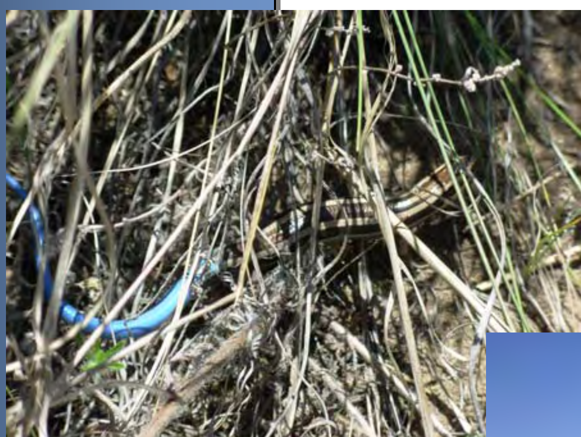
STOLLER-ESER-95

Survey and Review of Potential Impacts to Ecological Resources on the Idaho National Laboratory Due to Construction and Operation of the National and Homeland Security Research and Development Range

R. D. Blew
D. K. Halford
S. J. Vilord
A. D. Forman
J. R. Hafla



Environmental Surveillance, Education and Research Program

ESER

STOLLER-ESER-95

Survey and Review of Potential Impacts to Ecological Resources on the Idaho National Laboratory Due to Construction and Operation of the National and Homeland Security Research and Development Range

June 30, 2006

R. D. Blew
D. K. Halford
S. J. Vilord
A. D. Forman
J. R. Hafla

Environmental Surveillance, Education and Research Program

ESER

Table of Contents

Appendix

List of Figures

List of Tables

1.0 Introduction

The U.S. Department of Energy (DOE) proposes to establish a National and Homeland Security Research and Development (R&D) Range at the Idaho National Laboratory. This R&D range will support DOE's requirement to protect its critical assets and to provide assistance to National and Homeland Security. The range will be used for a variety of research projects including explosive effects, in situ explosive detection and ballistic penetration. The R&D Range would consist of a test bed, range safety fan/impact zone, equipment laydown/construction area, an Administrative/data acquisition area and access road.

The purpose of this report is to evaluate the potential impacts to ecological resources including threatened, endangered and sensitive species due to construction and operation of the R&D Range. This report addresses only the preferred alternative of constructing the facility on the INL.

1.1 The Preferred Alternative

Because a final description of the preferred alternative was not available as this report is being written, the proposed project as described here is based on discussions and communications with individuals associated with the proposed project, and includes a number of assumptions. The description of the Affected Environment and the analysis of the Environmental Impacts provided in this report are therefore limited by these assumptions.

1.1.1 Facilities

The R&D Range will be located at about 7.3 km (5 mi.) north of MFC at approximately 112° 41' 44"W and 43° 41' 40"N (Figure 1). Access to the R&D Range will be from MFC on T-25. T-25 will be widened to a one-lane-plus width and graveled. A new road will be constructed from T-25 to the Test Bed. This road will be approximately 2.2 km (1.4 mi) in length and will also be graveled.

A laydown/construction area will be established along the new road just off of T-25. This area will be about 7,000 m^2 (1.7 acres) in size. This area will also be graveled. A data acquisition line will be buried along the new road from the laydown area to the Test Bed.

It is expected that an area approximately 137 m (450 feet) in radius around the Test Bed center will either be mowed regularly or bladed to reduce fire hazard. A smaller area at the Test Bed center will be disturbed directly by the testing and activities associated with the testing. A berm will be pushed up near the Test Bed center to serve as a backstop for the projectile tests.

A Safety Fan/Impact Area for projectile tests will be established to the southwest of the Test Bed. This area will extend for 8 km (5 mi.) down range and a width of approximately 30 degrees. This area will be accessed rarely and that access will be by foot or ATV. The assumed location of the Safety Fan/Impact Area is shown in Figure 1.

