html. Utah has a significantly shorter state weed list that at this time focuses primarily on agricultural plant pests. Utah's list can be found at http://ag.utah.gov/plantind/nox_utah.html.

Although these lists may provide a starting place for identifying pests that affect a particular region, most are not specific enough to help land managers decide which species to pay particular attention to and in what locations or situations. Ranking systems (protocols) are tools to help land managers sort and prioritize exotic species based on several aspects of an invasive species' total impact:

1. Ecological impact (the cumulative impact of the species over time)
2. Current distribution and abundance
3. Trend in distribution and abundance (its potential to establish itself in currently uninfested areas, spread, and increase in abundance)
4. Management difficulty (ease or feasibility of control)

Based on consideration of all these factors, a person with good taxonomic skills and knowledge of local or regional ecology can use a ranking system to greatly reduce the number of species with which a land manager needs to be concerned and separate those species that are relatively innocuous from those that are disruptive or have a high potential to become disruptive.

The NCPN of parks (16 parks, including DINO) is currently compiling species lists and reviewing and comparing several ranking systems in order to select the one that best meets the network's goals for future inventory, control, and monitoring needs. The end result will be a list and supporting documentation of priority species as well as a "watch list" for all northern Colorado Plateau parks. A few of the established ranking systems being reviewed include Natureserve's recently released *Invasive Species Assessment Protocol* (Morse et al. 2004), California Exotic Pest Plant Council and Southwest Vegetation Management Association's *Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands* (Warner et al. 2003), and Heibert and Stubbendieck's *Alien Plant Ranking System* (APRS Implementation Team 2001) that was originally developed for NPS.

It is expected that development of a NCPN-wide list of invasive species and ranking system will be completed by 2007. Although DINO has not analyzed its list of 75 non-native species using an established ranking system to date, it has identified 24 of those species for active or opportunistic management. These species were identified as priority based on previous inventories, their known impacts in other parts of the western U.S., regional and state mandates, and personal observations and experience of monument staff. DINO will use the forthcoming NCPN priority list plus any additional species unique to the monument to create a monument-specific prioritized list using the ranking system chosen by the network. No major changes to current monument priority species are expected, though site priorities may change as a result of this process. Using the NCPN ranking process will ensure consistency across all park units on the Northern Colorado Plateau by facilitating use of mutual data systems and through clear communication of priorities with cooperator and sister agencies.

7. Work with adjacent landowners, local, state and federal agencies, local interest groups, weed cooperative networks, and others to develop and achieve common goals of invasive plant management

The spread of invasive plants throughout Utah and Colorado poses a serious environmental and economic threat to public land, ranchland, farmland and private property in Uintah and Moffat counties. Because success of a weed management program is, in part, only as successful as your neighbors, DINO has joined with other federal, state and local government agencies, non-profit organizations, and private landowners to develop joint strategies for curbing this silent threat.

The following agencies, organizations, and landowners have expressed interest in invasive species in DINO and have active partnerships with the monument concerning invasive species management:

- Uintah Basin Cooperative Weed Management Area
- Dinosaurland RC&D
- Uintah County, Utah
- Moffat County, Colorado
- Routt County, Colorado
- Rio Blanco County, Colorado
- Uintah County weed board
- Chew Family Ranch
- U.S. Bureau of Reclamation
- U.S. Bureau of Land Management
- U. S. Fish and Wildlife Service
- Tamarisk Coalition
- The Nature Conservancy
- Outward Bound West
- National Outdoor Leadership School
- Sierra Club
- Friends of the Yampa
- Utah State University
- Colorado State University
- Colorado Division of Wildlife
- Colorado State Parks
- Colorado Department of Agriculture

Examples of existing partnerships and projects include:

- DINO's Weed Warrior Program has worked for 7 years with over 5000 Colorado Outward Bound and National Outdoor Leadership School students removing tamarisk along the Green and Yampa River canyons while exchanging educational and interpretive opportunities concerning national and local invasive species issues and concerns. Friends of the Yampa, a local volunteer group from Steamboat Springs, CO, has volunteered over 1650 hours removing tamarisk in innovative ways from the river canyons in DINO for the last four years while advocating for invasive species awareness in local communities.
- DINO has actively participated in supporting and organizing several Uintah Basin Cooperative Weed Management Area and Dinosaurland RC&D workshops, meetings, and workdays to help focus multi-agency weed education and control efforts in the Uintah Basin.

Potential project partnerships include:

- Cooperative Russian olive and tamarisk removal with the Chew Family on adjacent monument and private land along the Green River in Utah - partners may include cooperative extension services, Uintah County, NRCS, and other private landowners along the Green River.
- Yampa River Tamarisk and Russian Olive Management Cooperative Initiative, Routt and Moffat Counties, Colorado– partners include BLM, Moffat and Routt counties, The Nature Conservancy, CO Division of Wildlife, and CO State Parks, volunteer organizations, and private landowners.

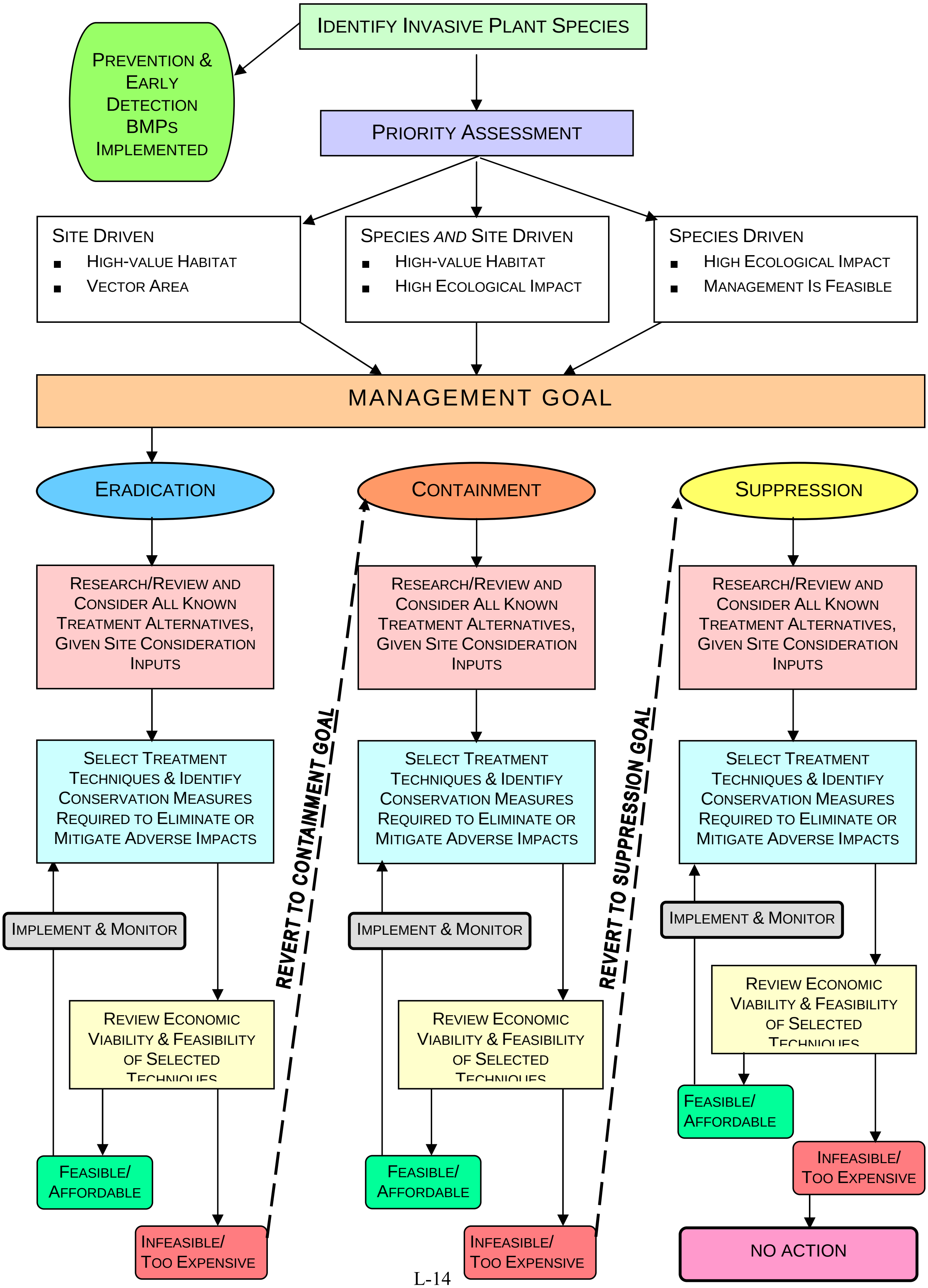
DINO continues to participate in Colorado Weed Management and Utah Weed Control Associations – organizations dedicated to statewide invasive species issues, and remains committed to pursuing new partnerships with interested entities to manage weeds cooperatively in northwestern CO and northeastern UT.

8. Identify control techniques most appropriate for each species

Using the NEPA process, control techniques will be selected that achieve maximum effectiveness in control while minimizing risks to humans and natural and cultural resources. Table 3 summarizes two infestation characteristics of priority invasive species that factor heavily into the selection process of appropriate control techniques – size class and habitat type. Based on 2002-2004 inventory data, the table below shows that, with the exception of the most abundant species, a majority of infested acres occur in riparian corridors (Green and Yampa Rivers) in isolated patches of ¼ acre or less. Appropriate control techniques for these smaller sized infestations will include those that have the least impacts on resources, both in scope and duration, such as weed whipping, hand pulling, spot spraying, and sawing. In many cases, all known infestations of entire species (Dalmatian and yellow toadflax and spotted knapweed, for instance) can be treated in this manner, making eradication a possible management goal.

However, several species are simply too abundant and/or widespread to achieve management goals of suppression or containment using the same smaller-scale techniques. While smaller, isolated populations of these more common species can be treated using these types of techniques, larger acreages require different strategies and techniques to more effectively and efficiently work towards stated management goals. Examples of techniques for treating larger, more widespread or dense infestations include mowing, discing/plowing (in old agricultural pastures), spraying from a motorized vehicle (roadsides, agricultural areas), biological control release, and use of prescribed grazing of domesticated livestock and/or fire. Techniques and tools will be identified as appropriate by using the IPM Decision Matrix.

Integrated Pest Management Decision Matrix



Infestation Characteristics of Size Class and Habitat Type of Priority Invasive Species

Invasive species of highest management priority	Acres mapped to date	Acres by infestation class			Infested acres by habitat type		
		0 - 0.25 A	0.5 – 2.5 A	5 + A	Riparian	Upland	Wetland
Black henbane	**tr**	tr			tr		
Bull thistle	**14**	12	2		13	1	
Canada thistle**	**105**	55	28	22	91	13	1
Cheatgrass**[1]	**-**	-	-	-	-	-	-
Common burdock	**32**	2	1	29	30	2	
Dalmatian toadflax	**tr**	tr			tr		
Hoary cress	**2**	1	1		2	tr	
Houndstongue	**1**	1			1		
Jointed goatgrass	**tr**	tr			tr		
Leafy spurge	**4**	4			4		
Meadow/perennial sowthistle	**2**	tr	2		2	tr	
Musk thistle	**1**	1			tr	1	
Perennial pepperweed**	**280**	130	118	32	157	122	1
Russian knapweed**	**140**	44	77	19	57	82	1
Russian olive	**45**	17	21	7	39	6	tr
Scotch thistle	**tr**	tr			tr	tr	
Spotted knapweed	**tr**	tr			tr		
Tamarisk**	**638**	197	271	170	581	56	1
Yellow sweetclover	**143**	60	39	44	88	55	tr
Yellow toadflax	**tr**	tr			tr		
TOTALS	**1407**	524	560	323	1065	338	4

tr = trace infestations which are <0.1 A in size

* Quackgrass and Siberian elm are also planned for active management, though no detailed inventory data exists for them at this time. Quackgrass and other non-native perennial grass species will be treated opportunistically as part of a restoration plan in areas where it occurs (such as Cub Creek). Siberian elm will be treated opportunistically as part of riparian restoration projects.

* * These species vary the most in density throughout the monument (trace amount, low, moderate, high, majority); density of particular infestations or areas of infestation will factor in to treatment technique selection.

[1] Cheatgrass is by far the most abundant and widespread invasive species in the monument and occurs in every habitat and vegetation community type. For these reasons, mapping this particular species is both difficult and impractical and will only be completed to determine local infestation characteristics in areas where restoration is planned. Therefore, "active" cheatgrass management will be performed opportunistically as part of a restoration plan in areas where it is likely to adversely affect restoration potential of desirable plants and/or communities.

The control technique must be effective at killing exotic plants or managing infestations at an acceptable threshold level.

There are five basic categories that all management techniques fall into: mechanical control, cultural control, chemical control, biological control, and prevention. Each category is described below and provides both the definitions and background used for impact analysis in Chapter 4.

Mechanical Control

Mechanical techniques for control of weeds in DINO include mowing, cutting/sawing, digging, pulling, spudding (severing of roots below the root crown), discing/plowing and smothering. Mechanical techniques can be especially effective in preventing seed production in annual and biennial forbs and exhausting root reserves in perennial plants (Meunscher 1980), and timing of these controls can be extremely important in determining outcome. For example, mowing cheatgrass in the "red" stage (post-flowering ["green"] but pre-curing ["tan"]) has proven to be very effective in some types of habitats. For perennial plants that reproduce vegetatively from root parts, mechanical treatments are generally not expected to provide complete control, even when repeated. Most often, they can be used as a tool for stressing the plants, making other treatments more effective (Derscheid et al. 1961, Renz and DiTomaso 1998).

The following mechanical controls have been found to be effective on weeds found in Dinosaur National Monument (See Appendix C for details and citations):

Mechanical Control:	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Mowing	X	X		X	X	X	X	X	X		X		X	X		X						
Cutting/sawing			X			X	X	X		X		X			X			X	X		X	X
Smothering									X													
Digging/pulling/ spudding	X						X	X		X	X				X		X				X	
Plowing/discing	X	X			X		X		X					X		X	X			X		

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress **CRUNU** musk thistle **CENDI** diffuse knapweed **CENMA** spotted knapweed **CIRAR** Canada thistle **CIRVU** bull thistle **CYWOF** houndstongue **ELGAN** Russian olive **ELRE3** quackgrass **EPHES** leafy spurge **HYSNI** black henbane **LEPLA** perennial pepperweed **LINDA/LIVU2** Dalmatian toadflax/yellow toadflax **MEUOF** yellow sweet clover **ONRAC** Scotch thistle **SONUL** meadow sowthistle **TAARA** tamarisk / saltcedar **ULMPU** Siberian / Chinese elm

Some mechanical control techniques (mowing, discing/plowing) involve the use of motorized vehicles, such as ATV's and tractors. There is a monument-wide ban on off-road uses of these types of vehicles, including for use in routine park operations, except under special circumstances that requires additional scrutiny by monument staff. Weed management is no different than other park operations and use of motorized vehicles for weed control will be considered only in areas appropriate for their use (larger infested areas of highly disturbed or altered vegetation with easy accessibility) and on a project-by-project basis.

Cultural Control
Cultural controls consist of actions that managers can take to indirectly impact weed populations. They can often be very cost-effective and therefore useful on large scales. Proposed treatments that have been shown to be effective on weeds in DINO include: prescribed grazing of domestic livestock, prescribed fire, and restoration/revegetation.

Land managers can use domestic livestock to selectively overgraze certain weed species to prevent seed set or weaken plant structure. In general, sheep and goats prefer forbs and can be used to graze broad-leaved weeds, while cattle prefer grasses and can be used to manage undesirable grasses (Tu et al. 2001). Both can be effective in reducing litter build-up prior to herbicide applications.

DINO is one of the few units in the NPS that currently has active cattle grazing allotments within its boundaries. **It is important in this document to draw a distinction between prescribed grazing as a tool for weed management and current permitted grazing management operations within the monument.** This plan includes use of all classes of domestic livestock (cattle, sheep, and goats) for weed management purposes only and does not attempt to address or change (with the exception of particular Best Management Practices in Appendix D) current permitted grazing operations as permitted and described in Dinosaur National Monument's founding legislation. The monument recognizes the opportunity for partnerships between the monument and current permittees to utilize cattle for prescriptive grazing to benefit resource management when the goals, objectives, and schedule of the grazing activity are agreeable to both parties. Such opportunities will be considered on a project-by-project basis and will be developed in close coordination and communication with the operator. In 1960, Congress set forth provisions for the systematic phasing out (retiring) of grazing activities within the monument over time, however, this plan seeks to use domestic livestock in a prescriptive manner for weed management regardless of the status of permitted grazing operations on allotments within the monument.

There has been ongoing concern across the West about the presence of domestic goats and sheep within Rocky Mountain bighorn sheep range regarding disease transmission. There is a currently a general recommendation to corral goats and sheep at night to prevent interactions and not allow "free-ranging" grazing during special-use prescribed grazing projects to eliminate the chance of goats and sheep becoming feral and contacting bighorn sheep (Woolever 2004, Wild 2004). In order to ensure the safety and protection of both livestock operations and native ungulates, the NPS wildlife veterinarian (and any additional federal, state, cooperative extension wildlife/large mammal veterinarians as necessary or desired) will be consulted on all proposed prescriptive grazing projects to explore current disease transmission issues and to identify any further required mitigation practices.

Prescribed burning consists of planning, setting, and managing fire to accomplish resource management objectives (CNAP 2000). Fire is sometimes necessary to prompt germination of some plants, but it can also reduce the abundance of some species. The most successful uses of fire for invasive species control result from burns that try to mimic or restore historical (natural) fire regimes, which have been disrupted by land use changes, suppression practices, fire breaks, or development (Tu et al. 2001).

Restoration can be defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2002). In the context of this EA, damage or degradation refers to the presence of weeds, while the establishment of desirable native vegetation is the recovery that we are trying to assist. Assisting the establishment of desirable vegetation through revegetation practices contributes to the larger goal of restoration as well as the goal of weed management (Jacobs et al. 1998). The establishment of a diverse community of desirable vegetation can prevent weed encroachment by utilizing all or most available resource niches (Sheley et al. 1996). Revegetation practices include seedbed preparation, broadcast seeding, drill seeding, container planting and sprigging live branches (Roundy 1996).

Some cultural control techniques (discing/plowing, fire operations, livestock transportation) involve the use of motorized vehicles, such as ATV's and tractors. There is a monument-wide ban on off-road uses of these types of vehicles, including for use in routine park operations, except under special circumstances that requires additional scrutiny by monument staff. Weed management is no different than other park operations and use of motorized vehicles for weed control will be considered only in areas appropriate for their use (larger infested areas of highly disturbed or altered vegetation with easy accessibility) and on a project-by-project basis.

The following cultural controls have been found to be effective against weeds found in Dinosaur National Monument (see the Scientific Literature Review at the end of the plan for details and references):

Cultural Control	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Prescribed Fire	X			X			X		X			X	X	X							X	
Prescribed Grazing		X			X	X		X	X	X				X		X			X	X		
Revegetation	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress **CRUNU** musk thistle **CENDI** diffuse knapweed **CENMA** spotted knapweed **CIRAR** Canada thistle **CIRVU** bull thistle **CYWOF** houndstongue **ELGAN** Russian olive **ELRE3** quackgrass **EPHES** leafy spurge **HYSNI** black henbane **LEPLA** perennial pepperweed **LINDA/LIVU2** Dalmatian toadflax/yellow toadflax **MEUOF** yellow sweet clover **ONRAC** Scotch thistle **SONUL** meadow sowthistle **TAARA** tamarisk / saltcedar **ULMPU** Siberian / Chinese elm

Chemical Control

Chemical control in this document refers to the use of herbicides to kill or injure target plants, as well as chemicals applied with herbicides that improve their efficacy (adjuvants). Herbicides are classified according to their mode of action, or how they affect the target plant. Of the seven modes of action, three are most relevant to weed management in natural areas – plant growth regulators, amino acid inhibitors, and photosynthesis inhibitors. Plant growth regulators are designed to move from the leaves to the actively growing part of the plant, thereby interfering or completely eliminating plant growth. They are used for control of annual and perennial broadleaf plants and are useful where non-target species are grasses. Amino acid inhibitors also act on actively growing parts of the plant and are used to control annual grasses, cool-season perennial grasses and certain broadleaf plants. They are relatively non-selective and are only effective when applied to foliage, as they rapidly deactivate in soil. Other types of amino acid inhibitors stunt root growth, which in time starves the plant. Photosynthetic inhibitors move upward through the plant, showing symptoms of activity from the bottom to top on plant shoots. For this reason, photosynthetic inhibitor herbicides are used in control of established perennials, since potential control must come from the continued soil uptake and not movement down through the plant from the shoots. These herbicides typically have good soil activity and are used pre and post-emergence on certain annuals and established perennials (Ross and Childs 1996).

When using synthetic herbicides, three soil characteristics are particularly relevant: percent organic matter, available water capacity, and soil permeability. When incorporated into the soil, part of the herbicide dissolves in the soil water and part is adsorbed onto soil particles (primarily organic matter). The amount of herbicide adsorbed onto soil particles depends on the characteristics of the chemical and on the amount of organic matter and fine material in the soil. Any herbicide that remains in water in the soil is available for uptake by plant roots. However, if the water moves off-site or out of the rooting zone, it takes some of the dissolved herbicide with it. Depending on the distance of travel, the concentration of the herbicide, and type of herbicide used, this herbicide movement can be a problem for susceptible plants and other organisms (USDA USFS 1996).

Some herbicides analyzed here can be absorbed fairly readily from soil moisture by susceptible plants. Also, some of these herbicides can move with water as it moves through the soil. Soil permeability and water-holding capacity determine how much water moves through the soil into ground water or in surface water after rainfall. If the soil retains a large quantity of water in its upper horizons for later use by plants, the water and dissolved herbicide will have little opportunity to move. In contrast, if soil is highly permeable and has little water-holding capacity, water passes through the soil rapidly and carries some of the herbicide with it (USDA USFS 1996).

The following herbicides are known to be effective on weeds present in Dinosaur National Monument see the Scientific Literature Review at the end of the plan for details and references):

Herbicide: (brand name)	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
Chlorsulfuron (Telar)					X				X		X					X						
Clopyralid (Reclaim, Transline)		X				X		X	X										X	X		
Fluazifop-p-butyl (Fusilade DX, Fusion, Tornado)	X			X									X									
Glyphosate (Roundup, Rodeo)	X	X	X	X					X			X	X	X								
Hexazinone			X										X									

Herbicide: (brand name)	AEGCY	CENRE	ARFMI	BROTE	CADDR	CRUNU	CENDI	CENMA	CIRAR	CIRVU	CYWOF	ELGAN	ELRE3	EPHES	HYSNI	LEPLA	LINDA	MEUOF	ONRAC	SONUL	TAARA	ULMPU
(Velpar)																						
Imazapyr (Arsenal, Habitat)		X			X							X	X			X					X	
Imazameth/ Imazapic (Plateau)				X										X								
Metsulfuron (Ally, Escort)			X		X	X					X					X			X			
Sulfometuron-methyl (Oust)					X									X								
Triclopyr (Garlon)												X									X	
2,4-D (Navigate, Weed-pro, Justice)		X	X		X	X	X	X	X	X	X	X		X	X		X	X	X	X		X

(Humburg et al. 1989, Tu et al. 2001)

AEGCY jointed goatgrass **CENRE** Russian knapweed **ARFMI** common burdock **BROTE** cheatgrass **CADDR** hoary cress **CRUNU** musk thistle **CENDI** diffuse knapweed **CENMA** spotted knapweed **CIRAR** Canada thistle **CIRVU** bull thistle **CYWOF** houndstongue **ELGAN** Russian olive **ELRE3** quackgrass **EPHES** leafy spurge **HYSNI** black henbane **LEPLA** perennial pepperweed **LINDA/LIVU2** Dalmatian toadflax/yellow toadflax **MEUOF** yellow sweet clover **ONRAC** Scotch thistle **SONUL** meadow sowthistle **TAARA** tamarisk / saltcedar **ULMPU** Siberian / Chinese elm

Often times, substances are added to herbicides to improve their efficacy. They are collectively called adjuvants. They include surfactants, penetrants, thickening agents, spreaders, anti-foaming agents and dyes (Tu et al. 2001). Some adjuvants are already mixed with commercially available herbicides and some must be added by the user. Herbicide labels generally specify what adjuvants are appropriate. Adjuvants are considered "inert" ingredients and are generally unregulated. However, some have been found to be environmentally harmful (eg. the surfactant in RoundUp) in certain situations. These types of adjuvants are recommended for the following herbicides considered for use in DINO:

Herbicide:	non-ionic surfactant	crop oil concentrate	methylated seed oil	silicon-based surfactant
Chlorsulfuron	X			
Clopyralid	X			
Fluazifop-p-butyl	X	X		
Imazapyr	X	X	X	X
Imazameth/ Imazapic	X	X	X	X
Metsulfuron	X			
Triclopyr	X		X	
2,4-D	X	X		

(Humburg et al. 1989, Tu et al. 2001)

In terms of direct toxicity, risk to wildlife is assessed based on two factors: acute toxicity and persistence (Koerth 1996). Persistence in the environment increases the window of opportunity for wildlife to come into contact with the substance, while acute toxicity is a measure of how much of the pesticide would need to be present in the body to cause damage. For aquatic wildlife, soil mobility and aquatic toxicity are also important factors and are discussed in the Water Quality section (p.125). The following chart outlines persistence and acute toxicity for herbicides considered for use in DINO:

Herbicide:	**Half-life:**	**Oral Toxicity (LD50):**
Chlorsulfuron	28-42 days	Low- 5545 mg/kg (rat)
Clopyralid	40 days	Low -4300 mg/kg (rat)
Fluazifop-p-butyl	15 days	Low-4096 mg/kg (rat)
Glyphosate	47 days	Slight-5600 mg/kg (rat)
Hexazinone	90 days	Low-1690 mg/kg (rat)
Imazapyr	25-141 days	Slight->5000 mg/kg (rat)
Imazameth/ Imazapic	31-233 days	Slight->5000 mg/kg (rat)
Metsulfuron	7-42 days	Low- >2510 mg/kg (duck)
Sulfometuron-methyl	20-28 days	Slight- >5000mg/kg (rat)
Triclopyr	30 days	Low- 713 mg/kg (rat)
2,4-D	10 days	Low- 764 mg/kg (rat)

(Humburg et al. 1989, Tu et al. 2001)

Herbicides and adjuvants can be assessed for their risk to aquatic resources based on three characteristics: persistence, mobility in the soil and toxicity to aquatic organisms. The following table outlines these characteristics for the herbicides considered for use in DINO. All are unclassified-use herbicides that do not require a state certified pesticide applicator license.