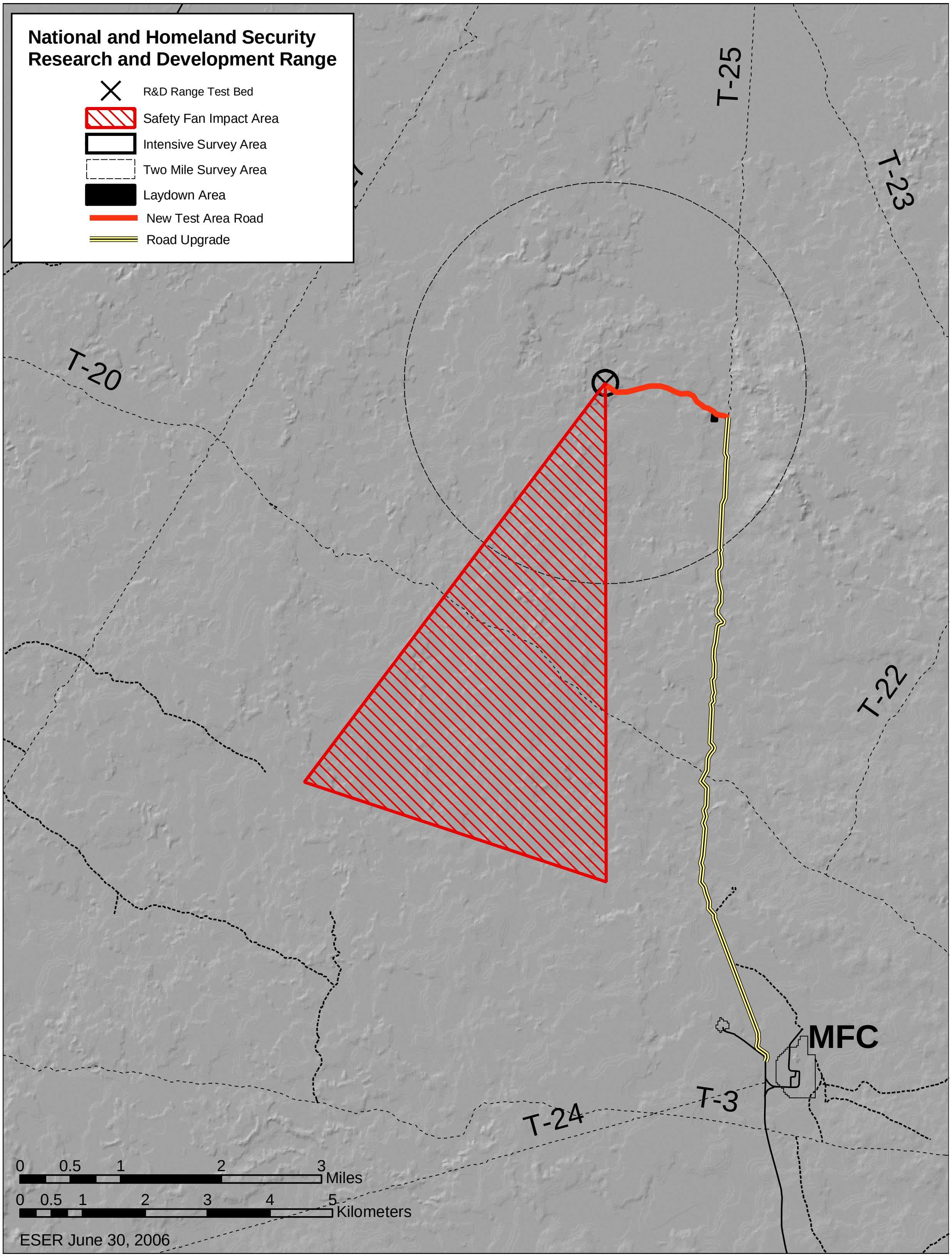


Figure 1. Location of National and Homeland Security Research and Development Range, access roads and safety fan.

An area up to 8 km (5 mi.) in radius around the Test Bed will be closed to non-project personnel during testing.

Initially, this project would not require installation of water wells, septic or waste systems. Project personnel would use bottle water and portable sanitary facilities on site. These systems may be installed if the Site usage increases to a point that would make them feasible. Electrical power will be provided by portable electrical generators or the installation of a feeder line from the east loop power line located along T-25 to the laydown area. If practical, this line will be underground.

1.1.2 Operations

Although it is impossible to predict future activities, it is reasonable to assume that the range will receive the following level of use. The range will be used most working days from March through November. Use between December and February is expected to be sporadic. Large explosive events (11,000 – 20,000-lb Net Explosive Weight [NEW]) are expected to occur once every five years. Mid-range events (3,000 – 10,000-lb NEW) are expected to occur once or twice a year. Small events (100 – 3,000-lb NEW) will occur once per month and very small events (less than 100-lb NEW) would occur weekly. Small scale projectiles (30 mm or less) will probably be fired on a bi-weekly basis. Large projectiles (40 mm to 120 mm and 50 cal.) will probably be fired three or four times per year.

Routine daily workforce at the R&D Range would include 5-10 people while larger tests (twice a year) may include as many as 25 people. Routine travel to and from the R&D Range will typically be by pickups or SUVs. Flat-bed trucks would likely be used to transport test materials to the range and waste materials away from the range. Cement trucks might be expected once a year. Access to the range fan is expected once a year, via ATV.