Herbicide:	Half-life (soil):	Half-life (water):	Soil Mobility:	Aquatic Toxicity:
Chlorsulfuron	28-42 days	?	high	moderate ->250mg/kg (trout)
Clopyralid	40 days	8-40 days	mod.-high	moderate -125mg/L (bluegill)
Fluazifop-p-butyl	15 days	Stable in water	moderate	high -.53mg/L (bluegill)
Glyphosate	47 days	12-70 days	low	moderate -120mg/L (bluegill)
Hexazinone	90 days	2->270 days	mod.-high	moderate -370 mg/L (bluegill)
Imazapyr	25-141 days	2 days	high	moderate -100mg/L (bluegill)
Imazameth/ Imazapic	31-233 days	<8 hours	high	moderate -100mg/L (bluegill)
Metsulfuron	7-42 days	29 days	high	moderate ->150mg/kg (trout)
Sulfometuron-methyl	20-28 days	1-60 days	low	high ->12.5 mg/L (trout)
Triclopyr	30 days	4 days	mod-high	moderate -148 mg/L (bluegill)
2,4-D	10 days	hours to months	mod.-high	moderate -263 mg/L (bluegill)

(Humburg et al. 1989, EXTOXNET 1996, Tu et al. 2001)

Some techniques used for chemical application involve the use of motorized vehicles, such as ATV's and tractors. There is a monument-wide ban on off-road uses of these types of vehicles, including for use in routine park operations, except under special circumstances that requires additional scrutiny by monument staff. Weed management is no different than other park operations and use of motorized vehicles for weed control will be considered only in areas appropriate for their use (larger infested areas of highly disturbed or altered vegetation with easy accessibility) and on a project-by-project basis.

Biological Control

Biological control can be defined as the deliberate introduction or manipulation of a pest's natural enemies (such as insects and pathogens) with the goal of suppressing the pest population (Wilson and Huffaker 1976). The theoretical framework for the use of biological controls is based on the hypothesis that the success of many non-native invasive weeds is the result of their release from predators or pathogens from their native range when they are introduced in a new range (Cronk and Fuller 1995). By introducing predators or pathogens, usually from the weeds' native range, their success can be curbed, allowing native plants to compete on more equal terms. Bio-control agents are not capable of completely eradicating a weed population, because as the number of host plants declines, so does the population of bio-control agents. However, bio-control can be a useful tool in reducing the initial size or density of a weed infestation, making other treatments more feasible.

To date no known or permitted releases of non-native biocontrol agents in Dinosaur National Monument for the control of invasive species have occurred. However, one controversial insect species, *Rhinocyllus conicus* may be present in the park and could negatively impact native thistles, specifically *Cirsium ownbeyi*. It was not intentionally released in the monument but may have dispersed naturally. *R. conicus* was widely released in the U.S. in the 1960s for the control of non-native thistles (such as musk and plumeless thistle) when the threat of non-native thistles was thought to be of a greater risk to ecosystem health than the threat of *R. conicus* to native thistles (which pre-release tests showed it had affinity for). Gary Dodge, a graduate student from University of Maryland, conducted surveys during the summer of 2004 in several *C. ownbeyi* locations within the monument but did not find *R. conicus.* Surveys occurred again in June 2005 in coordination with BLM in the Yampa canyon and other sites to determine *R. conicus* presence in the monument, its extent, and any impacts to native vegetation.

The following is a list of APHIS-approved bio-control agents currently available for release in the U.S. and effective against weeds found in DINO. However, the monument does not have plans to release any of these insects simply because of their availability and potential effect on invasive species present within the monument. Any release of biocontrol agents within the monument would depend on several variables including infestation location, size, distribution, abundance, accessibility for follow-up monitoring and restoration (when required), potential effect on non-target species (especially listed plant species and particularly those related to the target invasive species), and whether or not other control techniques are first capable of or effective in reducing the infestation(s) to acceptable threshold levels.

Bio-control Agent	CARNUT	CENRE	CENDI	CENMA	CIRAR	CIRVU	EPHES	LINDA
Agapeta zoegana			X	X				
Bangasternus fausti			X	X				
Cyphocleonus achates			X	X				
Larinus minutus			X	X				
Larinus obtusus				X				
Metzneria paucipunctella			X	X				
Pterolonche inspersa			X	X				
Sphenoptera jugoslavica			X	X				
Terellia virens			X	X				
Urophora affinis			X	X				
Urophora quadrifasciata			X	X				
Subanguinea picridis		X						
Aceria acroptiloni[1]		X						
Ceutorhynchus litura					X			
Urophora cardui					X			
Urophora stylata						X		
Apthona nigriscutis							X	

[1] *Aceria acroptiloni* is in the late stages of the permitting process for Russian knapweed.

Bio-control Agent	CARNUT	CENRE	CENDI	CENMA	CIRAR	CIRVU	EPHES	LINDA
Apthona lacertosa							X	
Hyles euphorbia							X	
Oberea erythrocephala							X	
Spurgia esulae							X	
Brachypterolus pulicarius								X
Calophasia lunula								X
Mecinus janthinus								X
Tricosirocalus horridus	X							

CENRE Russian knapweed **CENDI** diffuse knapweed **CENMA** spotted knapweed
CIRAR Canada thistle **CIRVU** bull thistle **ELGAN** Russian olive **EPHES** leafy spurge
LINDA/LIVU2 Dalmatian toadflax/yellow toadflax

Research is currently being done on at least two additional biocontrol agents that may contribute greatly to weed management in DINO. Tamarisk and cheatgrass occupy the most area of any of the 24 invasive species found in DINO. Cheatgrass is so widespread that it has not been mapped in great detail, but it is known to occupy, and in many situations dominate, every native vegetation type in the monument. Current research on a head smut disease caused by the fungus *Ustilago bullata* shows some promise for the control of cheatgrass (Meyer), though no time frame is available for potential release nor is approval for its release guaranteed.

More information is known, however, about tamarisk within the monument. 2002-2004 inventory reports show that an estimated 650 acres of riparian habitat is occupied by tamarisk. In August 2005, USDA APHIS approved the release of a nonindigenous leaf beetle (*Diorahabda elongata)* into 14 western states (CO and UT included) that has shown promise in reducing the density and extent of tamarisk infestations in those areas (USDA APHIS 2003). APHIS received concurrence from USFWS in June 2005 and a Finding of No Significant Impact (FONSI) for the beetle release was signed in early July 2005. DINO has been selected as a monitored field release site. DINO plans to move forward with beetle releases in spring 2006.

D. elongata is a leaf-eating beetle native to the Fukang region of central China. After 10 years of research by APHIS, it has been found to be one of the very few tamarisk-affiliated insects host-specific to tamarisk and therefore a good candidate for use in a biocontrol program. Simply put, *D. elongata* successfully controls tamarisk by completely defoliating a shrub, preventing it from photosynthesizing and therefore producing viable seed. Tamarisk, native to Asia, appears to be an ideal candidate for classical biocontrol because, unlike most problem plant species in N. America, there is only one related family (Frankeniaceae) in the same order (Tamaricales) as tamarisk. Six species of *Frankenia* occur in the west/southwest U.S. and northern Mexico. One of the six, *Frankenia johnstonii*, is federally listed as endangered (though a proposed rule to delist it was published in the Federal Register by FWS in May 2003). In no-choice-quarantine tests, leaf beetle larvae fed and developed on *Frankenia* as well as on tamarisk, but in multiple-choice selection tests in large outdoor cages, adults were not attracted to *Frankenia* and rarely laid eggs on it. In similar experimental cages at the release site in Pueblo, CO, only slight feeding was observed on *Frankenia* in spite of the presence of hundreds of starving adults and larvae that had defoliated the tamarisk plants (PEST CABweb 2003). There are no species of *Frankenia* found in northwest CO / northeast UT and all lab and field tests performed to date have shown the unlikelihood of the beetle to move off-target to unrelated plants. Therefore, Dinosaur National Monument expects no damage to desirable plant species, including the seven listed and candidate plants found in and/or adjacent to the planning area.

Additionally, DINO is outside the documented range of the federally endangered Southwest willow flycatcher (*Empidonax trailii extimus*) – the northernmost extent of which reaches into southern CO. Potential loss of Southwest willow flycatcher nesting habitat caused by leaf beetle defoliation is a high concern for FWS with regards to the proposed tamarisk biocontrol program because the flycatcher is known to nest in tamarisk below the 37th parallel. Temporary loss of nesting habitat due to beetle predation on tamarisk is not expected to impact resident or migratory bird populations in/adjacent to the planning area – even for the ESA candidate yellow-billed cuckoo (*Coccyzus americanus*) - which to date has not been found in the monument, though suitable habitat for the cuckoo does exist in the monument.

Proposed *D. elongata* Release Location

Dinosaur N.M. proposes to release *D. elongata* in spring 2006 in Echo Park, which is located at the near geographic center of the monument and is the confluence of the Green and Yampa Rivers. Echo Park was selected as a near-ideal test release location because of its relative isolation (from a plant and animal perspective) due to the steep canyon walls surrounding the area, though it is easily accessible by 4WD vehicle (there is a campground and boat ramp in the area) for pre-and post-release activities, such as monitoring and restoration, as needed. Echo Park has one of the largest, nearly monotypic stands of tamarisk found within the monument, and even though a 1-acre area has been cleared using a combination of mechanical and chemical control measures (primarily for safety purposes to allow easy visitor access to the river in the event of a wildfire in the area), approximately 7-8 acres of solid tamarisk remains along the river. It is anticipated this stand will provide all the necessary features required by *D. elongata* for successful establishment and reproduction – adequate initial food supply, a duff layer for diapause retreat, annual natural flood cycles that will not eliminate reproductive populations, and longer day lengths (14.5 – 15 hours) that are important for successful reproductive, dispersal, and feeding periods (Dinosaur lies at approximately the same latitude [40ºN] as the most successful test site in Lovelock, NV).

From a preventative standpoint, having an established, active biocontrol program at the confluence of the Green and Yampa Rivers will hopefully arrest the progression of tamarisk that is already well established upstream on the Green River up the mouth of the Yampa River canyon, where tamarisk is just beginning to invade. The Yampa River is unique in that it is the last remaining unregulated major tributary in the Colorado River system and therefore retains a relatively natural hydrologic regime. This, in addition to having a high quality, intact native riparian vegetation community, has slowed tamarisk establishment compared with regulated reaches within the system (such as the Green River), but the Yampa still remains vulnerable to invasion. For tamarisk already established on sand and cobble bars in the rivers at the confluence, other treatment options that can be used elsewhere in the monument, namely mechanical and chemical, are not viable options because of accessibility and because of the importance of those areas as spawning habitat for several of the four federally endangered fish that occur in the vicinity. Dinosaur remains cautiously optimistic that the use of the leaf beetles in this particular area will provide better control of tamarisk than has been achieved thus far in the interest of protecting and restoring critical habitat for listed Colorado River fish as well as migratory songbirds.

Post-release Monitoring
Monitoring is planned for this release, as is required by FWS for approval of use of biocontrol for tamarisk. In 2004 the Tamarisk Coalition, with the partnered support of the CO Division of Wildlife, Mesa State College, CO State University, BLM, Rocky Mountain Bird Observatory, CO Department of Agriculture, and Dinosaur National Monument, received $12,000 from the Central UT Project Completion Act (CUPCA) grant program to fund a graduate entomologist to establish and monitor two *D. elongata* release sites on CO's western slope – Echo Park and a BLM site along the Colorado River west of Grand Junction in Horse Thief Canyon. The insects were not released in 2004 or 2005 because of lingering issues with the APHIS environmental assessment and the timing of this plan and EA's approval process, but the monitoring protocol has been developed by Dr. Andrew Norton of CSU and was initiated in summer 2005 in anticipation of a release in 2006. Events documented under this protocol include beetle rate of spread/dispersal, diapause activity, reproductive success, and direct effects to tamarisk.

The Tamarisk Coalition and its partners have applied to CUPCA for 2005 dollars to supplement the leaf beetle monitoring work with additional monitoring specifically targeting migratory bird communities and vegetation community response. If funded, Rocky Mountain Bird Observatory and Mesa State College will develop and implement protocols to document post-(insect) release bird nesting and migration patterns and the response, condition, and diversity of plant (both native and exotic) communities. These monitoring programs will occur for a minimum of three years beginning in 2006 with the hope of continued funding to extend the studies for 5-10 years. As the beetle, bird, and vegetation monitoring programs progress and effects are accrued, DINO staff is prepared to do work as needed, including active restoration and follow-up treatments, to preserve natural stream dynamics and migratory bird use of riparian habitats. Finally, the Tamarisk Coalition and CSU will develop educational materials for public use on the western slope biological control program with some of the requested CUPCA 2005 monies.

Area Coordination and Support
Dinosaur has notified surrounding agencies, landowners, lessees, and concessionaires of its desire to use biocontrol, specifically on tamarisk, as part of an integrated weed management program. Notice of this desire was given in an initial call for comments in late 2003 for this monument-wide weed management planning process. All scoping comments received were in favor of adopting an integrated approach, which included the use of biocontrol agents. In addition, several agencies have expressed the desire for future coordinated insect releases in the are using the Echo Park "insectary" as a source once it is established. Agencies/organizations in support of the *D. elongata* release and subsequent establishment in northwest CO and northeast UT include Moffat County, CO commissioners and weed coordinator, Uintah County, UT commissioners and weed coordinator, Bureau of Land Management, and USFWS Ouray and Brown's Park National Wildlife Refuges.

Dinosaur National Monument realizes that the use of biocontrol will not achieve rapid or total control of tamarisk - we do not know yet how many times or years a mature plant has to be repeatedly defoliated in order for the plant to be killed. Rather, biocontrol agents are being employed to, at a minimum, prevent annual seed set (a mature plant can produce an estimated 600,000 windborne seeds per year) over the long term and, at best, kill tamarisk plants. Dinosaur National Monument will not rely solely on biocontrol agents for tamarisk control - tamarisk in other parts of the monument will continue to be actively removed using mechanical and/or chemical methods.

Prevention

IPM also includes actions that don't directly impact weed populations and don't require environmental analysis (and thus are not analyzed in the impact analysis in Chapter 4), but are an integral part of a successful weed management plan. These actions include prevention and early detection of weed introductions and spread, inventory, monitoring, and education.

Prevention is generally agreed to be the most effective and economic form of weed management (Sheley et al. 1999b, DiTomoso 2000). There are countless ways of preventing weed introductions, such as minimizing unnecessary soil disturbance, containing neighboring weed infestations, and establishing and properly maintaining desirable vegetation. General prevention measures such as these are also known as Best Management Practices and are outlined in Proposed Management Action 1. Proposed education, inventory, monitoring efforts for DINO are also addressed in Proposed Actions 2, 3, and 4, respectively.

The control technique poses little to no risk to native vegetation, wetlands, wildlife, or other natural resources.

Dinosaur National Monument will continue to make a good faith effort and use extreme care in evaluating treatment options and ensuring all environmental compliance standards are met, especially in protecting water quality and aquatic resources. DINO will continue to review new relevant scientific literature and references and support research to ensure a control technique is biologically sound. Examples of work in DINO that addresses natural resource protection include:

- Experiment using repeated hand pulling in river floodplains to reduce overall density and cover of perennial pepperweed. Most literature does not list handpulling as a recommended treatment, but repeated pulling for 3+ years in the same location has dramatically reduced patch size and density (Naumann 2003).

- Manual removal of entire tamarisk plants down to the root crown along river corridors is releasing sediment trapped over time in the branches of tamarisk, slowly restoring cobble bars and returning that sediment to the river system to shape and nurture riparian systems downstream. Research by Dr. Jack Schmidt and Greg Larson of Utah State University investigates the relationship between tamarisk and fluvial geomorphic form in the dam-regulated Green River and the relatively unregulated Yampa River that will contribute to our understanding of those areas where tamarisk removal, in conjunction with planned dam operations, is most likely to be successful (and unsuccessful) in the long-term restoration of portions of these rivers.

Dinosaur National Monument will also adopt a hazardous materials spill plan within 6 months of this plan's adoption that will outline response, cleanup, and reporting actions of any hazardous material (herbicide) spills in both terrestrial and aquatic environments. DINO's spill plan will be modeled after ones created by USFS Arapaho/Roosevelt National Forests and Pawnee National Grasslands as well as guidelines in place for tamarisk management along the Colorado River in Grand Canyon National Park. Pending approval of herbicide use in DINO, the spill plan will be added as an appendix to this plan.

The control technique poses little to no risk to cultural resources.
Dinosaur National Monument will continue to make a good faith effort to evaluate treatment options and ensure all Section 106 compliance standards are met. DINO will continue to review new relevant scientific literature and references to ensure control technique is sound for use in areas of cultural significance.

The control technique poses little to no risk to the human environment or to the safety of park visitors or park employees.
Some techniques have the potential to harm humans. Injuries can occur when using everything from a shovel or saw to fire and herbicide. Visitors and other staff can be harmed as well if management is occurring in areas where the public frequent.

For this reason, job hazard analyses are developed for many techniques, such as sawing and using herbicide. The purpose of these analyses is to define the technique and tools required for the activity, identify potential hazards for each step or phase of the technique, and mitigate for problems and injuries while performing the particular technique. These are reviewed every year for thoroughness and are required reading for anyone (volunteer or staff) participating in the activity.

Other precautions for reducing and eliminating risk to humans during weed activities include posting notice of the activity in high use areas or timing the technique (when possible) during low visitor use to the area (both time of day and time of year). DINO is committed to complying with the requirements of Colorado's Pesticide Applicators' Act, Title 35, Article 10, C.R.S. that notifies individuals of the Registry of Pesticide Sensitive Persons. This registry is updated annually and as of February 2004, no person in Moffat County is on the list. The state of Utah does not have a similar registry, however, any person in Uintah County wanting to be notified of specific pesticide application activities will be updated as requested. DINO will continue to review and refine treatment activities to avoid negatively impacting human use and safety in and near treatment areas.

The control technique is cost-effective to implement.
Cost is not the only driving factor in selecting control techniques, but is considered in the context of size, location, integrity of resources threatened, and management goal (eradication, suppression, containment) for a particular infestation or area. Choice of techniques and management strategy has both short and long-term cost implications. Short-term impacts are mostly negative and include the cost of the initial treatments and possibly foregoing an activity (closing hiking trails, removing livestock for a period of time) while the area recovers. However,

protecting the larger surrounding non-infested areas or ecosystem functions in the long-term is a key in realizing and understanding the actual versus potential future costs of weed management for the entire monument and surrounding lands and not just the acreage actually infested.

9. Create annual work plans to guide invasive plant management activities

There are specific recommended control techniques for most of the 24 species of invasive plants found in DINO outlined in Proposed Action #8. Using this guidance as well as considering the size, location, and management objective for the area (if complete eradication is not feasible, the management objective [by area or by species] will be to suppress or contain the infestation below the threshold level with consideration to any federal and state management directives on the particular species), a monument-wide annual work plan will be created to guide control, monitoring, restoration, and prevention/education efforts. Appendix A is an example of a draft invasive plant management work plan for a particular area of the monument - the Cub Creek drainage. The Cub Creek area is one of the more challenging areas for weed management in the monument because of the complexity of natural and cultural resource issues that need to be considered for potential impacts by weed management activities.

The annual work plan will also be used to guide sources of labor to weed projects of appropriate size and nature. Staff and volunteers are the primary source of weed management labor in the monument. However, adoption of a weed plan will also enable the monument to make use of the Exotic Plant Management Team (EPMT), a new resource to the Colorado Plateau. Modeled after teams used to fight wildfires, EPMTs are a highly trained, mobile strike force of invasive plant management specialists to assist parks in the control of exotic plants. As of 2003, 16 EPMTs are established and serve 217 parks across the United States. The Colorado Plateau EPMT was funded in 2003 and will begin work serving the 35 park units on or near the Colorado Plateau in 2005.

10. Restoration

Before any weed control takes place, a stewardship plan that establishes desired future condition objectives relevant to anticipated land use must be considered. Strictly killing weeds is an inadequate objective, especially for large-scale infestations. However, a generalized objective might be to develop a healthy plant community that is relatively weed-resistant, while meeting other land-use objectives such as listed species habitat, roadside, or recreational use maintenance (Jacobs et. al. 1999). In many cases, no active restoration may be necessary if there is enough desired vegetation in proximity to occupy niches opened by weed control procedures (James 1992). However, when desired vegetation canopy is nonexistent or inadequate for the site conditions, active restoration is required to speed recovery of a healthy and competitive plant community.

In dry, desert environments like those at Dinosaur National Monument, restoration in general has the potential to be costly and has a high risk of failure, even when properly planned. Depending on the site and characteristics of the infestation(s) to be treated, DINO will identify a strategy for larger, active restoration projects that considers factors such as creating a self-sustaining and persistent desirable plant community that meets management objectives, involving neighboring landowners/managers when necessary, species and seeding method, and follow-up treatments that will best achieve desired conditions (Jacobs et. al. 1999). Information regarding restoration projects in the monument will also be entered in a restoration module within the forthcoming NCPN invasive species management database described in Proposed Action #5.

DINO has incorporated native seed production into long-term restoration projects since NPS Natural Resource Challenge funds were first used in 1998 to maintain native grass seed production plots at the Upper Colorado Environmental Plant Center in Meeker, Colorado. Grass seed is grown at the center (from seeds collected in Dinosaur National Monument) is harvested, cleaned and stored, so that there is a ready supply of native seed for use in restoring disturbed sites. To date, the seed has been used in several road construction and grading projects.

Review of Scientific Literature Pertaining to Weed Species Proposed for Control at DINO

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
Acroptilon repens **(CENRE)**	**Russian knapweed**	perennial forb with creeping root system	**Cutting/mowing**: 3x/year (Carpenter and Murray 2003) **Cultivation/discing/plowing:** Every two weeks (Derscheid et al. 1961) **Grazing:** Goats intensive (pers. com Benz); goats or sheep (Tu et al. 2001) ***Chemical:*** Clopyralid(.32 kg ai/ha) +2,4-D(1.65 kg ai/ha) July, August or October (Bottoms and Whitson 1998, Benz et al. 1999, Benz. et al. 1999) Glyphosate (1.1 kg ai/ha) June and August(Bottoms and Whitson 1998, Benz et al. 1999, Benz. et al. 1999) Imazapyr (2-3 pints + 1 qt/A MSO fall applied after senescence begins (2004 label) *Other chemicals labeled for control/suppression: Chlorsulfuron, Imazapic, Metsulfuron* **Bio-control:** *Subanguinea picridis* (climate dependant) (Rees et al. 1996) *Aceria acroptiloni*-noticibly stunted(Carpenter and Murray 2003) **Revegetation:** Thickspike wheatgrass, western wheatgrass, streambank wheatgrass (Bottoms and Whitson 1998, Benz. et al. 1999)

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
Aegilops cylindrica **(AEGCY)**	**jointed goatgrass**	annual grass	**Plowing:** Before seed-set (Donald and Ogg 1991) **Mowing/pulling:** Before seed-set (Meunscher 1980) **Fire:** August (Donald and Ogg 1991) **Chemical:** Glyphosate (.3 kg/ha)(Donald and Ogg 1991) (.2-.5 kg/ha, depending on vigor)-March or April, at lower rates glyphosate didn't affect perrenial grasses (Beck et al. 1995) Fluazifop *(Donald and Ogg 1991)* *Other chemicals labeled for control/suppression: Sulfometuron-methyl*
Arctium minus **(ARFMI)**	**common burdock**	biennial forb	**Cutting:** Before seed-set (Meunscher 1980) **Chemical:** 2,4-D amine (.18-.72kg/ha) during rapid vegetative growth (Dunham 1970) Hexazinone (.00013kg/ha/yr.) (Whitson et al. 2000) Metsulfuron (.004-.02 L/ha) (Whitson et al. 2000) Glyphosate (.14-1.88L/ha) (Whitson et al. 2000) *Other chemicals labeled for control/suppression: Clopyralid, Imazapyr, Triclopyr*
Bromus tectorum **(BROTE)**	**cheatgrass**	annual grass	**Mowing:** Every 3 weeks (Ponzetti 1997) **Grazing:** Cattle or goats-in boot stage (Vallentine and Stevens 1994, Mosley 1996) **Fire:** June (Carpenter and Murray 2004a) **Chemical:** Glyphosate (.028-.032 kg/ha)(Blackshaw 1991) (.2-.4 kg/ha) –low rates of glyphosate had limited effect on warm-season perennial grass. (Beck et al. 1995)

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
			Imazapic/Imazameth (.04-.12 kg/ha)- doesn't affect some perennial grasses (Carpenter and Murray 2004a) Fluazifop-p-butyl (.16-.24kg/ha) (Carpenter and Murray 2004a) *Other chemicals labeled for control/suppression: Imazapyr, Sulfometuron-methyl* **Revegetation:** Idaho fescue (*Festuca idahoensis*)(Nasri and Doescher 1995)
Cardaria draba **(CADDR)**	**hoary cress, whitetop**	perennial forb with creeping root system	**Mowing:** Mildly effective-(Selleck 1965, O'Brien and O'Brien 1994) **Discing/plowing/cultivation:** Every 5 days for 6-8 weeks, than less frequent into Oct.(Hulbert et al. 1934) Repeated cultivation (Barr 1942, Kott 1966) Within 10 days of re-emergence(Miller and Callihan 1991) **Grazing:** Sheep-(Scurfield 1962) **Chemical:** 2,4-D lv ester or amine (.32-.48 kg/ha) before flower bud stage (William et al. 2002) Chlorsulfuron (.02L ai/ha) prebloom to bloom or fall rosette (William et al. 2002) Metsulfuron (.007L ai/A) ai/ha prebloom to bloom or fall rosette (William et al. 2002) Sulfometuron Methyl (0.21-0.35 kg/ha) (Hall 1992) *Other chemicals labeled for control/suppression: Chlorsulfuron, Imazapic, Sulfometuron-methyl*
Carduus nutans **(CRUNU)**	**musk thistle**	annual or biennial forb	**Cutting/mowing:** Mowing within 2 days of first anthesis greatly reduces seed production (McCarty and Hatting 1975) Cutting at root crown just after anthesis (Heidel 2004) **Grazing:** Goats-during flowering will eat flowers only (Davidson 1990) **Chemical:**

Scientific Name (ITIS Code)	Common name	Growth form	Scientific Literature Pertaining to Weed Control:
			2,4-D (.24kg/ha) April 30 (Feldman et al. 1968) Clopyralid (Whitson et al. 2000) Metsulfuron(Whitson et al. 2000) *Other chemicals labeled for control/suppression: Chlorsulfuron, Imazapic, Sulfmeturon-methyl*
Centaurea diffusa **(CENDI)**	**diffuse knapweed**	annual, biennial or short-lived perennial forb	**Notes:** Plant is thought to contain a carcinogenic compound (Carpenter and Murray 2004b) **Cutting:** Repeated for several years; before seed-set(Carpenter and Murray 2004b) **Pulling:** Before seed-set, 3x annually (Carpenter and Murray 2004b) **Plowing:** Deep (seeds don't germinate below 3 cm.)(Watson and Renney 1974, Zimmerman 1997) **Fire:** Produces strong grass regrowth (Watson and Renney 1974, Zimmerman 1997) **Chemical:** 2,4-D (1.0 and 1.5 kg/ha) (Watson and Renney 1974) Glyphosate-2% (Monsanto 2003) Dicamba (.08-.16 kg/ha) (Beck 1997) *Other chemicals labeled for control/suppression: Clopyralid, Imazapyr* **Bio-control:** *Agapeta zoegana, Bangasternus fausti, Cyphocleonus achates, Larinus minutus, Metzneria paucipunctella, Pterolonche inspersa, Sphenoptera jugoslavica, Terellia virens,Urophora affinis, Urophora quadrifasciata*
Centaurea maculosa **(CENMA)**	**spotted knapweed**	biennial or short-lived perennial forb	**Mowing/cutting:** Only slightly effective due to persistant seedbank(Mauer et al. 2004) **Pulling:** Effectiveness limited by soil disturbance and seedbank(Mauer et al. 2004) **Grazing:** *Sheep-(5 yearlings/.1ha-never exposed to spotted knapweed before) reduced about*

Scientific Name (ITIS Code)	Common name	Growth form	Scientific Literature Pertaining to Weed Control:
			50% (Olson et al. 1997) **Chemical:** Clopyralid (.12-.24 L/ha) during active growth (Whitson et al. 2000) Clopyralid + 2,4-D (.21kg/ha +1.12kg/ha) Spring, Fall, bolt, bud and flower stages (Sheley et al. 2000) *Other chemicals labeled for control/suppression: Glyphosate* **Bio-control:** *Agapeta zoegana, Bangasternus fausti, Cyphocleonus achates, Larinus minutus, Metzneria paucipunctella, Pterolonche inspersa, Sphenoptera jugoslavica, Terellia virens, Urophora affinis, Urophora quadrifasciata* (Rees et al. 1996)
Cirsium arvense **(CIRAR)**	**Canada thistle**	perennial forb with creeping root system	**Notes:** Drought decreases chemical efficacy, but increases mechanical impact (Johnson 1912, Hansen 1918, Haderlie et al. 1987) **Mowing:** Every 21 days and leaving 20 cm of stem (Hunter et al. 1985, Nuzzo 2003) Does not improve efficacy of herbicides(Beck and Sebastian 2000) **Grazing:** Goats repeatedly (Drlik et al. 2000) **Tilling, plowing, cultivating:** 7-10 cm deep every 21 days (Hodgson 1968) **Smothering:** Boards, sheet metal or tarpaper (Spence and Hurlbert 1935) **Fire**: mid-July to mid-August (Smith 1985) **Chemical:** Clopyralid + 2,4-D (.028+.112 kg/ha) June (Donald 1993) Clopyralid (Fall at .56 kg/ha) to rosette (Miller and Lym 1998, Nuzzo 2003) Glyphosate (low concentrations 2.5-4% depending on ecotype, higher concentrations not more effective) (Boerboom and Wyse 1988) Fall application to

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
			rosette is most effective (Darwent et al. 1994) Chlorsulfuron-spring, effective in 2-5 years (Donald and Prato 1992) *Other chemicals labeled for control/suppression: Hexazinone, Imazapic, Imazapyr, Metsulfuron, Triclopyr, Sulfometuron-methyl* **Biocontrol:** *Ceutorhynchus litura* (Rees et al. 1996) **Revegetation:** *Pascopyrum smithii* (Wilson and Kachman 1999) *Leucantheum vulgare, Achillea millefolium & Reseda lutea* (Edwards et al. 2000)
Cirsium vulgare **(CIRVU)**	**bull thistle**	biennial forb	**Pulling/cutting/digging:** Before seed production; has a short-lived seed bank(Beck 1991, Doucet and Cavers 1996) **Grazing:** Goats-during flowering, will eat flowers only (Davidson 1990) **Chemical:** 2,4-D (.16 kg/ha) spring (Beck 1991) *Other chemicals labeled for control/suppression: Chlorsulfuron, Clopyralid, Imazapic, Imazapyr, Metsulfuron, Triclopyr* **Bio-control:** *Urophora stylata* (Rees et al. 1996)
Cynoglossum officinale **(CYWOF)**	**houndstongue**	biennial or short-lived perennial forb	**Pulling:** Before seed-set (Meunscher 1980) **Mowing:** Before seed-set resulted in 60% control (Dickerson and Fay 1982) **Spudding:** Fall or spring rosettes (Meunscher 1980) **Chemical:** Metsulfuron (.006-.02 L/ha) (Whitson et al. 2000) 2,4-D amine (1.12 kg/ha)-May 29 (in Montana) (Dickerson and Fay 1982, Upadhyaya and Cranston 1991)

Scientific Name (ITIS Code)	Common name	Growth form	Scientific Literature Pertaining to Weed Control:
			Chlorsulfuron (.07 kg/ha) May-June (Montana) (Dickerson and Fay 1982) (.04 kg/ha) (Upadhyaya and Cranston 1991) *Other chemicals labeled for control/suppression: Imazapic*
Elaeagnus angustifolia **(ELGAN)**	**Russian olive**	tree	**Mowing/Cutting**: Repeated (Stannard et al. 2002) **Girdling**: (Stannard et al. 2002) **Chemical:** 2,4-D ester, Imazapyr (hack &squirt), Glyphosate (hack & squirt), 2,4-D + Triclopyr (ester formulation as Pathfinder II applied as foliar or basal bark-w/ diesel), Triclopyr (basal bark-w/diesel) (Stannard et al. 2002) Imazapyr-seedlings (Edelen and Crowder 1997) **Shading**: (Stannard et al. 2002) **Fire:** Requires follow-up treatment (Stannard et al. 2002) **Bio-control:** *Tubercularia ulmea, Phomopsis arnoldiae, Phomopsis elaeagni, Lasiodiplodia theobromae*.-effectiveness?(Stannard et al. 2002)
Elytrigia repens **(ELRE3)**	**quackgrass**	perennial grass	**Mowing:** Before flower (FEIS 1996) ***Chemical:*** *Chemicals labeled for control/suppression: Fluazifop, Glyphosate, Hexazinone, Imazapyr*
Euphorbia esula **(EPHES)**	**leafy spurge**	perennial forb with creeping root system	**Mowing:** Starting before leaves fully develop, repeated (Derscheid et al. 1985) **Cultivation:** Overlapping Duckfoot,10cm. deep, 14 day intervals (Derscheid et al. 1985) **Fire:**

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
			Removes litter and forces seedbank & synchronizes phenology, which contributes to herbicide efficacy (Biesboer 2004) **Grazing:** Goats (12/acre for 1 month)(Walker et al. 1994, Merritt et al. 2002b) Sheep (4/acre for 1 month)-once acclimated to the taste (Merritt et al. 2002b) **Chemical:** Imazapic (.02-.036 L/ha) fall regrowth in early to mid-Sept. (Lym et al. 2002) Glyphosate (.12 kg/ha) after July1 to actively growing plants (Lym et al. 2002) Glyphosate + 2,4-D (.06+.63 kg/ha) seed set or fall growth (Lym et al. 2002) Sulfometuron Methyl (.032-.048 kg/ha) (Masters and Nissen 1998) **Bio-control:** *Apthona nigriscutis, A. lacertosa, Hyles euphorbia, Oberea erythrocephala, Spurgia esulae* (Rees et al. 1996, Merritt et al. 2002a) **Revegetation:** *Pascopyrum smithii* (Lym and Tober 1997) *Pseudoroegneria spicata* and *Thinopyrum ponticum* (Whitson et al. 1989)
Hyoscyamus niger **(HYSNI)**	**black henbane**	annual or biennial forb	**Cutting or digging**: Before seed-set (Meunscher 1980, Lorenz and Dewey 1988) **Chemical:** 2,4-D (1.12-1.24 kg/ha) (Morishita 1991) *Other chemicals labeled for control/suppression: Metsulfuron*
Lepidium latifolium **(LEPLA)**	**perennial pepperweed**	perennial forb with creeping root system	**Mowing:** At flowerbud stage and applying herbicide after recovery to flowerbud stage or at bolting stage every 14 days (Renz 2003) **Discing:** Fall, followed by spring mowing and herbicide(reduced quantity required) (Renz 2003) **Grazing**:

Scientific Name (ITIS Code)	Common name	Growth form	Scientific Literature Pertaining to Weed Control:
			Sheep, cattle, goats(Young et al. 1997, Renz 2003) **Chemical:** Glyphosate-2% (Monsanto 2003) Chlorsulfuron (.11kg/ha) June -at flowerbud stage (Young 1998) Imazapyr (.28-.42 kg/ha) flowerbud stage (Renz 2003) Metsulfuron methyl (.021-.042 kg/ha) flowerbud stage (Renz 2003) *Other chemicals labeled for control/suppression: Hexazinone, Imazapic, Sulfometuron-methyl*
Linaria dalmatica/ Linaria vulgaris **(LINDA/ LIVU2)**	**Dalmatian toadflax/ yellow toadflax**	perennial forb with creeping root system	**Pulling:** Consistently for 10-15 yrs. (Vujnovic and Wein 1997) **Discing/ plowing/ cultivation:** Sweep-type cultivator every 7-10days in first year and 4-5 times 2nd year (Vujnovic and Wein 1997) **Chemical:** Imazapic (12 oz/A in fall) (Beck 2001) *Other chemicals labeled for control/suppression: Chlorsulfuron, Metsulfuron* **Bio-control:** *Brachypterolus pulicarius, Calophasia lunula* (Rees et al. 1996)
Melilotus officinalis **(MELOF)**	**yellow sweet clover**	annual or biennial forb	**Mowing/cutting:** Before seed-set (Meunscher 1980) **Chemical:** 2,4-D (.42 kg/ha)-not as effective 2nd year (Greenshields and White) Glyphosate-(Tu et al. 2001) Most broad-leaved herbicides (Goplen and Gross 1977) *Other chemicals labeled for control/suppression: Chlorsulfuron, Imazapyr, Metsulfuron*
Onopordum acanthium **(ONRAC)**	**Scotch thistle**	biennial forb	**Cutting/mowing:** Before seed-set (Meunscher 1980, Beck 1991) **Grazing:** *Goats spring and summer (24-119 cm tall plants) 24/ha (Dellow et al.*

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
			1988, Mcgregor et al. 1990) During flowering -will eat flowers only (Davidson 1990) ***Chemical:*** Metsulfuron (.006-.02 L/ha) (Whitson et al. 2000) 2,4-D (.32 kg/ha) spring before bolting (Beck 1991) Clopyralid (.13-.25 L/ha) (Whitson et al. 2000) *Other chemicals labeled for control/suppression: Chlorsulfuron*
Sonchus uliginosus **(SONUL)**	**meadow sowthistle**	perennial forb with creeping root system	**Cultivation/plowing/discing:** In rosette stage, w/ 7-9 leaves (Downard and Morishita 1995) **Grazing:** Sheep or cattle (Downard and Morishita 1995) **Chemical:** Late rosette to bud stage, assumed to respond to herbicide the same as perennial sowthistle (*Sonchus arvensis*) (Downard and Morishita 1995) 2-4,D (.32 kg/ha) bud stage and regrowth 8-10 in high (William et al. 2002) Clopyralid + 2,4-D amine (.38-1.9 L/ha) prior to bud stage (William et al. 2002) *Other chemicals labeled for control/suppression: Imazapyr*
Tamarix ramosissima **(TAARA)**	**tamarisk, saltcedar**	tree	**Cutting:** Below root crown (Naumann 2003) **Hand-pulling:** Small (Carpenter 2003) **Burning**: Needs herbicide follow-up (Carpenter 2003) **Chemical:** Triclopyr (cut-stump) fall (Neill 1987, Sudbrock 1993) Triclopyr (basal-bark application) (Carpenter 2003) Imazypyr (1% v/v or + glyphosate .5% +.5%) -Foliar spray(Duncan 1994)

Scientific Name (ITIS Code)	**Common name**	**Growth form**	**Scientific Literature Pertaining to Weed Control:**
			Glyphosate (Monsanto 2003) **Revegetation:** Populus fremontii, salix spp. –sprigs (2.5-10 cm diam.) (Sudbrock 1993) Sprigs should be cut from dormant trees and placed with one end at the depth of the water table (Swenson and Mullins 1985)
Ulmus pumila **(ULMPU)**	**Siberian elm**	tree	**Chemical:** *Chemicals labeled for control/suppression: Glyphosate, Hexazinone, Imazapyr, Metsulfuron, Triclopyr (Garlon 3A & 4)*

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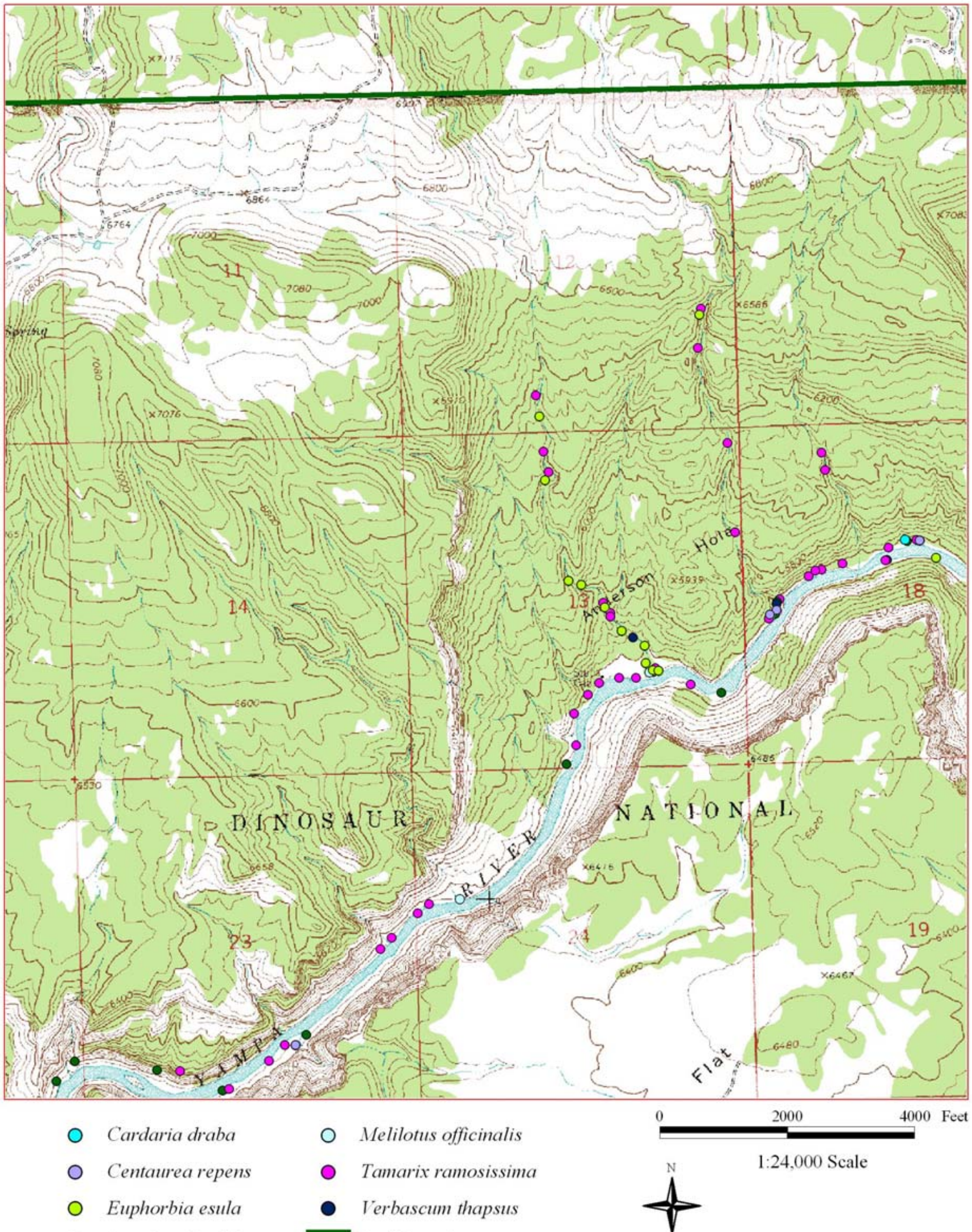
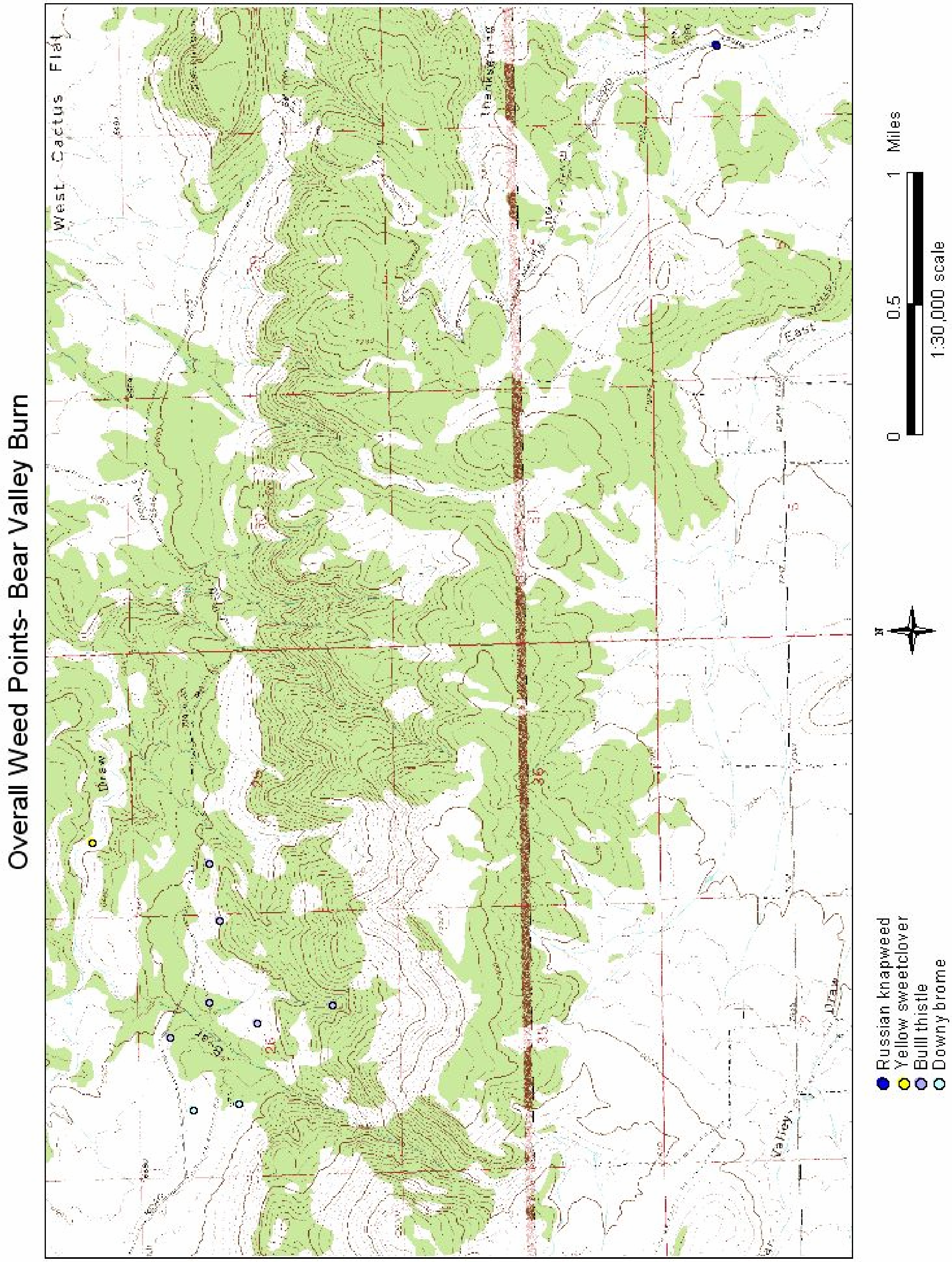
Monument-wide Inventory Results

The following maps show the results of 2002, 2003, and 2004 inventory efforts by Utah State University field crews:

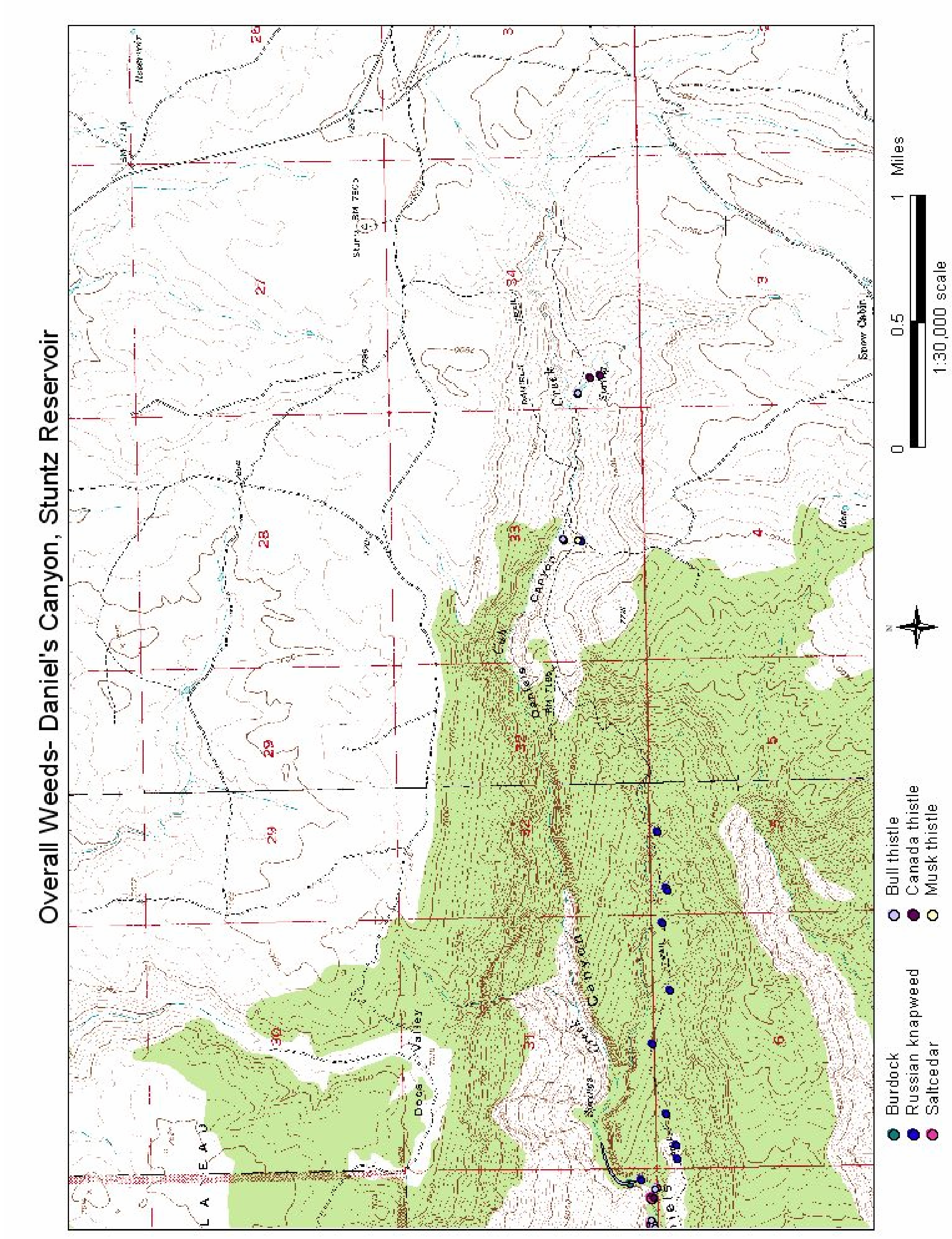
1. Anderson Hole
2. Bear Valley Burn
3. Daniel's Canyon and Stuntz Reservoir
4. Deerlodge Park (2 maps)
5. Dinosaur Quarry Entrance
6. Dinosaur Quarry
7. Disappointment Draw
8. Dry Woman Canyon
9. Echo Park (2 maps)
10. Gates of Lodore
11. Graham Gulch
12. Harding Hole
13. Harper's Corner and Jones Hole
14. Haystack Rock
15. Island Park
16. Johnson Canyon
17. (road to) Jones Hole
18. Jones Hole
19. Lily Park (road right-of-way)
20. Mud Springs Draw
21. Pearl Park
22. Plug Hat Rock
23. Rainbow Park
24. Red Rock Canyon
25. Sand Canyon
26. Schoonover Pasture
27. Split Mountain Boat Ramp
28. Split Mountain Canyon
29. Split Mountain and Morris Ranch
30. Starvation Valley
31. Tepee Draw
32. Twelvemile Gulch
33. Warm Springs
34. West Cactus Flat



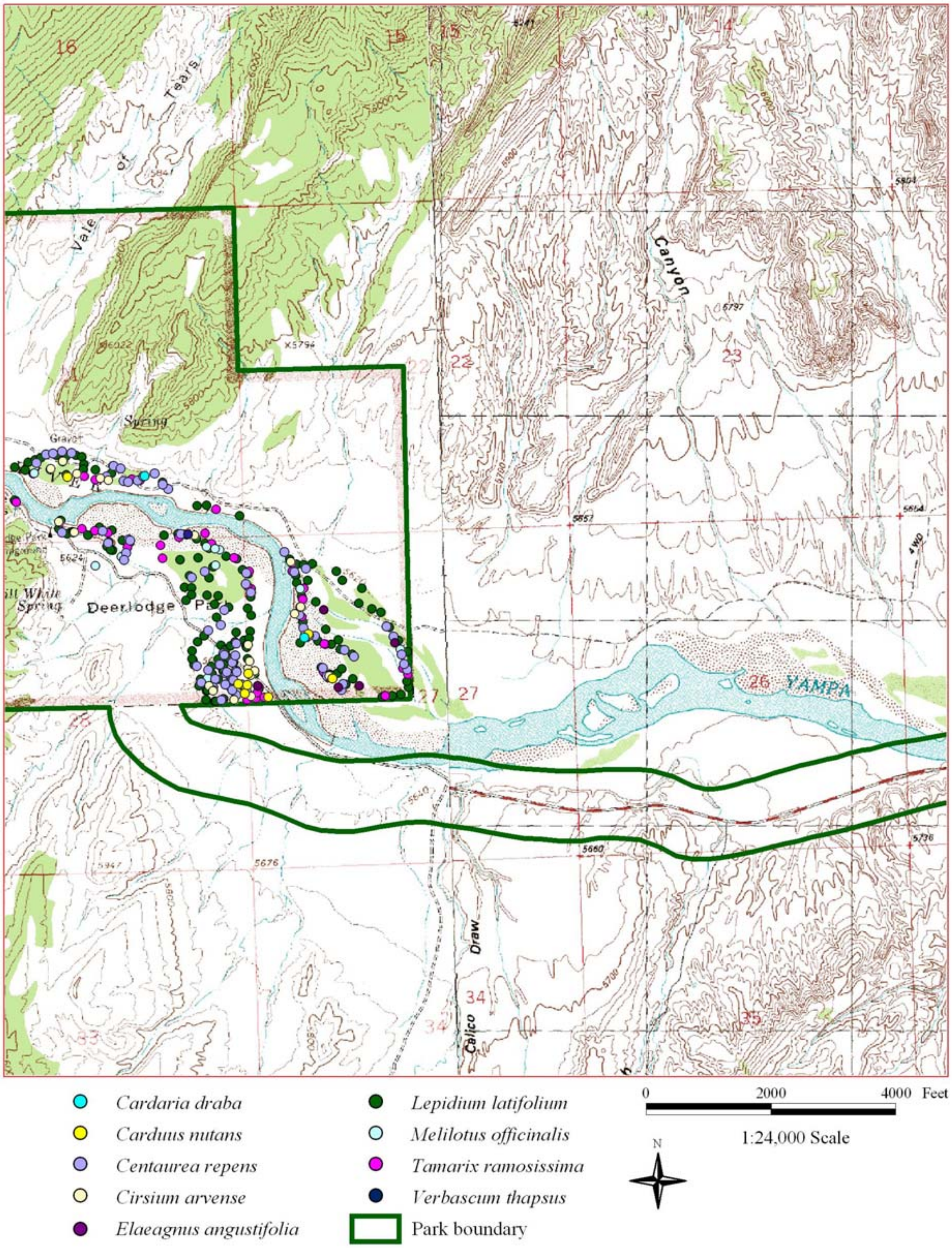
Anderson Hole



Bear Valley Burn

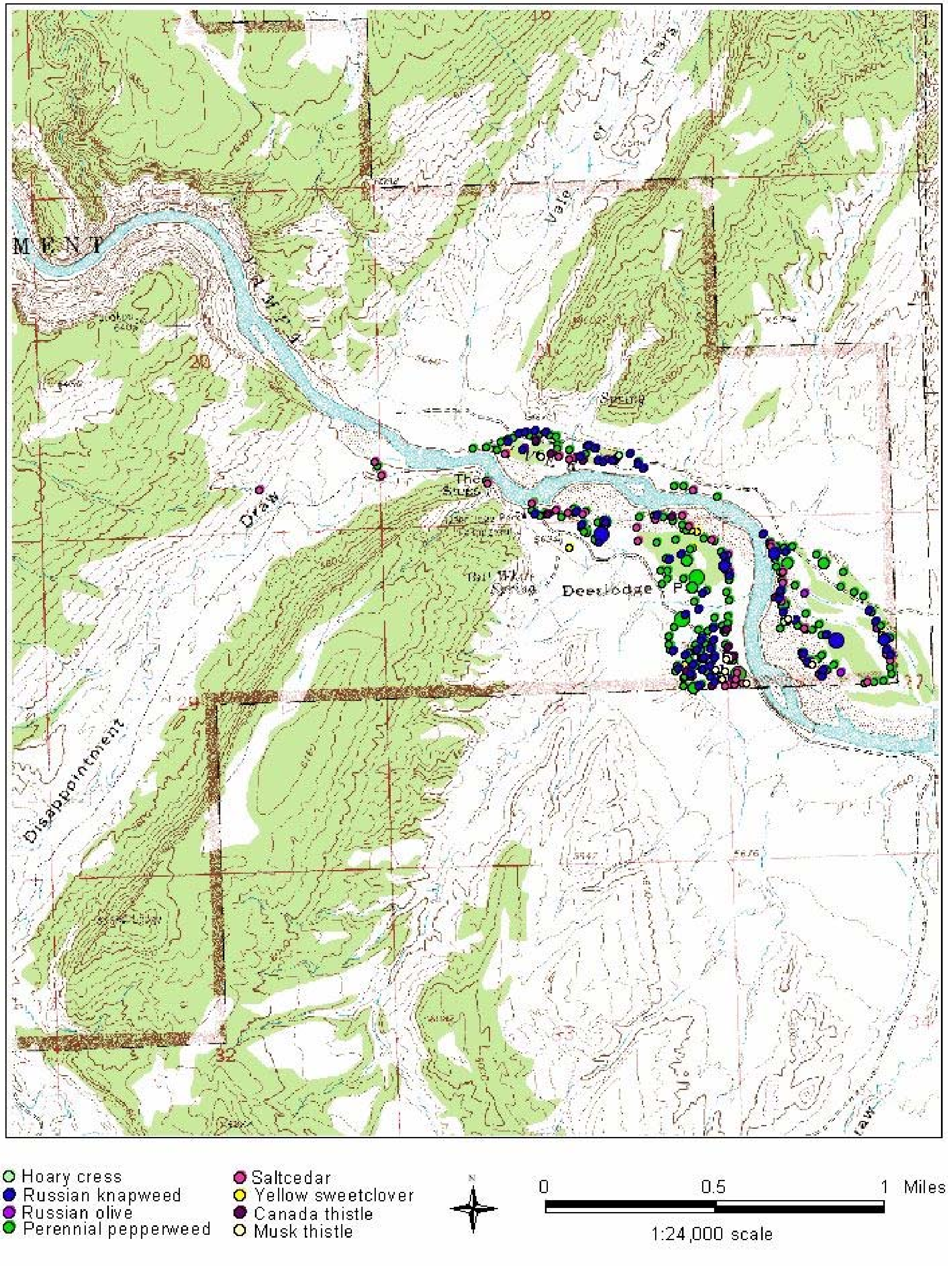


Daniel’s Canyon and Stuntz Reservoir

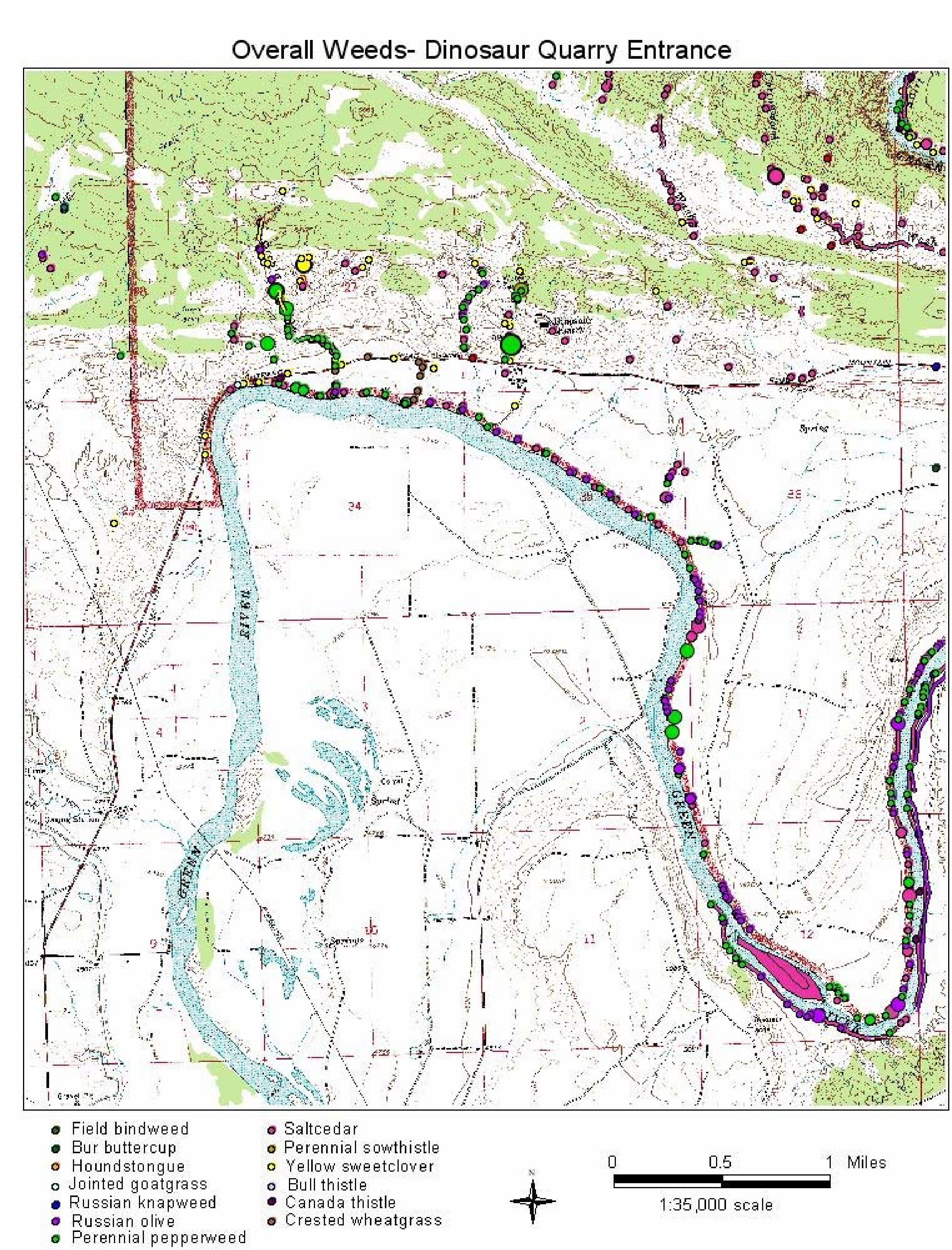


Deerlodge Park

Overall Weed Points- Deerlodge Park

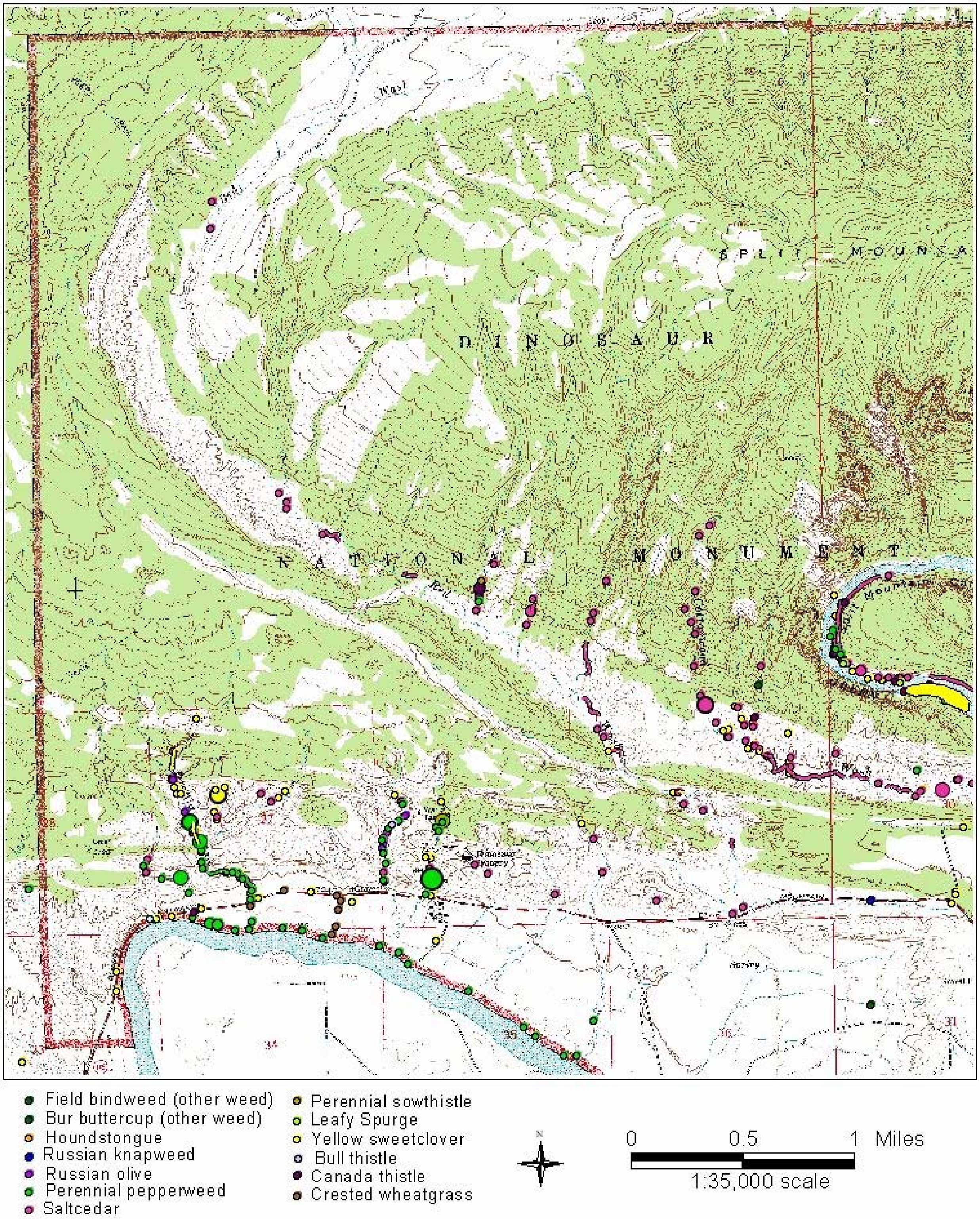


Deerlodge Park

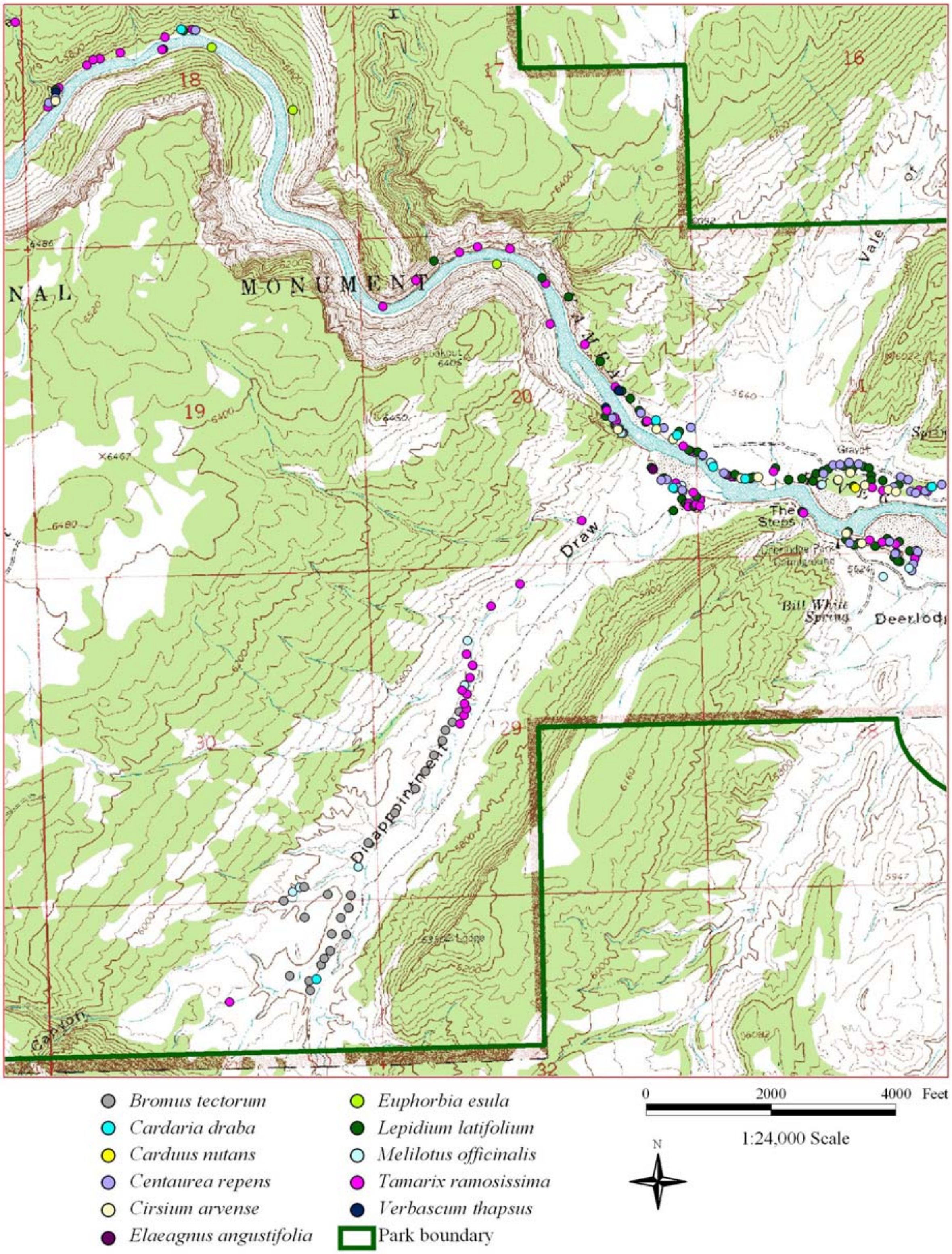


Dinosaur Quarry Entrance

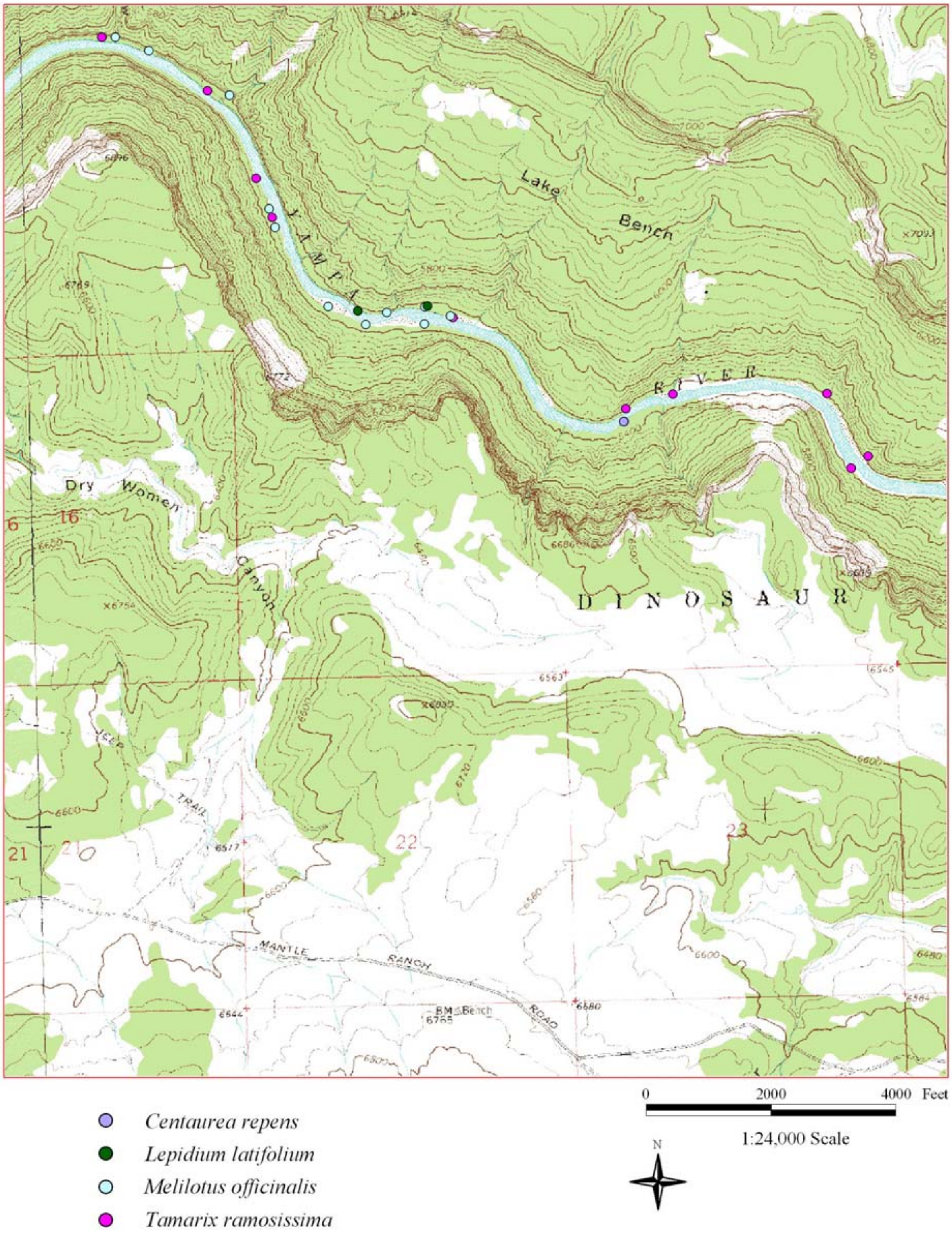
Overall Weeds- Dinosaur Quarry



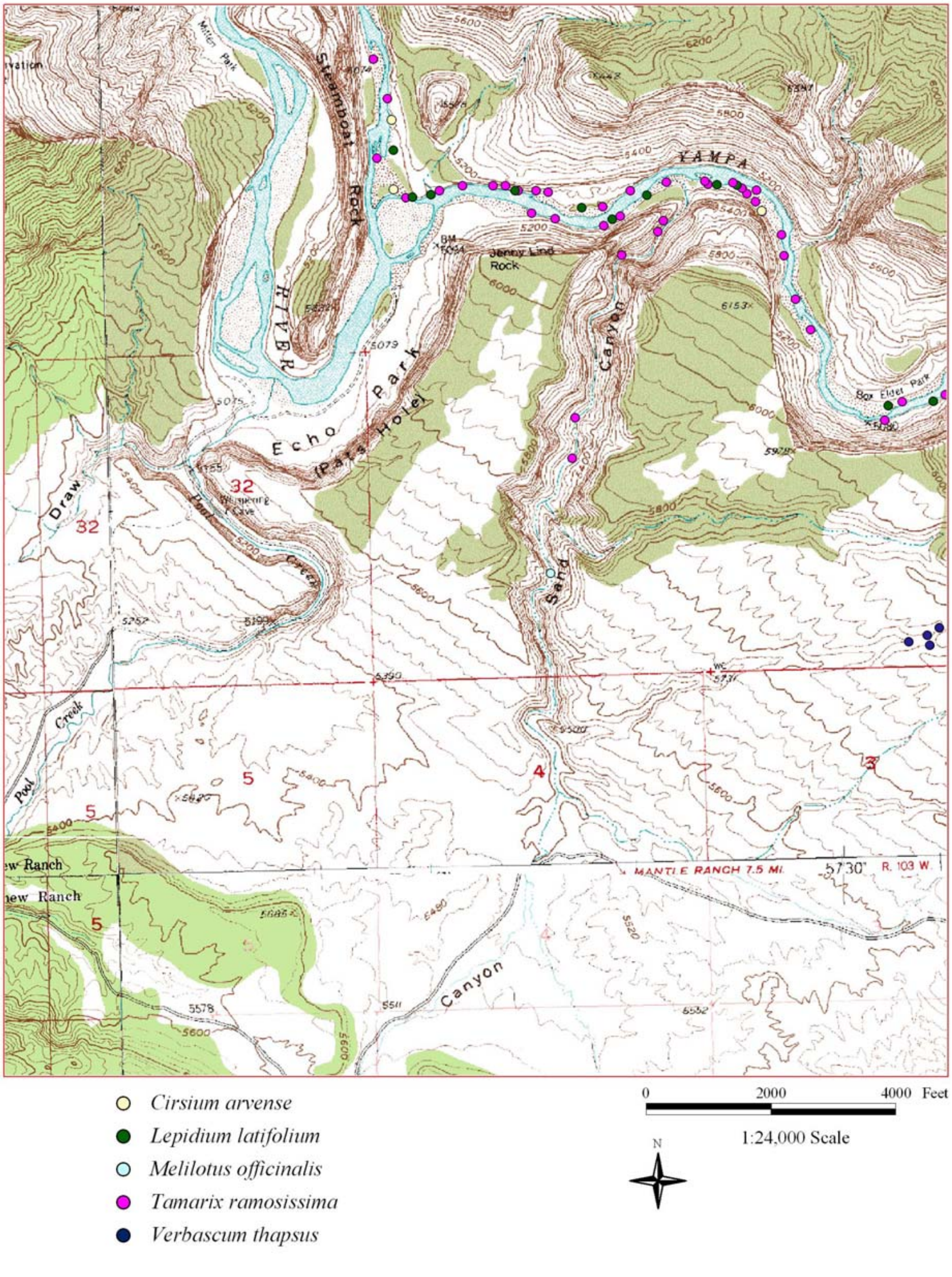
Dinosaur Quarry



Disappointment Draw

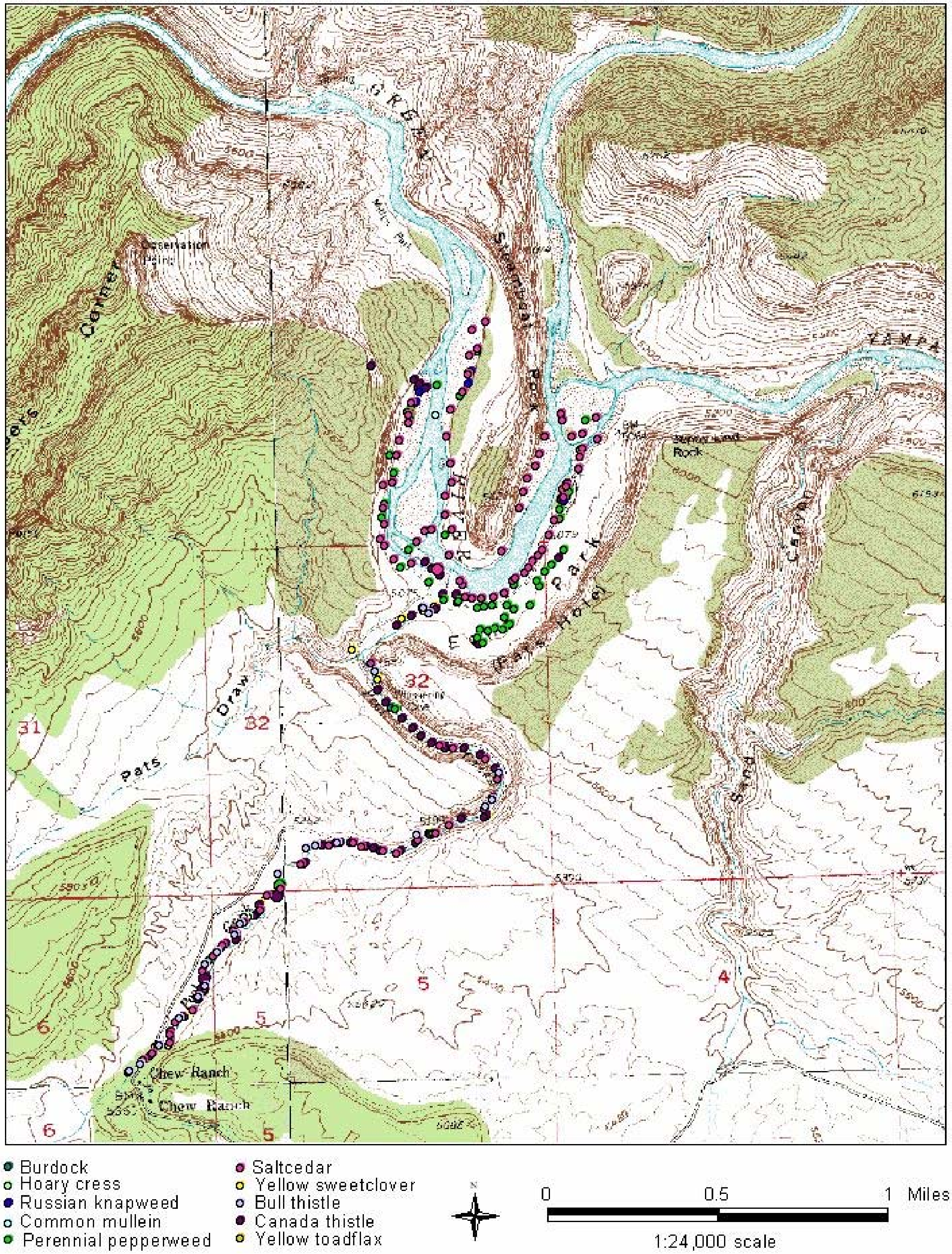


Dry Woman Canyon


Steamboat Rock
YAMPA
RIVER
Jenny Lind Rock
Echo Park
(Pats Hole)
Sand Canyon
Box Elder Park
Pool Creek
Draw
Canyon
MANTLE RANCH 7.5 MI.
R. 103 W.
Cirsium arvense
Lepidium latifolium
Melilotus officinalis
Tamarix ramosissima
Verbascum thapsus
0 2000 4000 Feet
1:24,000 Scale
N

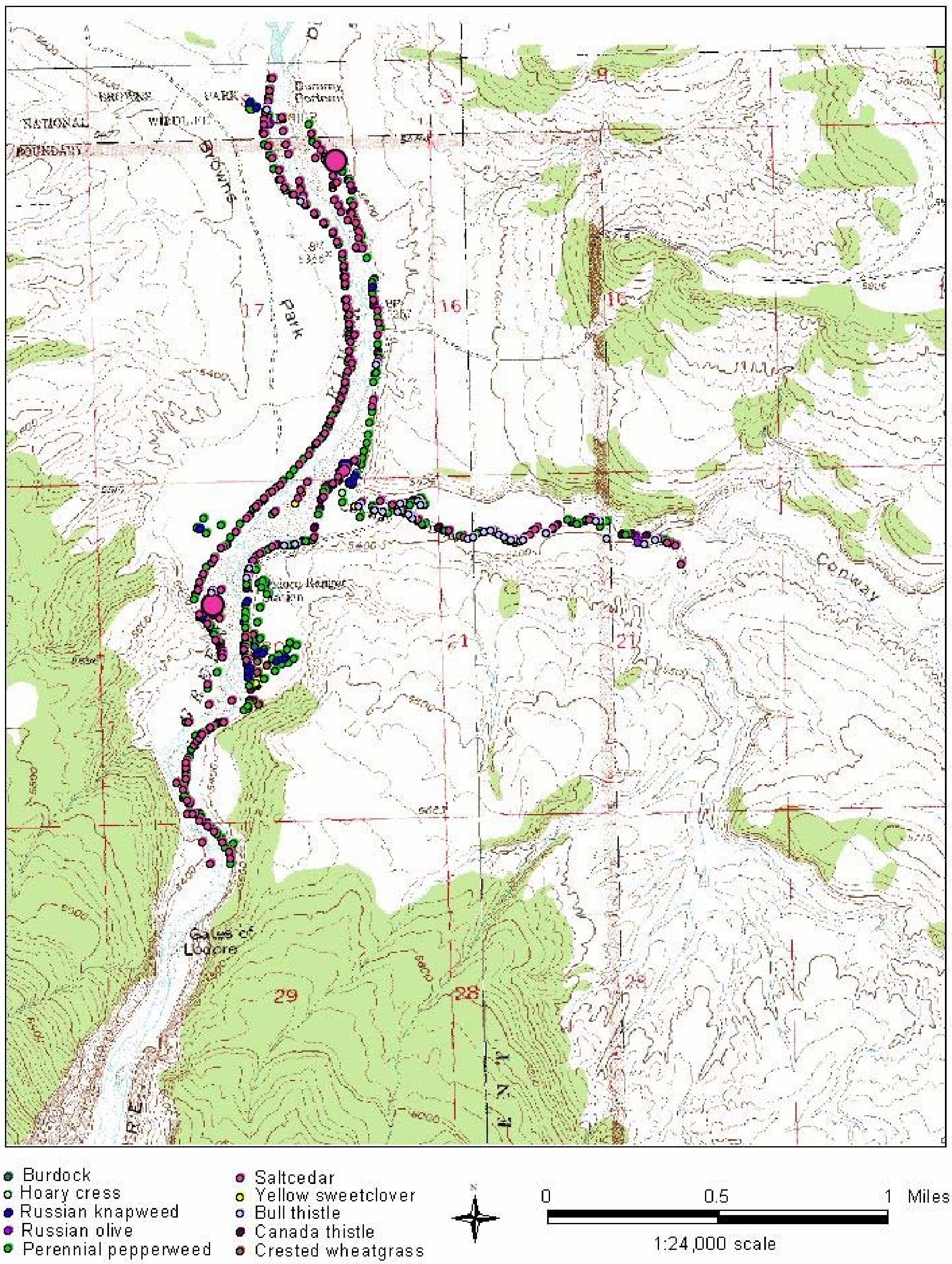
Echo Park

Overall Weed Points- Echo Park

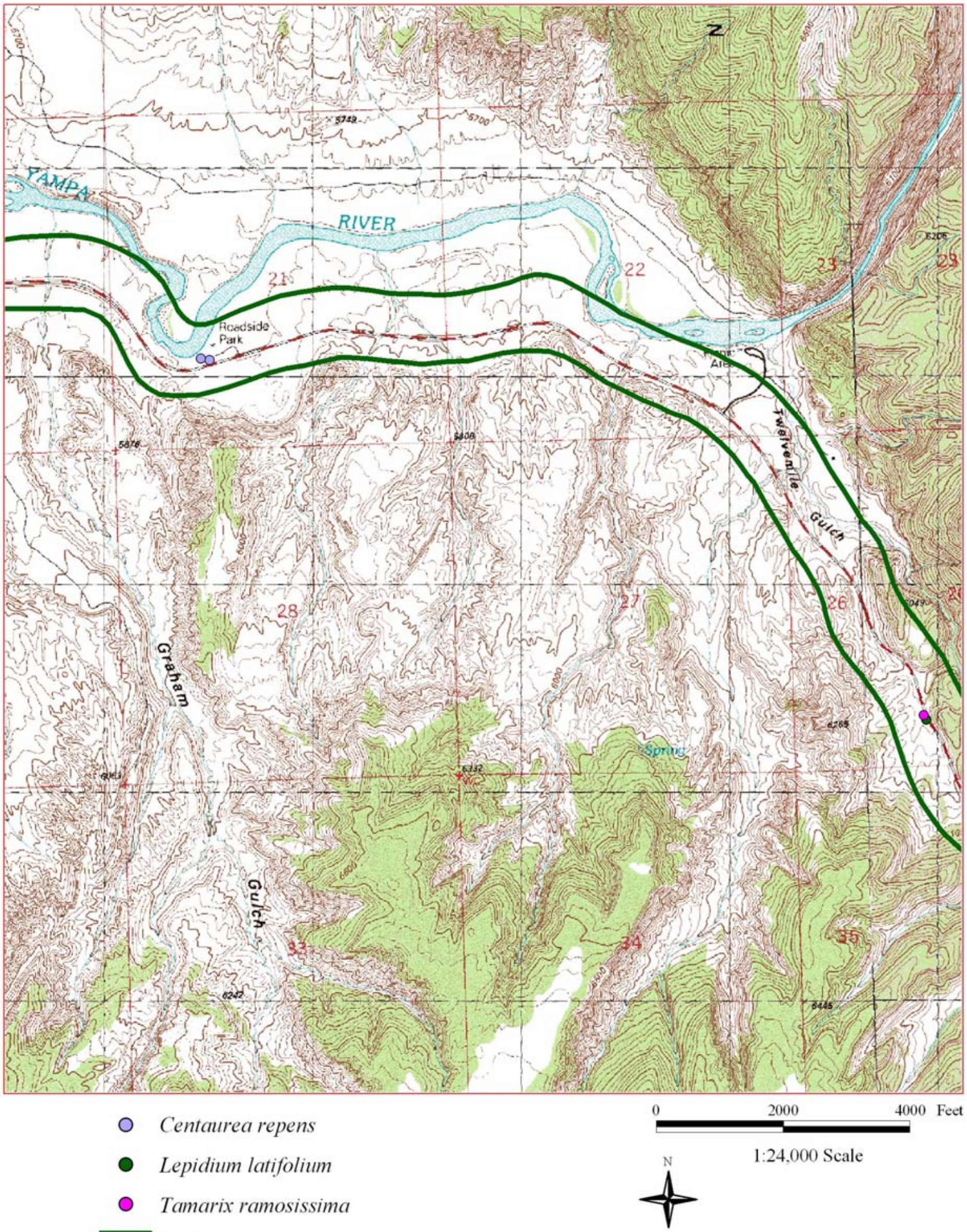


Echo Park

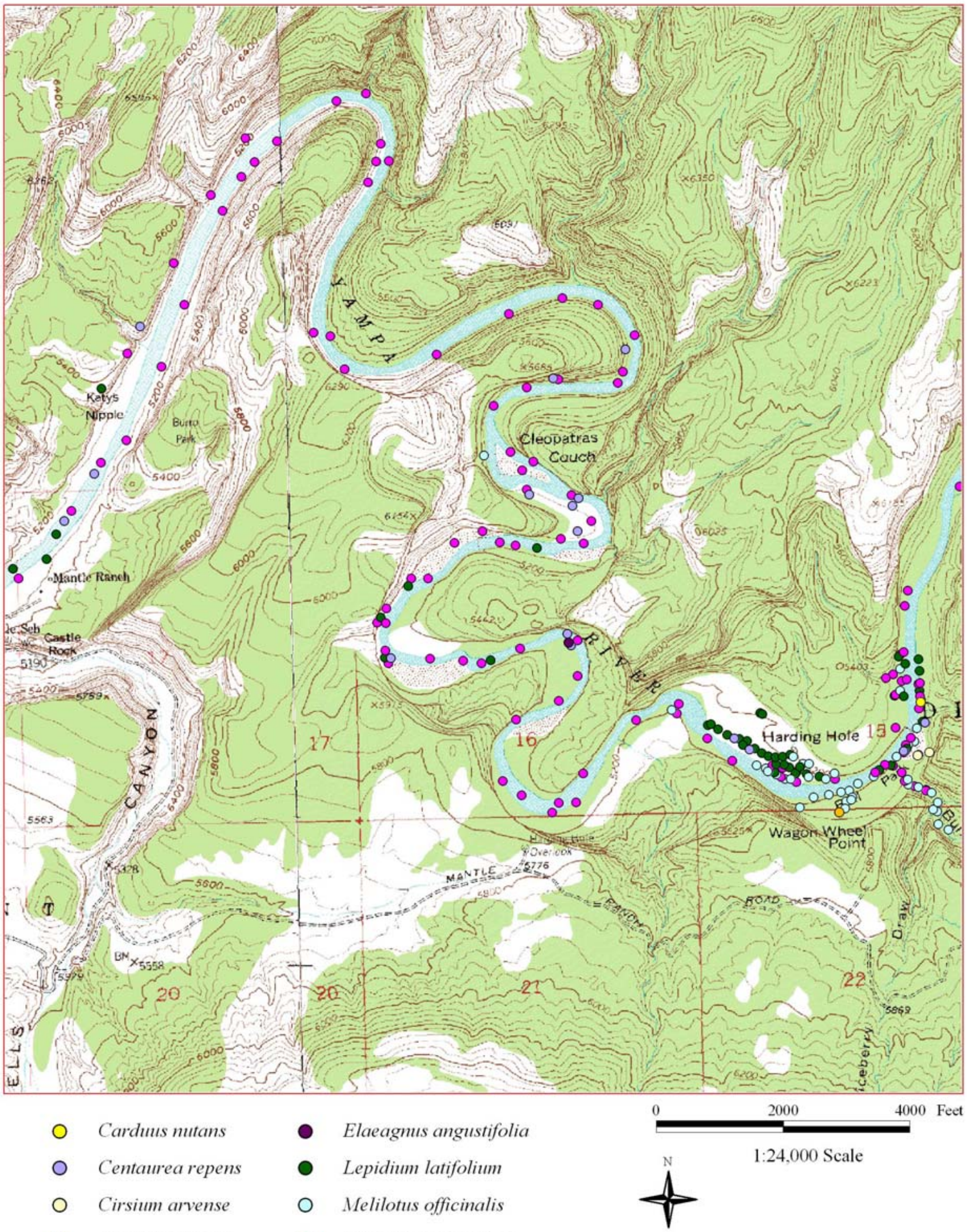
Overall Weed Points- Gates of Ladore



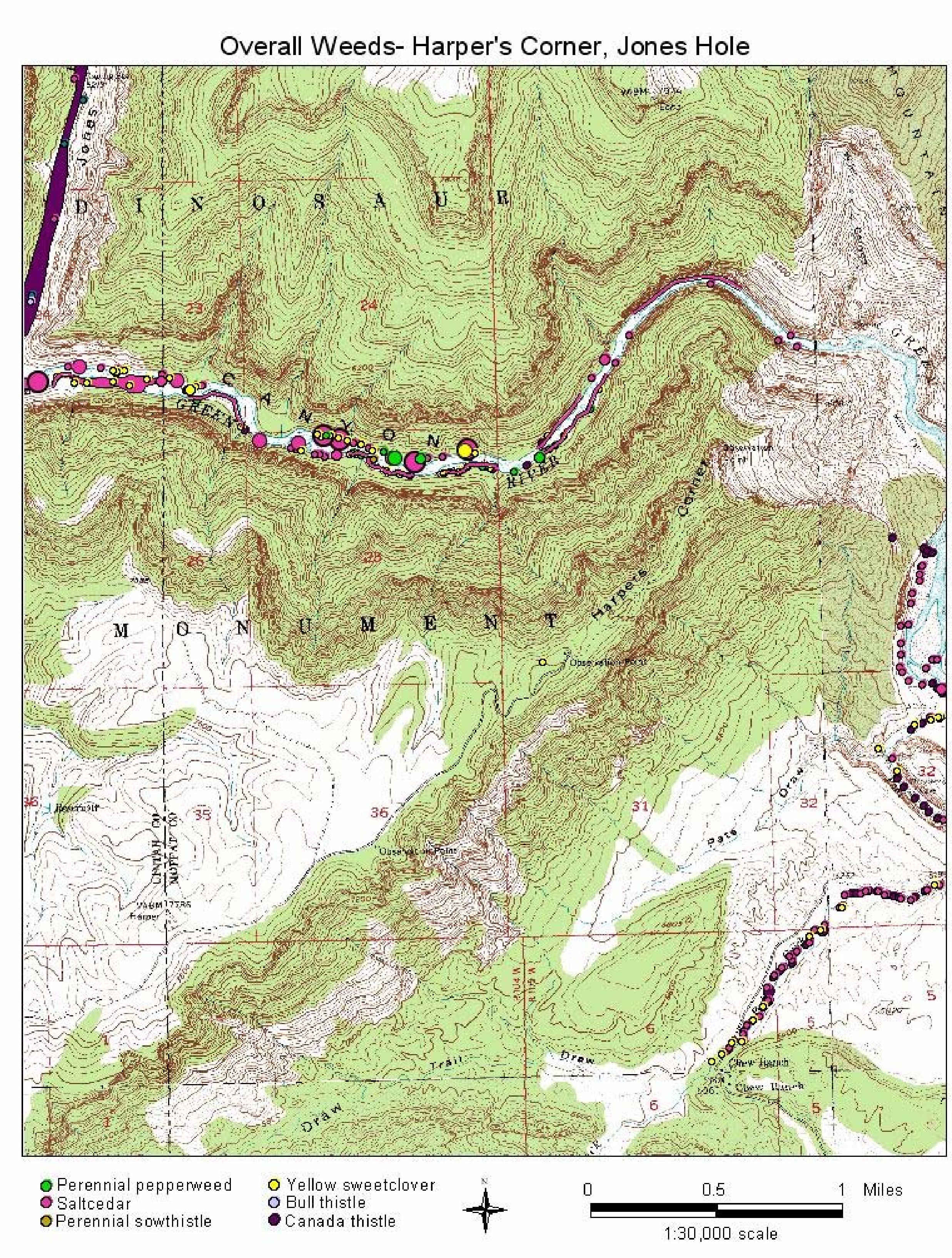
Gates of Lodore



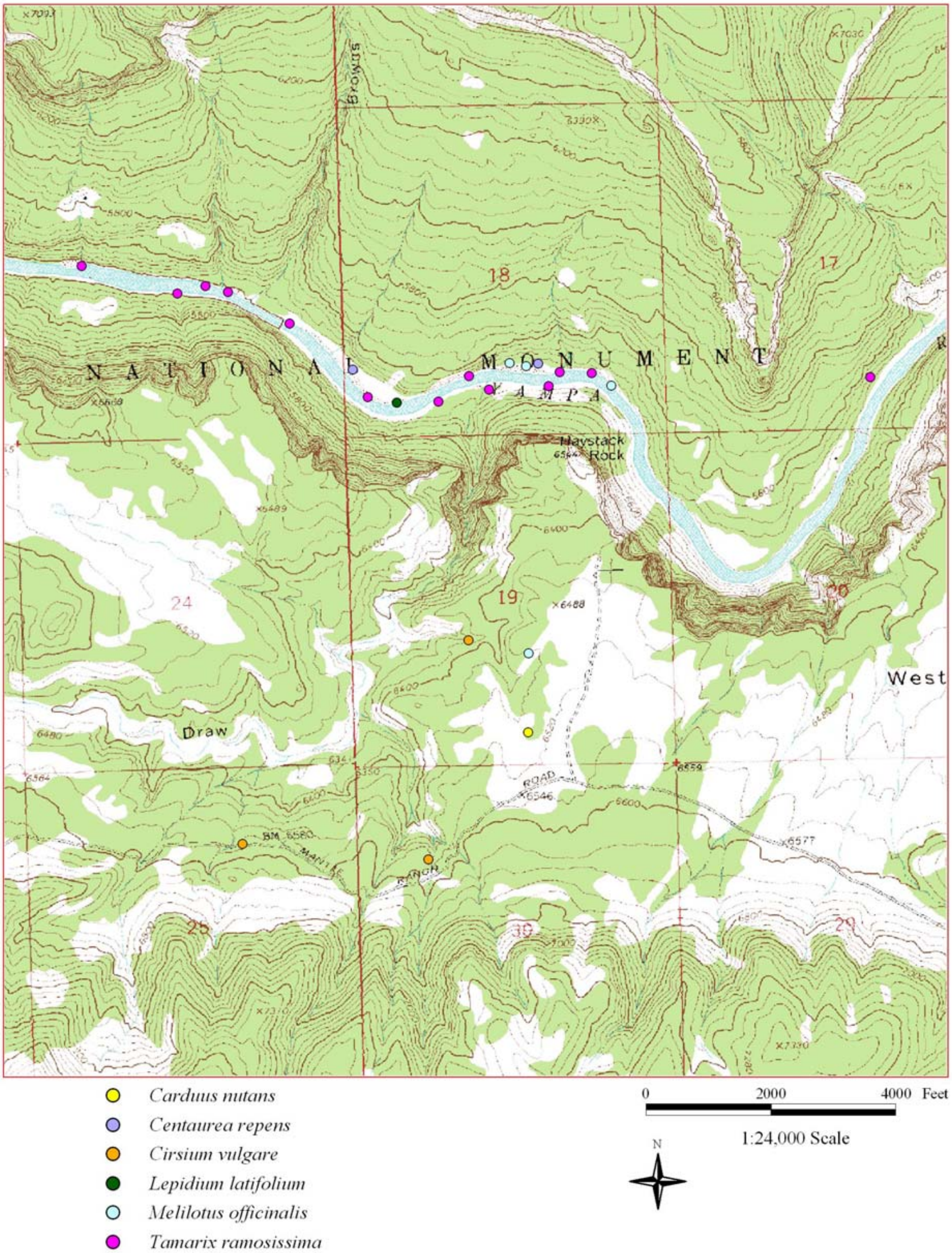
Graham Gulch



Harding Hole

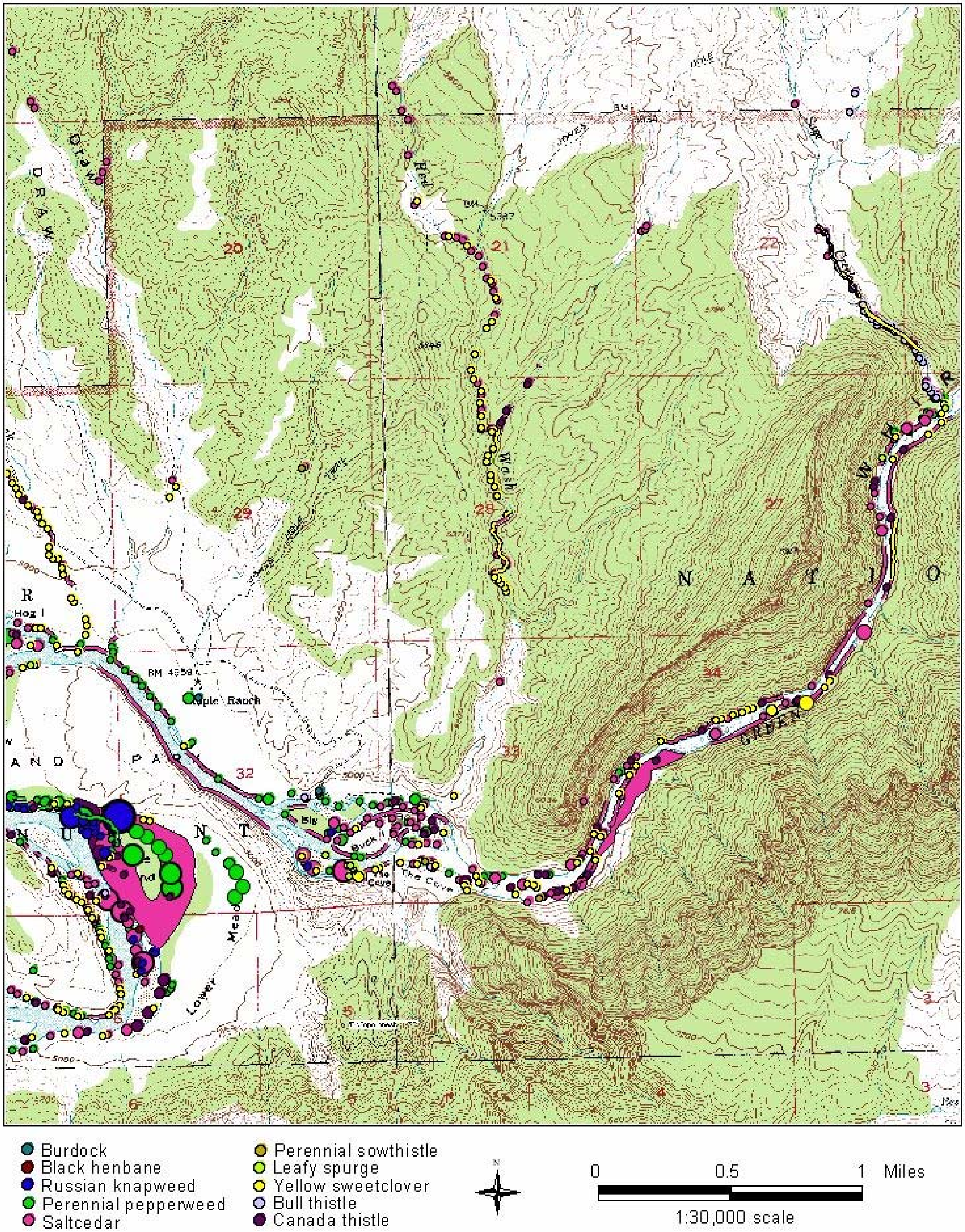


Harper’s Corner and Jones Hole

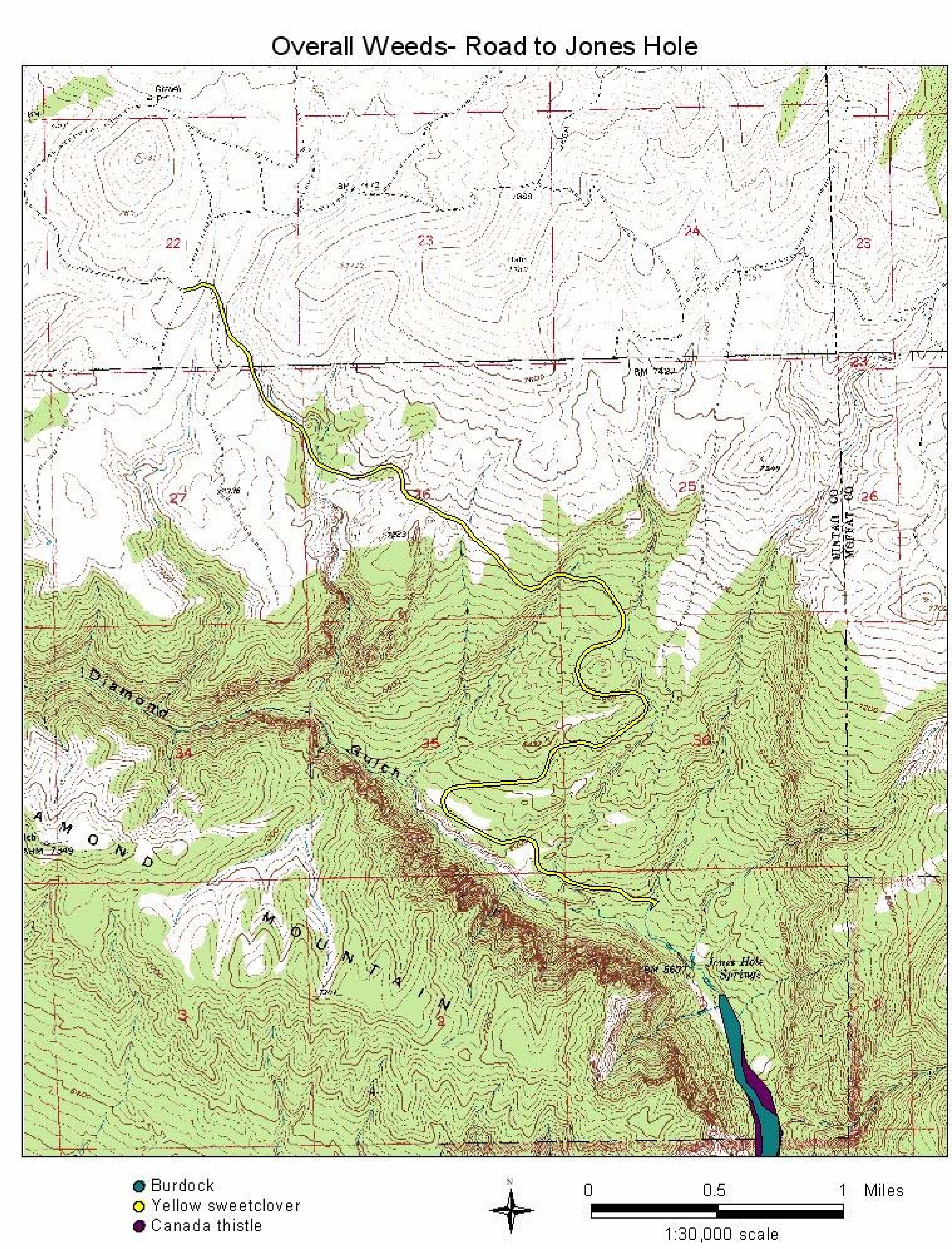


Haystack Rock

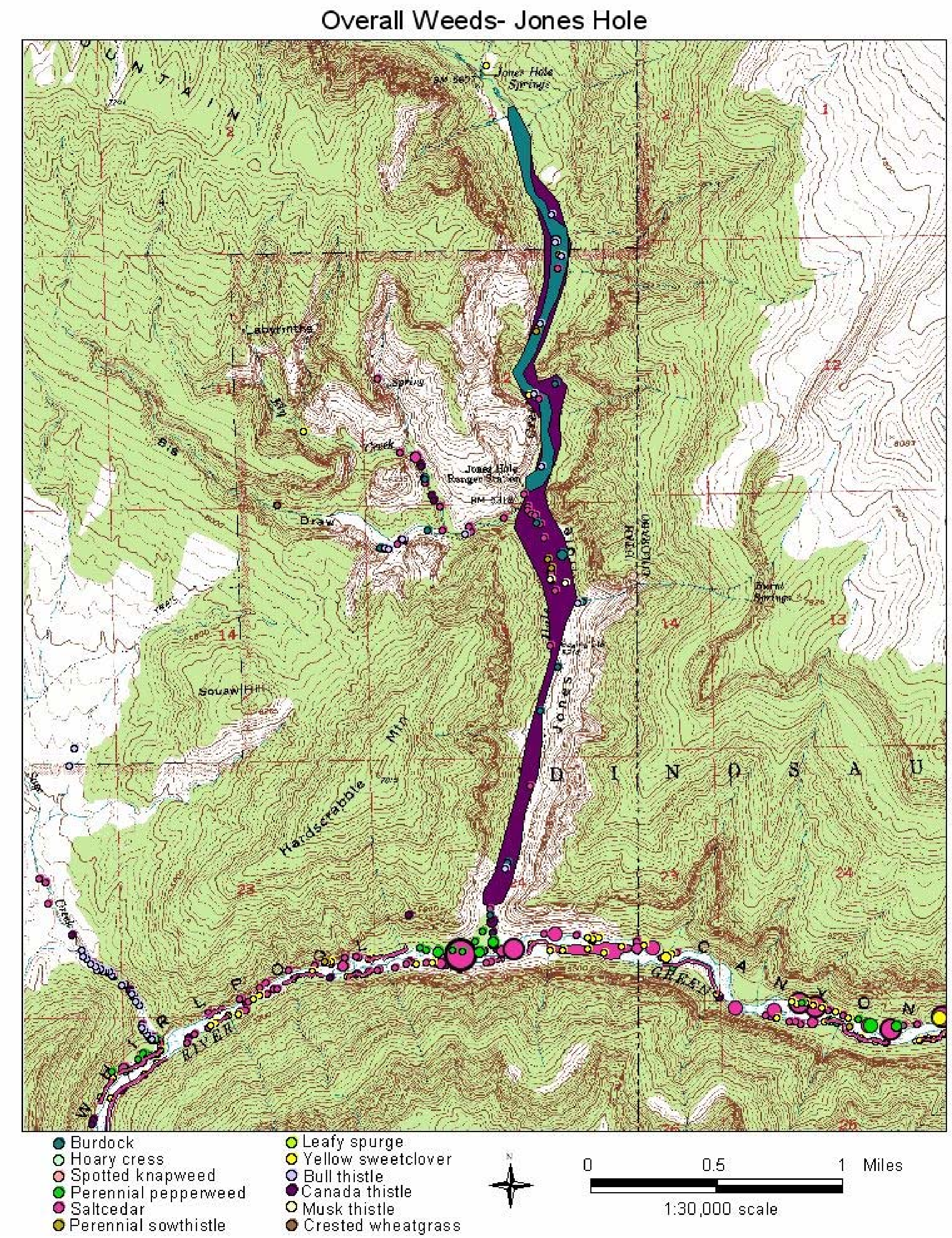
Overall Weeds- Island Park



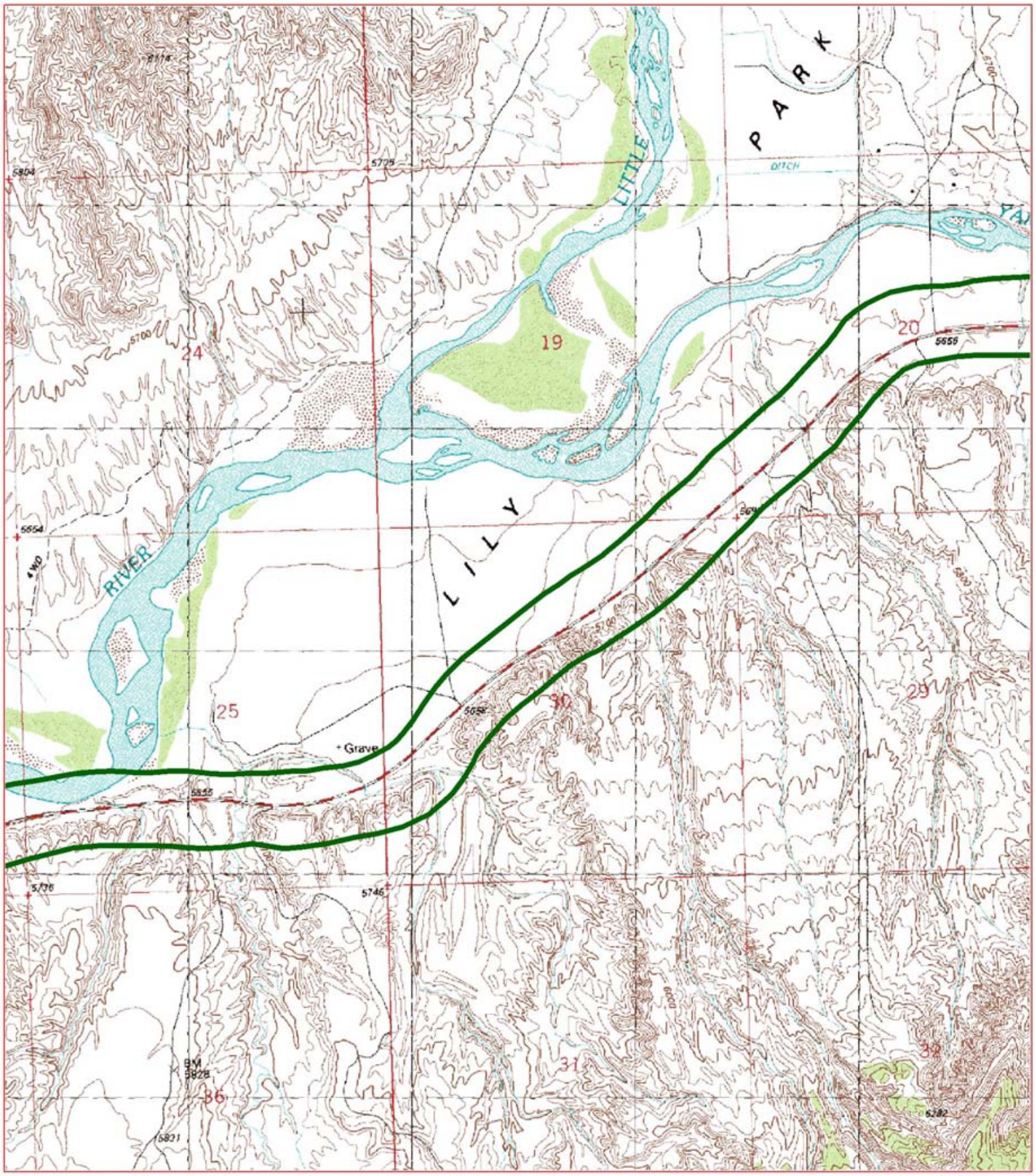
Island Park



Road to Jones Hole


Overall Weeds- Jones Hole
Jones Hole Springs
Labyrinth
Spring
Creek
Jones Hole Ranger Station
Draw
Big
Squaw
Hardscrabble Mtn
Jones Hole
UTAH
COLORADO
D I N O S A U
C A N Y O N
GREEN
RIVER
Burdock
Hoary cress
Spotted knapweed
Perennial pepperweed
Saltcedar
Perennial sowthistle
Leafy spurge
Yellow sweetclover
Bull thistle
Canada thistle
Musk thistle
Crested wheatgrass
0
0.5
1
Miles
1:30,000 scale

Jones Hole



0 2000 4000 Feet

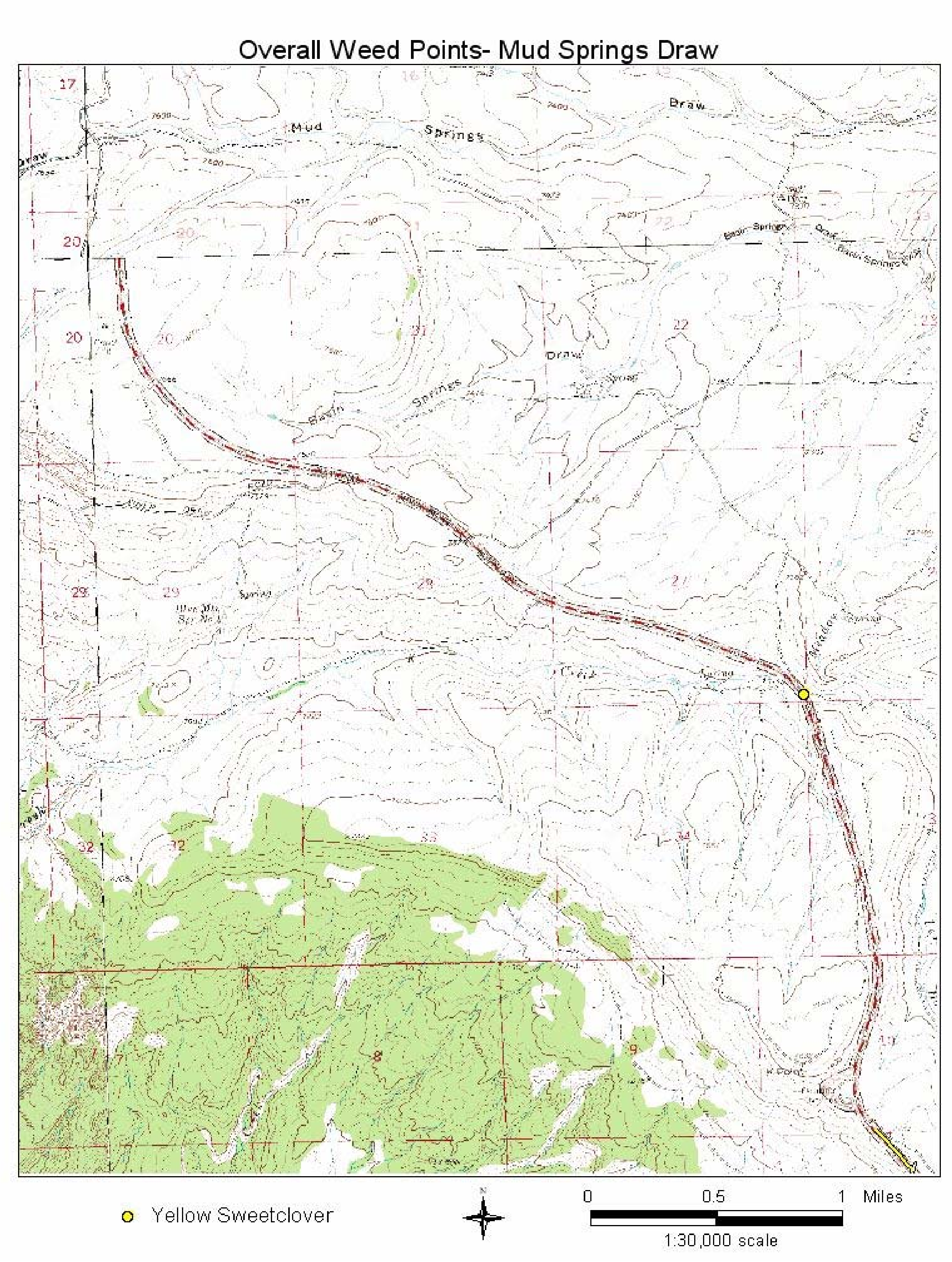
1:24,000 Scale

N

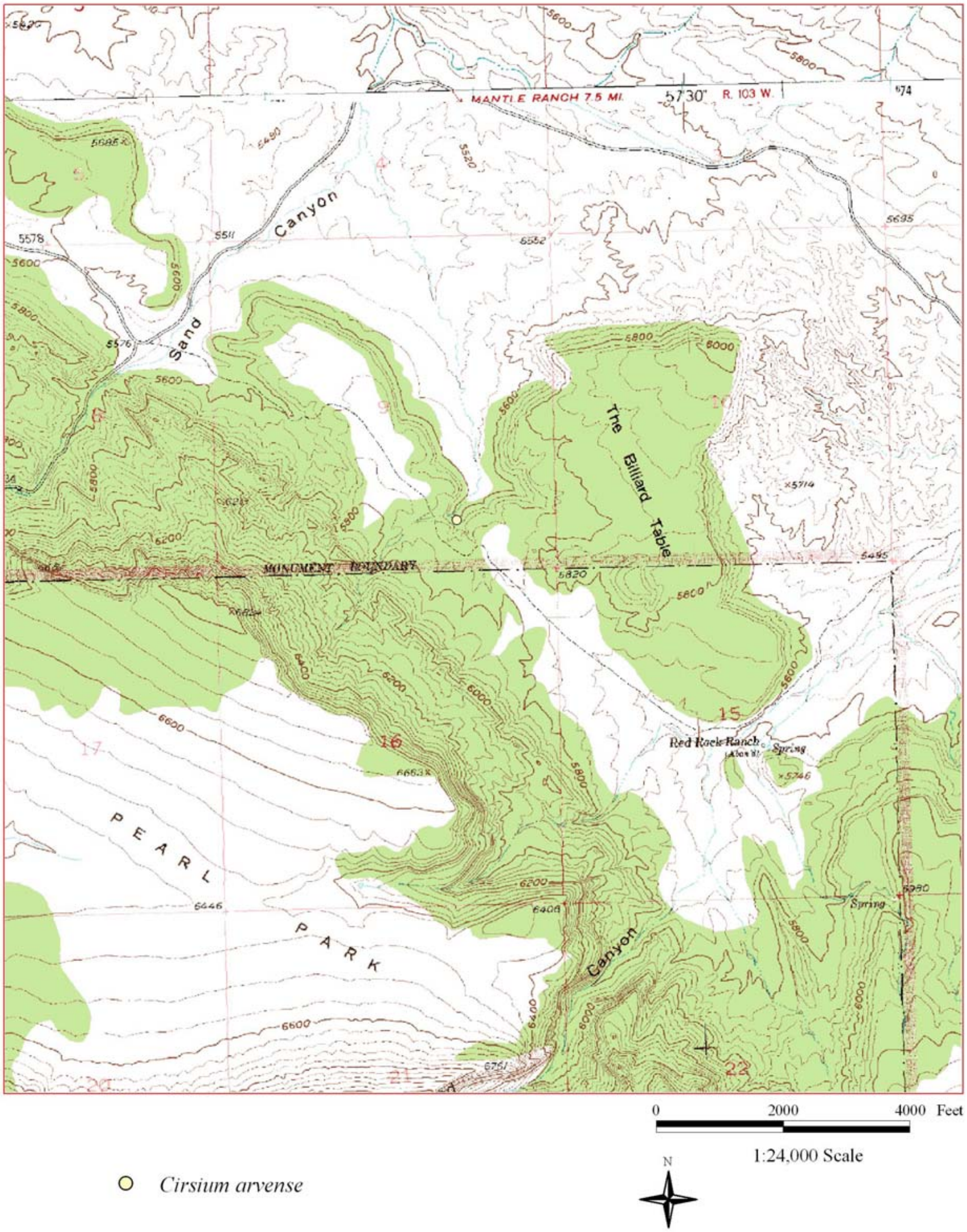
* No target weed species detected

Park boundary

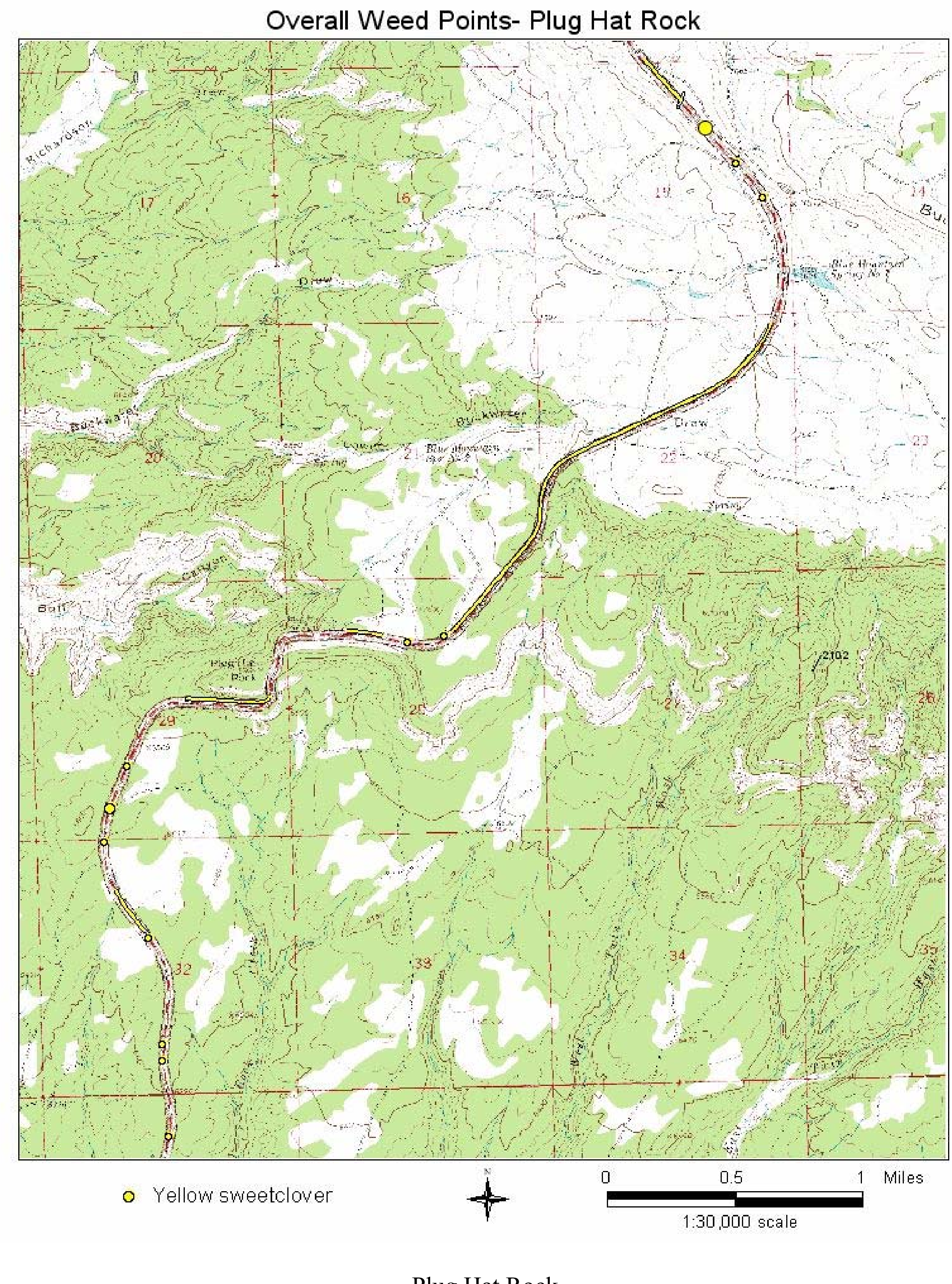
Lily Park (road right-of-way)



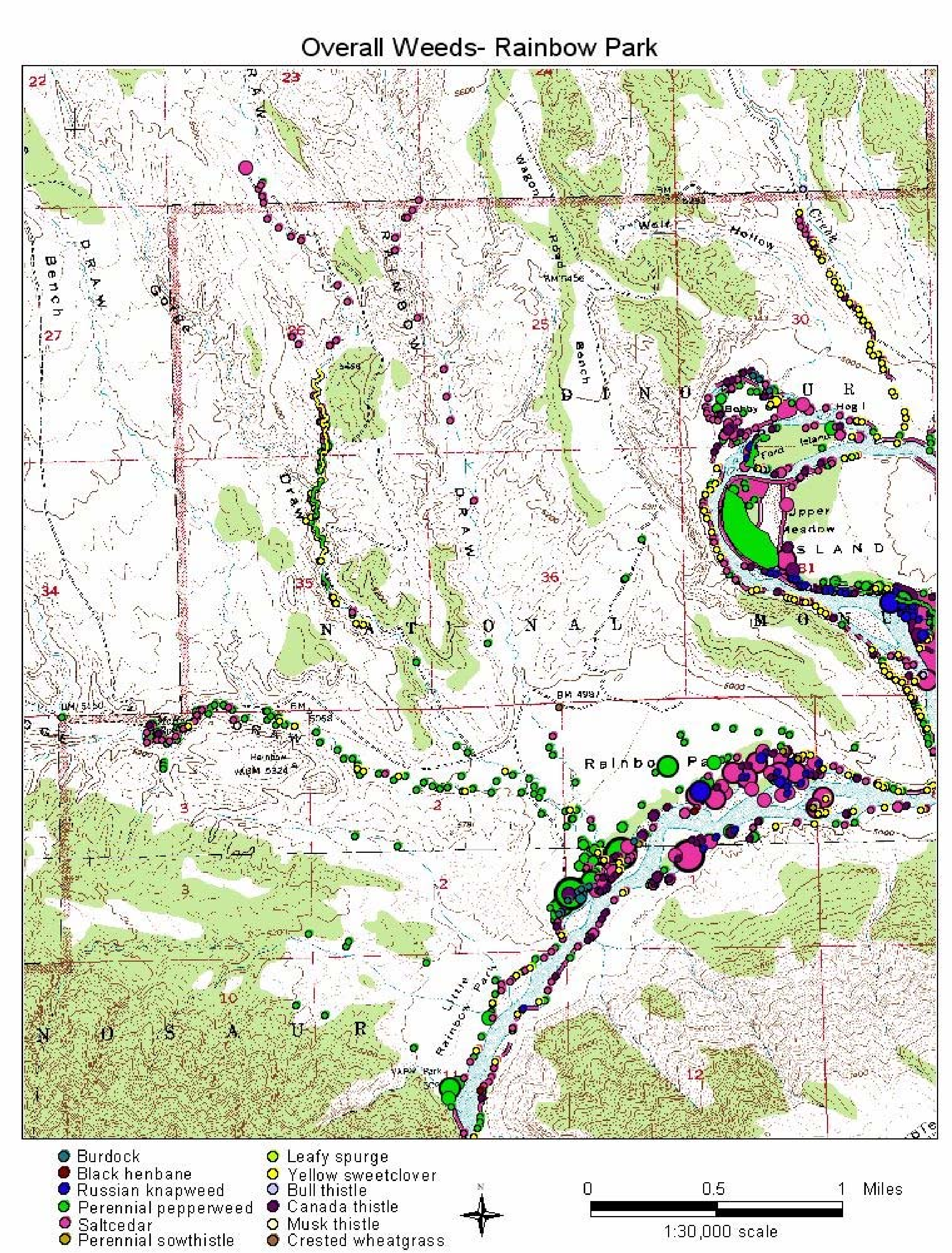
Mud Springs Draw


MANTLE RANCH 7.5 MI.
57'30"
R. 103 W.
Sand
Canyon
The Billiard Table
MONUMENT BOUNDARY
Red Rock Ranch
Spring
P E A R L
P A R K
Canyon
0 2000 4000 Feet
1:24,000 Scale
N
Cirsium arvense

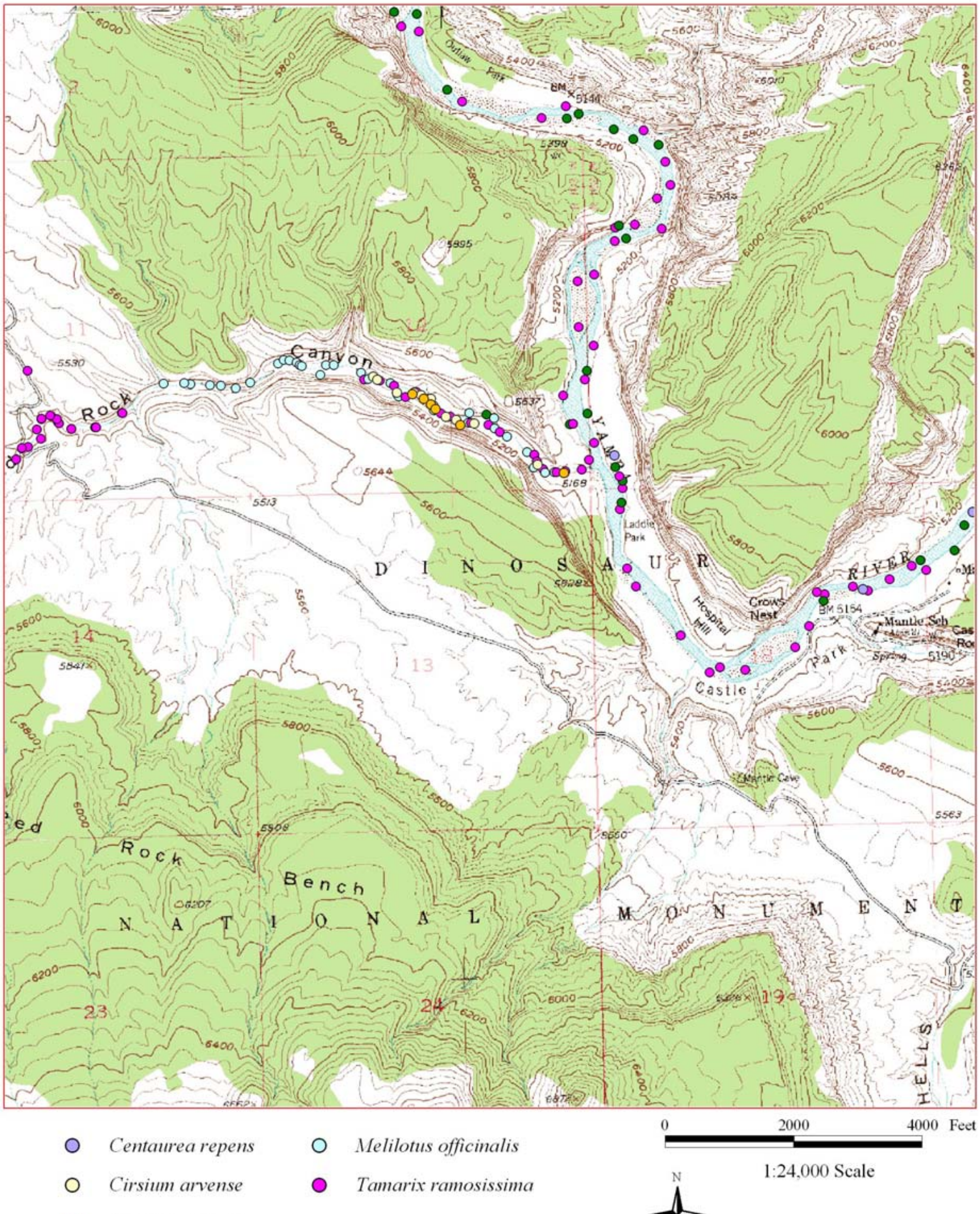
Pearl Park



Plug Hat Rock

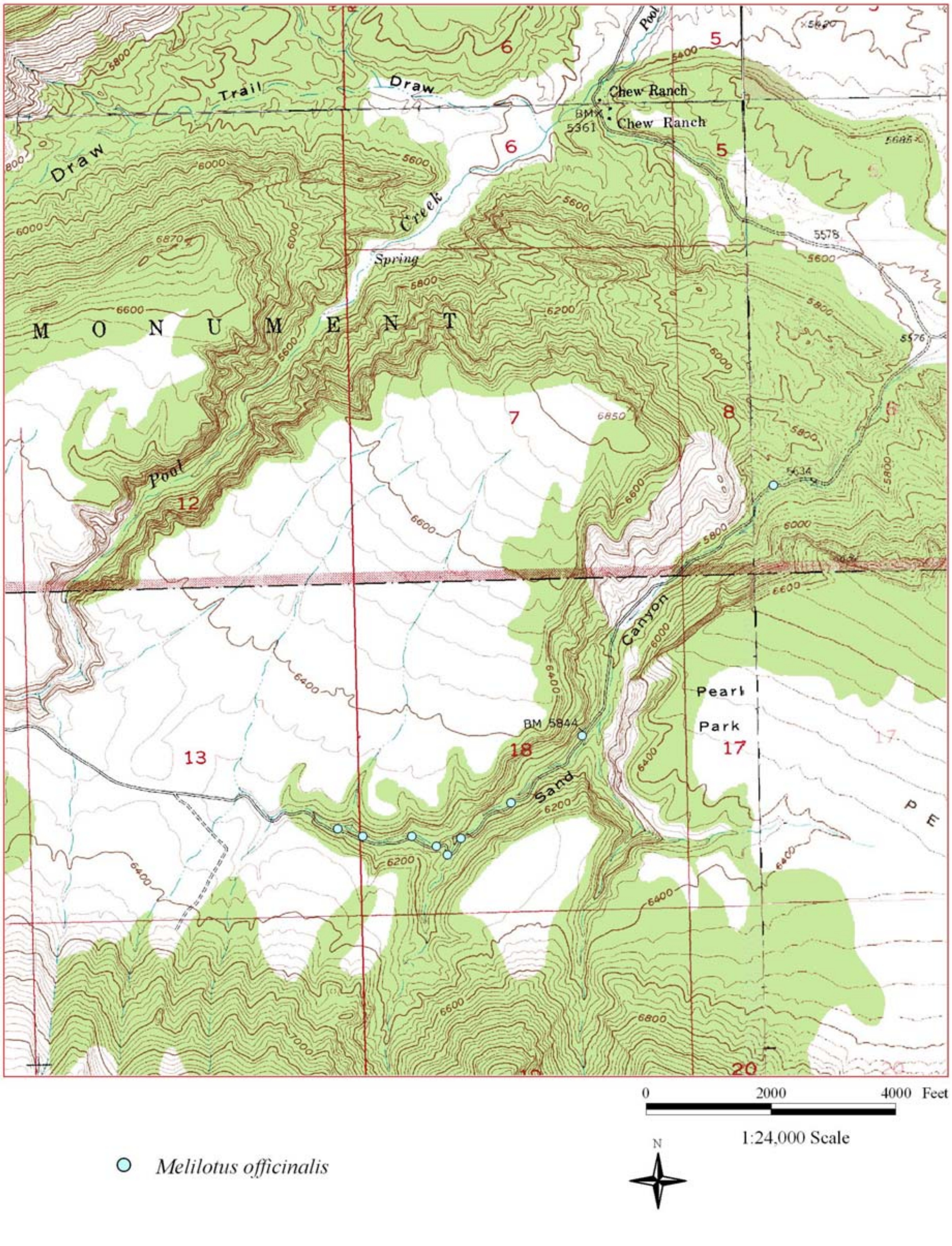


Rainbow Park



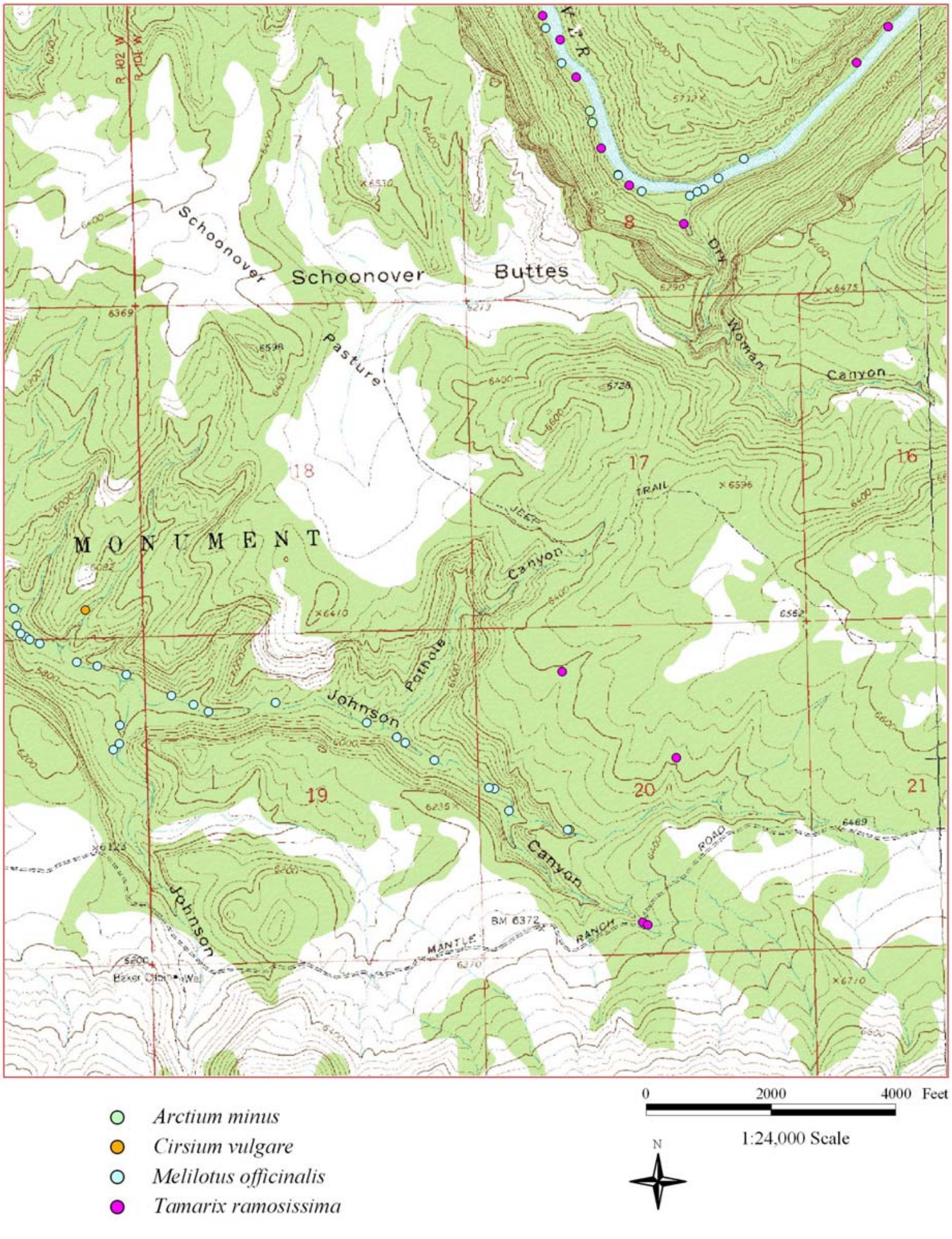
Centaurea repens
Cirsium arvense
Cirsium vulgare
Lepidium latifolium
Melilotus officinalis
Tamarix ramosissima

Red Rock Canyon

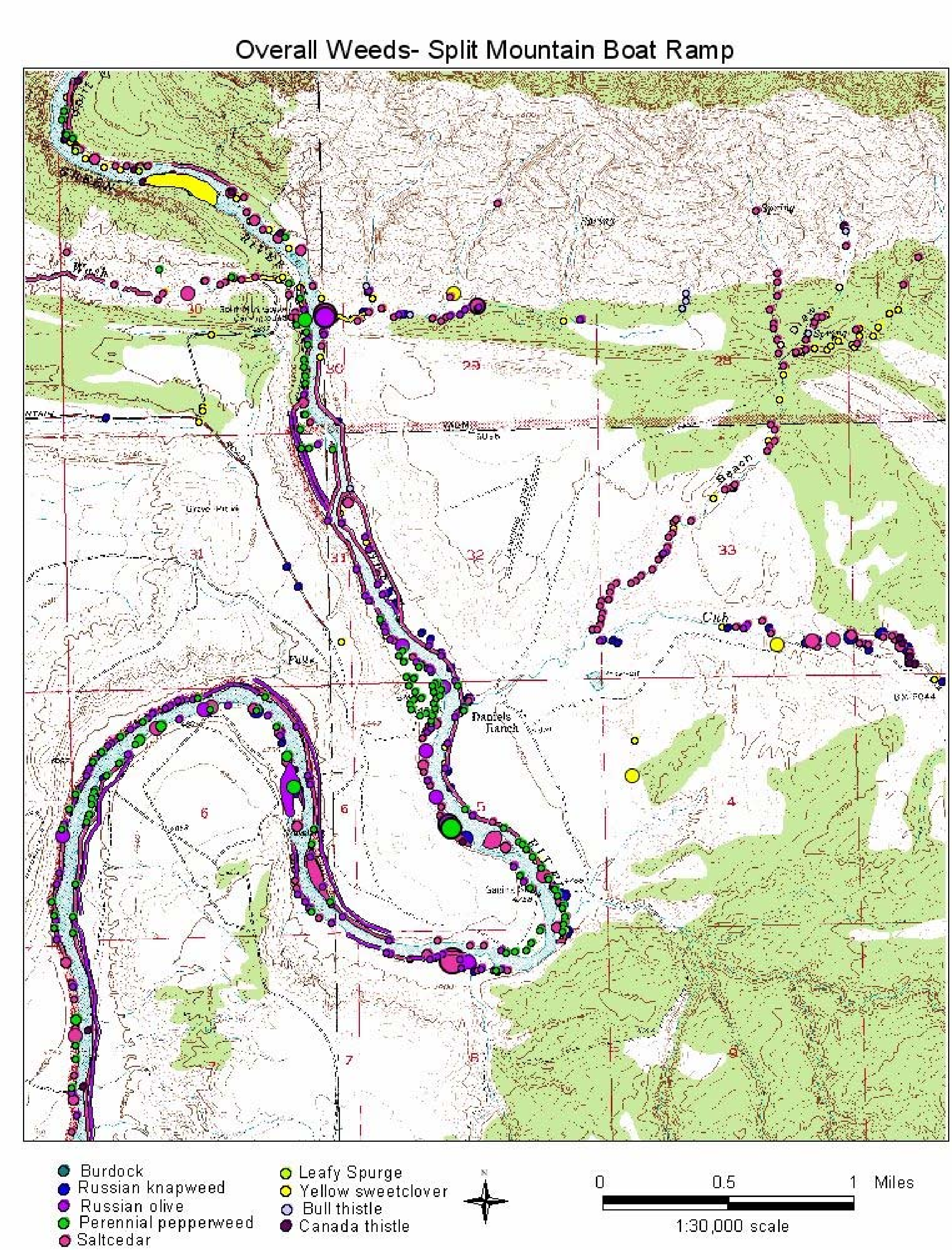


Trail
Draw
Pool
Chew Ranch
BM
5361
Chew Ranch
Creek
Spring
M O N U M E N T
Pool
Sand
Canyon
Pearl
Park
BM 5844
5578
5576
5634
6870
6850
6
5
7
8
12
13
17
18
20
0
2000
4000 Feet
1:24,000 Scale
N
Melilotus officinalis

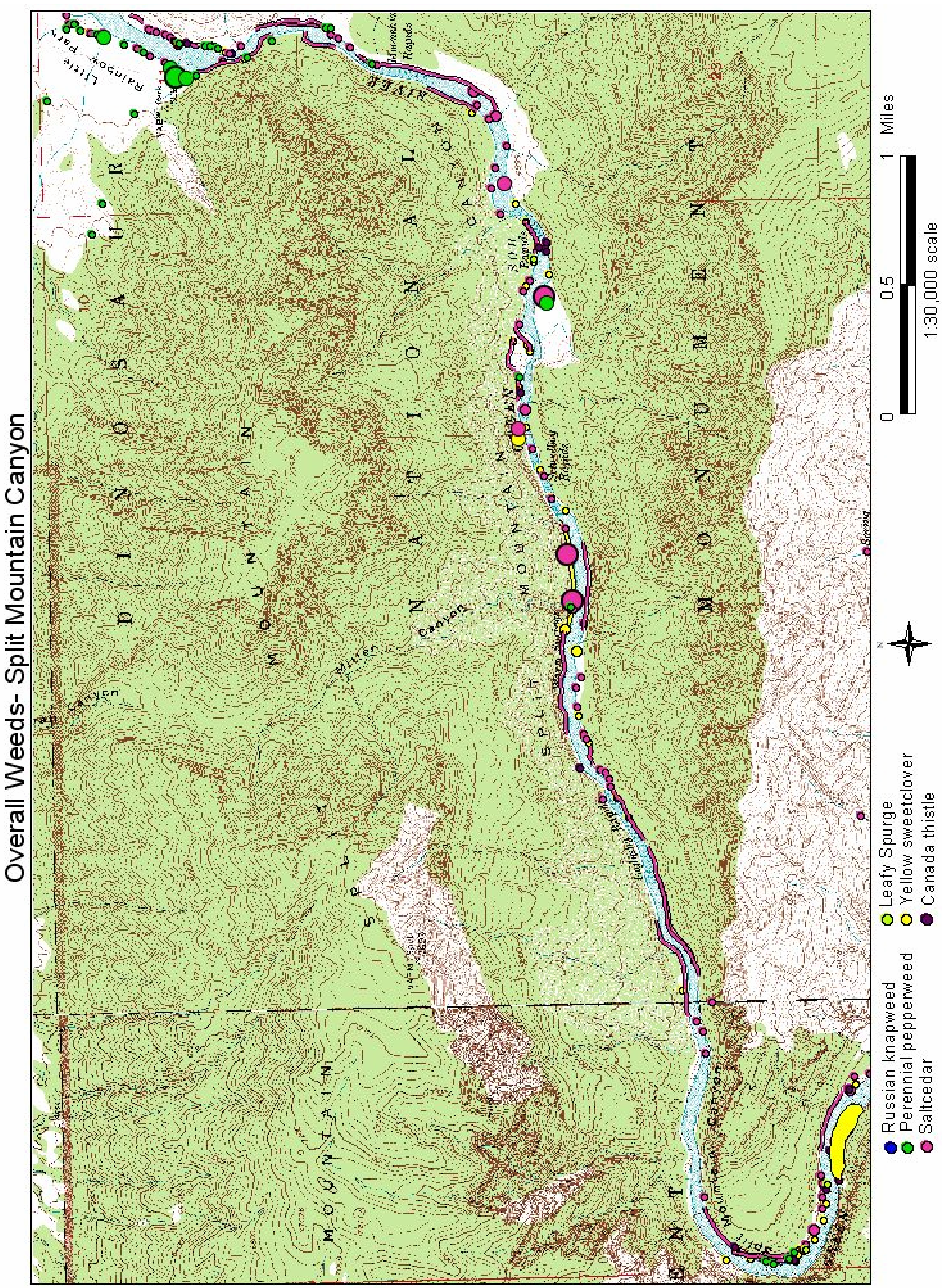
Sand Canyon



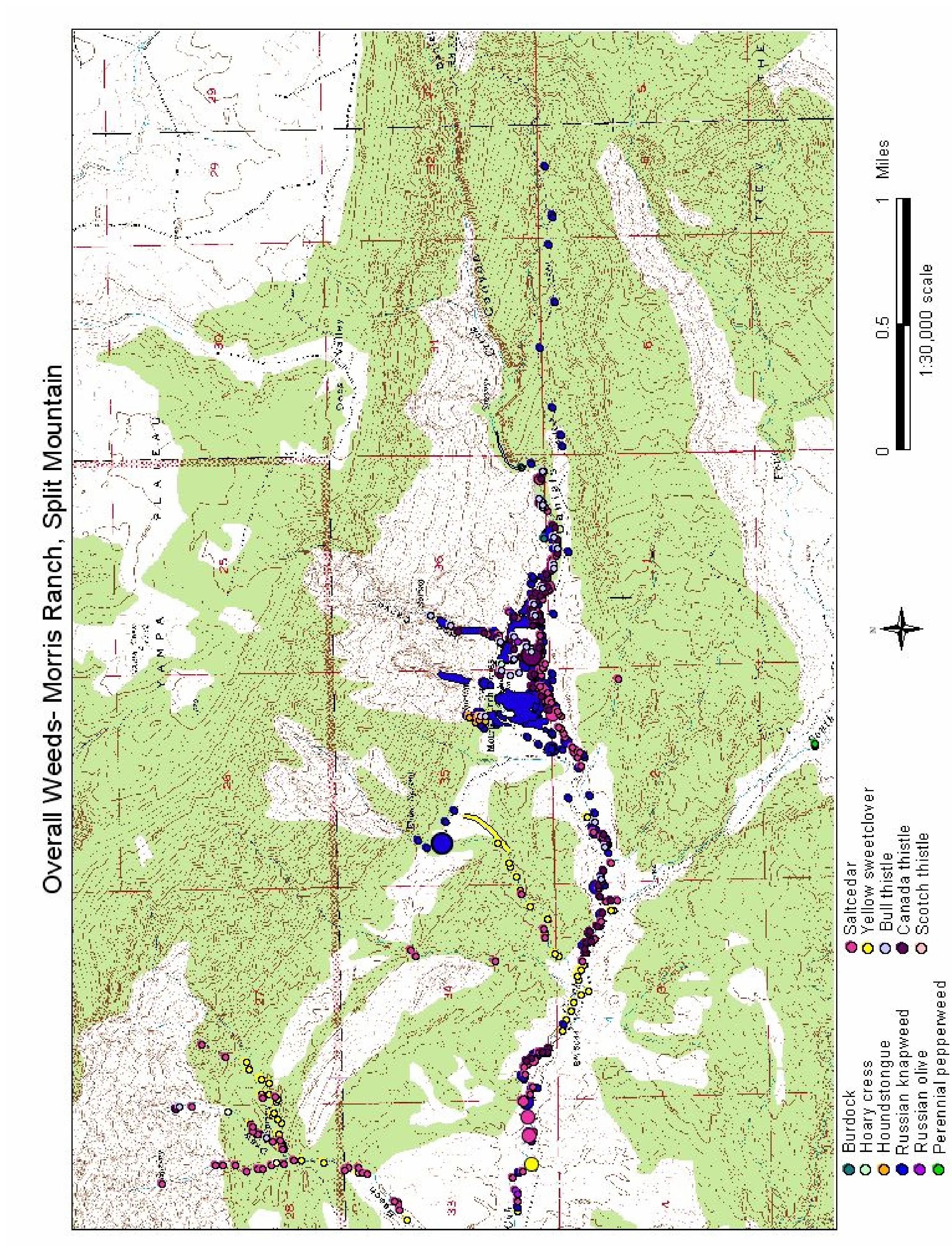
Schoonover Pasture



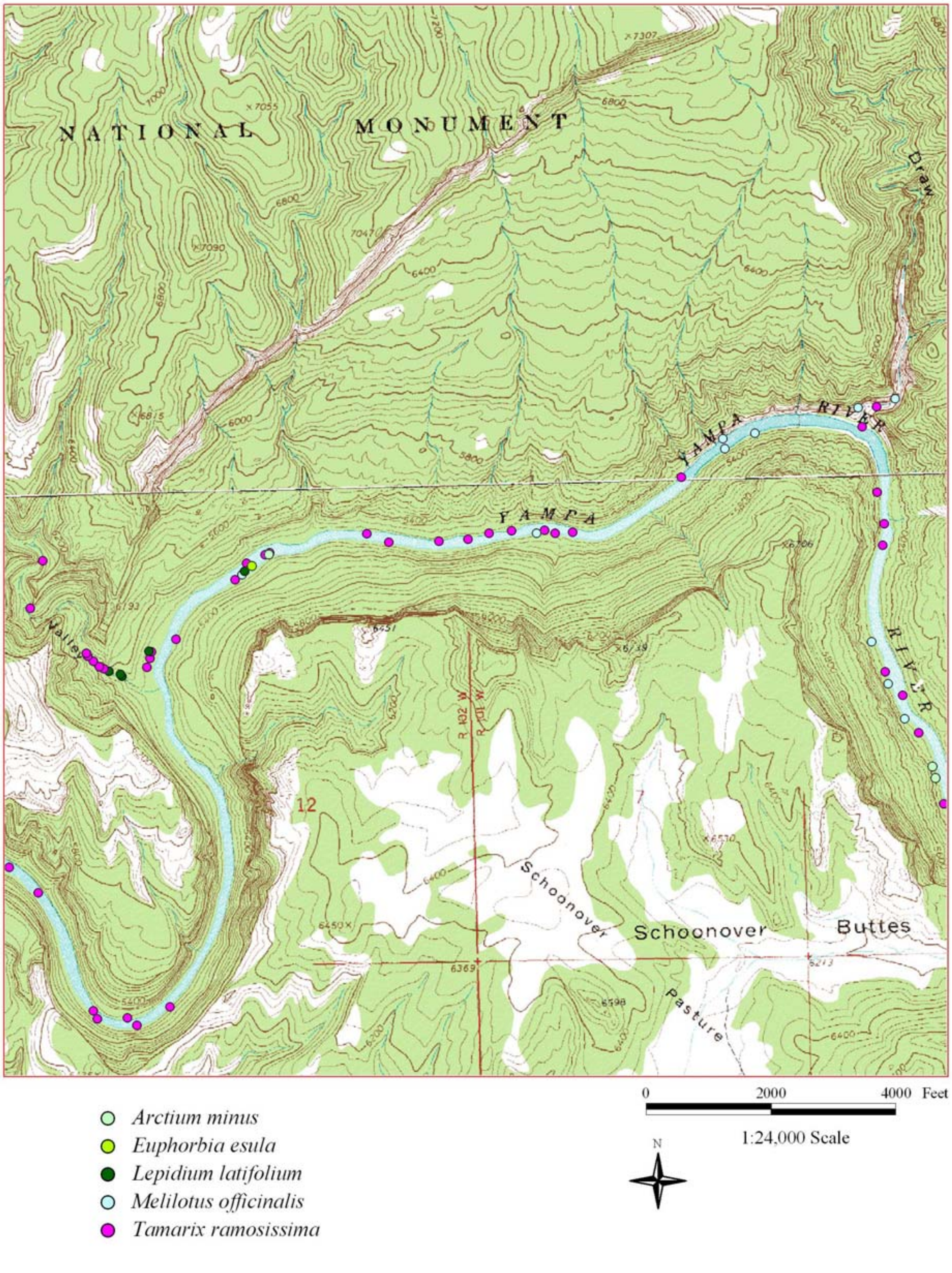
Split Mountain Boat Ramp



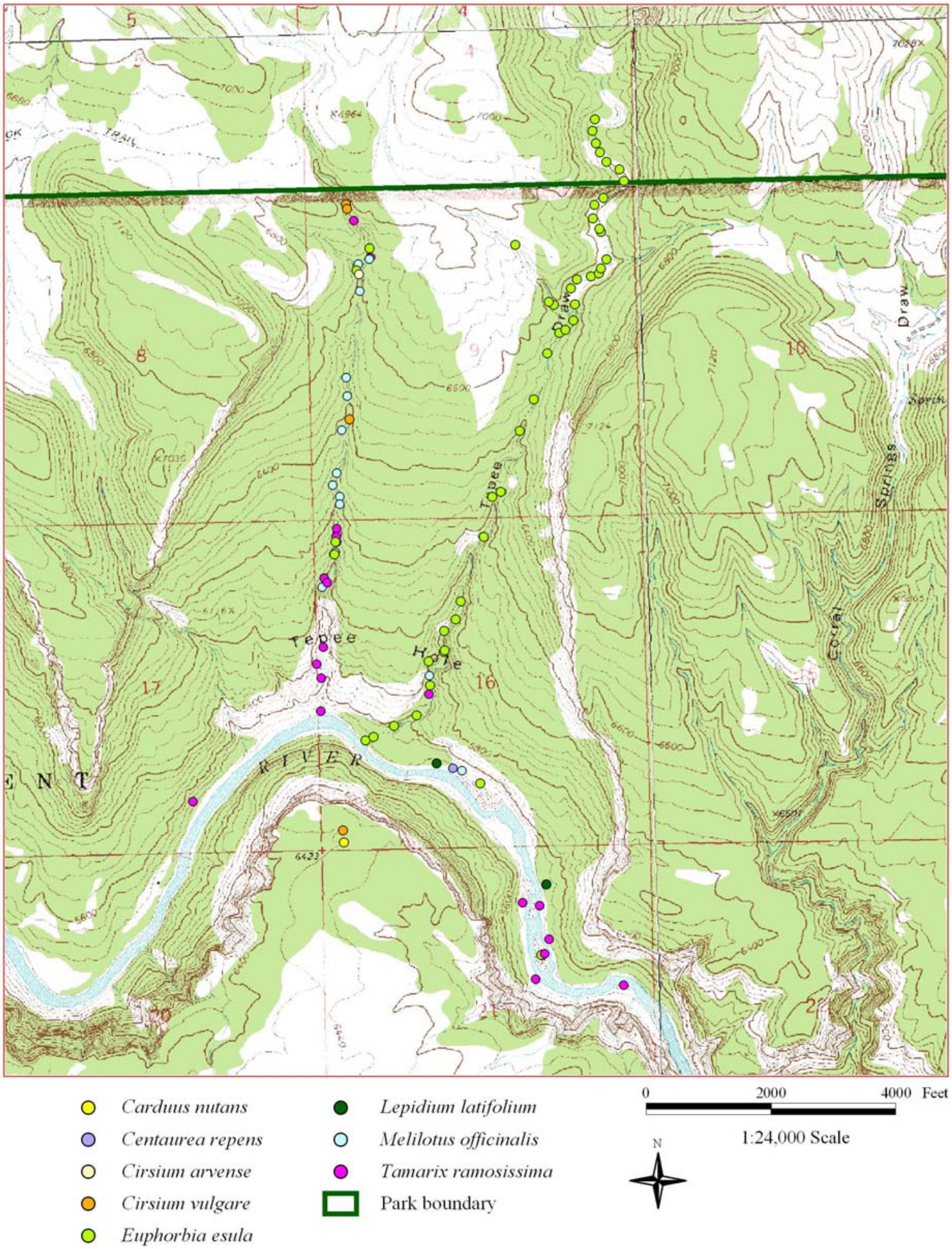
Split Mountain Canyon



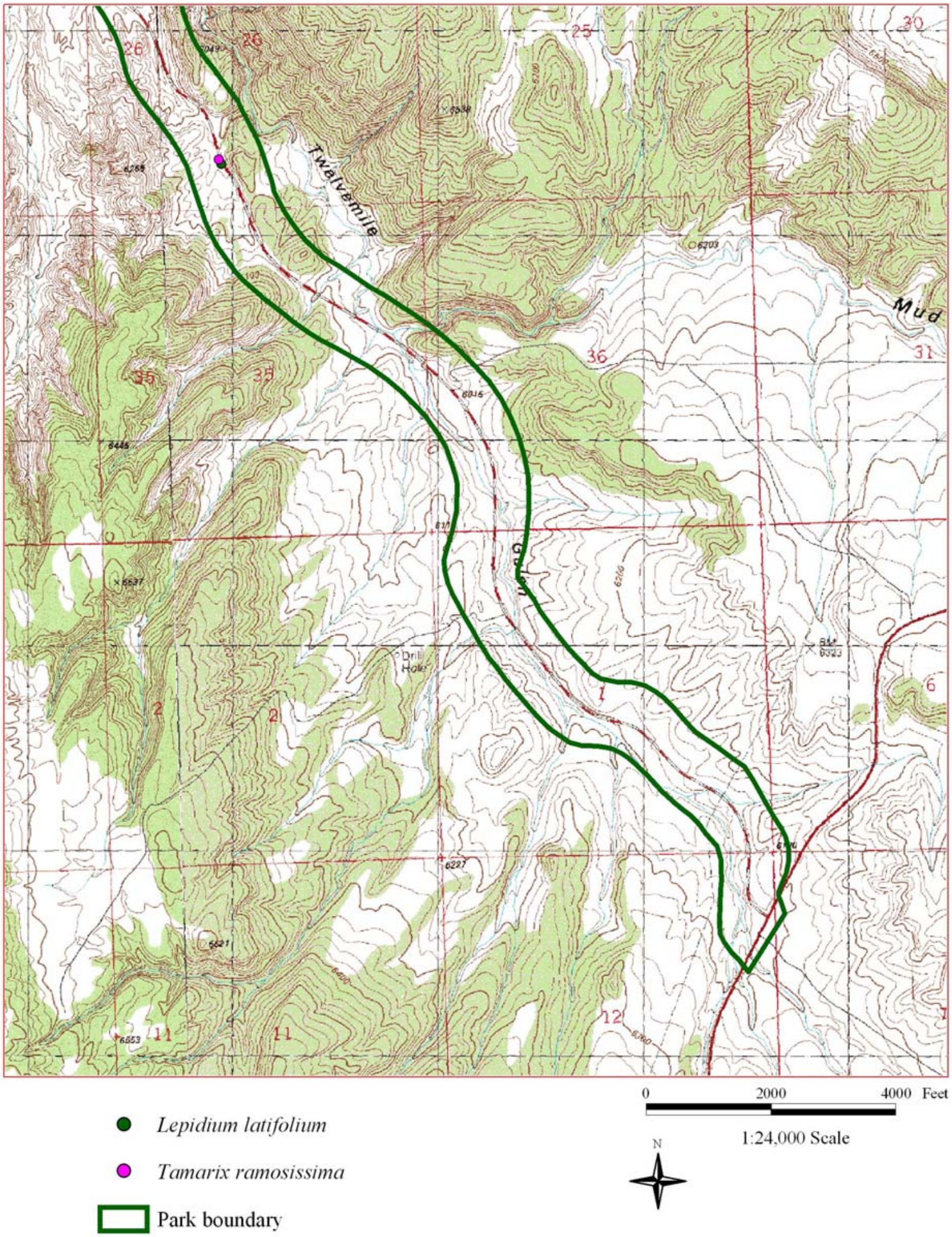
Split Mountain and Morris Ranch



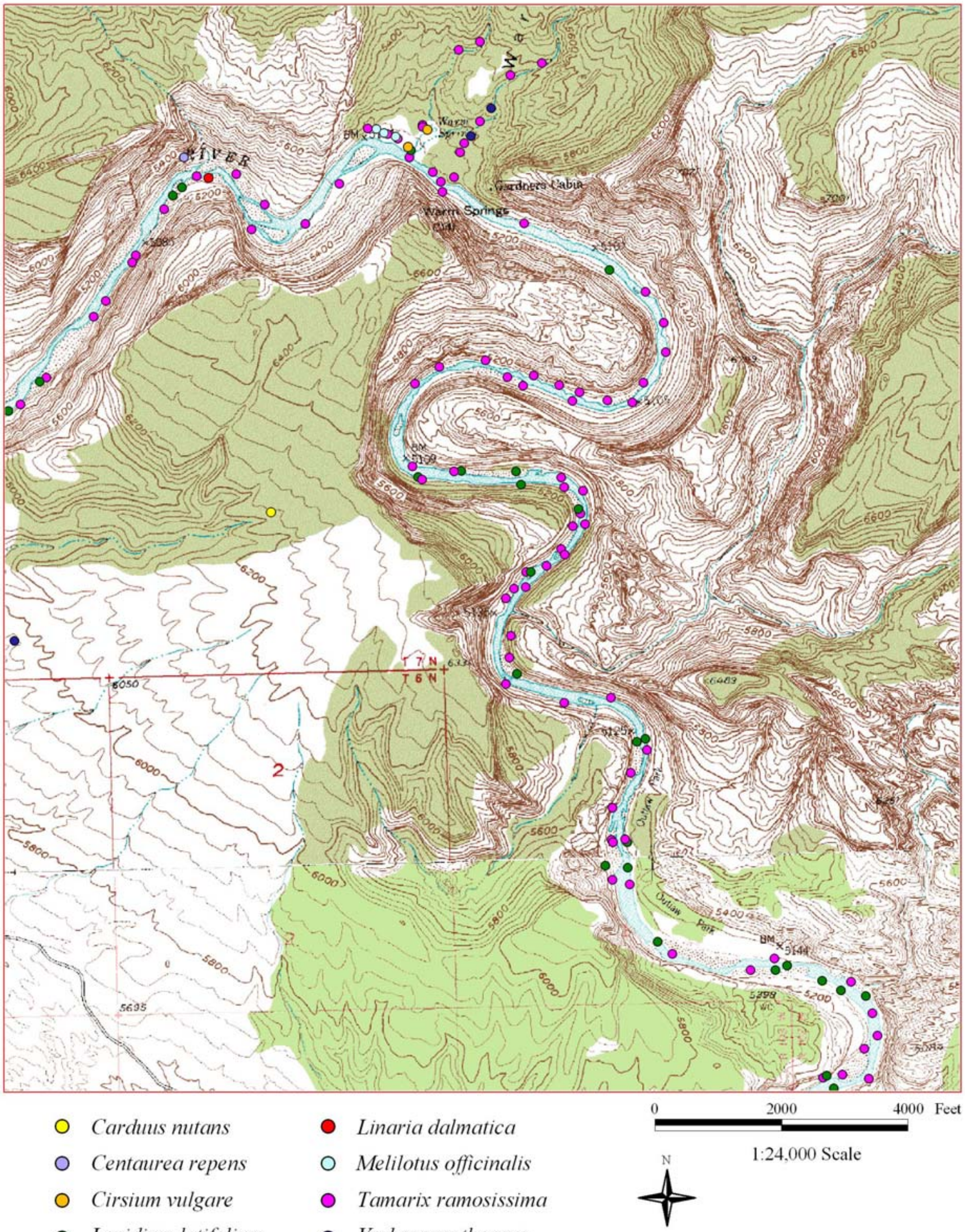
Starvation Valley


Tepee
Draw
Tepee
Hole
RIVER
Corral
Springs
Draw
TRAIL
Carduus nutans
Centaurea repens
Cirsium arvense
Cirsium vulgare
Euphorbia esula
Lepidium latifolium
Melilotus officinalis
Tamarix ramosissima
Park boundary
0
2000
4000 Feet
1:24,000 Scale
N

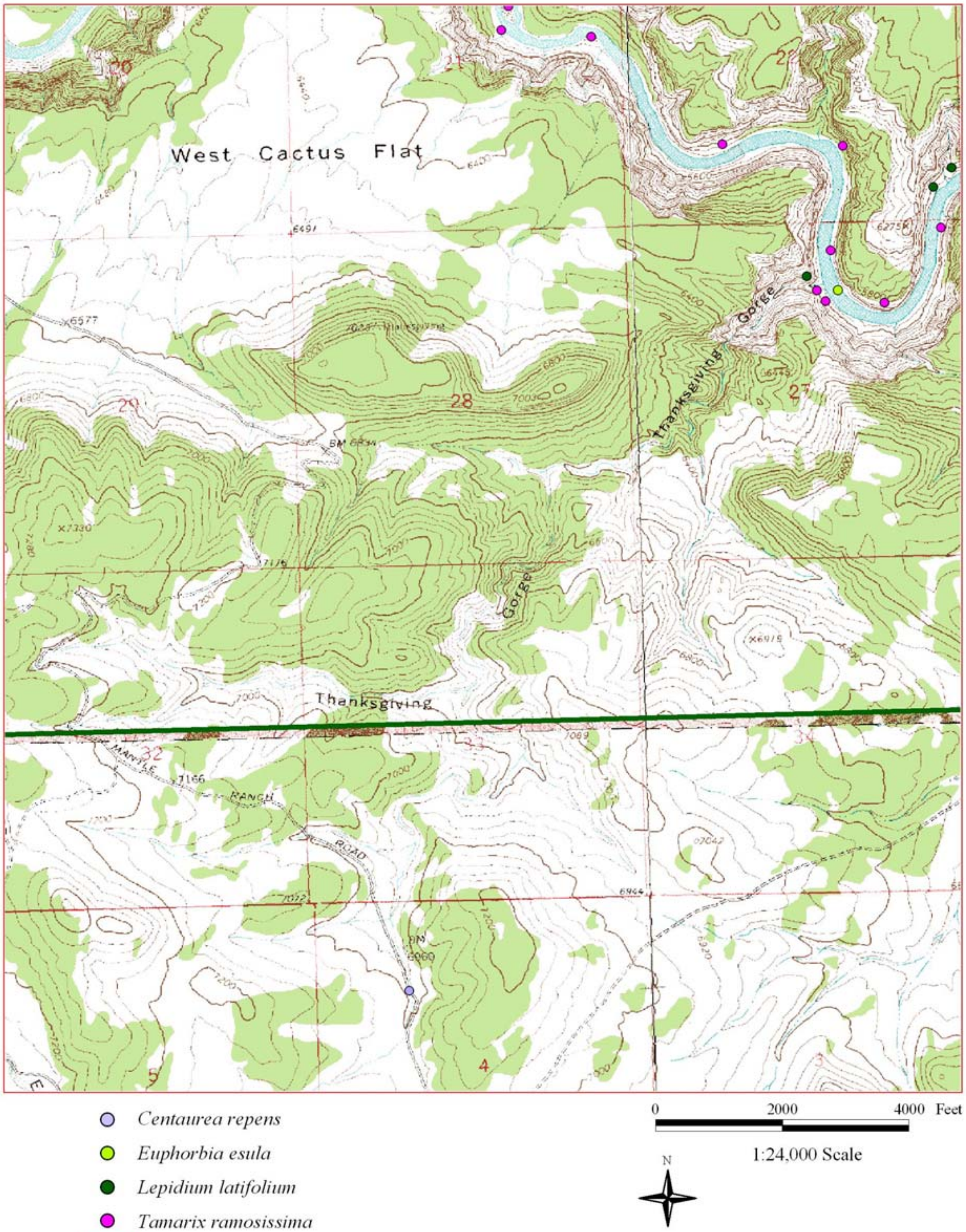
Tepee Draw



Twelvemile Gulch



Warm Springs



West Cactus Flat