Construction activities on the range and laydown area will be limited to the construction and installation of temporary test articles. Typical test articles would include chain link fencing, Jersey barriers, electronic sensors (microwave sensors, balanced magnetic switches, closed circuit television, etc.), security vehicles (drained of all fluids), reinforced concrete walls, armor plates and masonry walls. Targets will either be built offsite and erected at the R&D Range, or built at the R&D Range. All target material will be cleaned up after the test series and disposed of in the INL landfill in accordance with established INL procedures.

The laydown area will be used for temporary storage of targets and equipment. Portable or temporary facilities will be located in this same area for administrative work and data acquisition. These facilities will probably be specially converted truck trailers, but might also include Milvan containers and house trailers. These facilities will have to be moved for the larger explosive events. The intersection of T-25 and T-20 will be designated as a turnaround area for equipment and vehicles when this is done. A buried data acquisition trunk line will run from the test area to the administrative area.

1.2 INL Natural Resource Management Objectives

Under DOE Policy 430.1 (Facility and Land Use Panning, July 1996), "it is Department of Energy policy to manage all of its land and facilities as valuable national resources. Stewardship is based on the principles of ecosystem management and sustainable development. DOE integrates mission, economic, ecologic, social, and cultural factors in a comprehensive plan for each site that will guide land and facility use decisions. Each comprehensive plan for each site will consider the site's larger regional context and be developed with stakeholder participation. This policy will result in land and facility uses which support the Department's critical missions, stimulate the economy, and protect the environment."

Further, DOE along with thirteen other Federal agencies signed a Memorandum of Understanding (MOU) to Foster the Ecosystem Approach (December 15, 1995). As stated in the MOU, "An ecosystem is an interconnected community of living things, including humans, and the physical environment within which they interact. The ecosystem approach is a method for sustaining or restoring ecological systems and their functions and values. It is goal driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries. The goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals. These goals and approaches are reflected in the Natural Resource Objectives established for this Environmental Assessment."

The INL represents the largest remnant of undeveloped, ungrazed sagebrush steppe ecosystem in the Intermountain West (DOE 1997). This ecosystem has been listed as critically endangered with less than two percent remaining (Noss et al. 1995, Saab and Rich 1997). The INL is also home to the Idaho National Environmental Research Park (NERP). The NERP is an outdoor laboratory for evaluating the environmental consequences of energy use and development as well as strategies to mitigate these effects. A portion of the INL has been designated as the Sagebrush Steppe Ecosystem Reserve that has a mission of conducting research on and preserving sagebrush steppe.

The goal of ecological resource management on the INL is to perpetuate and protect a large, unfragmented native sagebrush steppe ecosystem, respond to existing Executive Orders, federal, state, and DOE mandates for protecting biological resources, and support NERP objectives (DOE 2003). Recognizing that there are requirements for road construction or improvement on the INL to meet DOE objectives, certain measures can be implemented to reduce or eliminate impacts to natural resources from these activities. Specific natural resource management objectives which fulfill DOE policy and Federal regulatory requirements include:

- **Reduce the need for land rehabilitation.** The goal of this objective is to reduce or eliminate the need to rehabilitate areas after construction or decommissioning.

Reducing or eliminating the need for rehabilitation maintains the established adjacent ecosystem in its current state.

- **Protect threatened, endangered and sensitive species (this includes State of Idaho designated species) and their habitat.** The Endangered Species Act (ESA) requires that Federal agencies "shall seek to conserve endangered and threatened species." The goal of this objective is to ensure that ESA listed and Idaho designated species are not adversely impacted by the proposed action.
- **Protect sage grouse and other sagebrush-obligate species and their habitat.** Because a number of the risk of being listed under ESA, the goal of this objective is not to adversely impact INL populations of sage grouse and other sagebrush-obligate species and their required habitat through the proposed action.
- **Prevent habitat loss and fragmentation.** Habitat loss and fragmentation can adversely impact plant, and animal species, biodiversity, and ecosystem stability. The goal of this objective is to minimize or prevent habitat loss and fragmentation.
- **Protect culturally significant flora and fauna.** This goal of this objective is to prevent impacts on culturally significant (to regional Native Americans) plants and animals from the proposed action and associated auxiliary actions.
- **Maintain a large undeveloped, sagebrush steppe ecosystem.** The goal of this objective is to conserve large tracts of sagebrush which eliminate impacts to flora, fauna, biodiversity and threatened and endangered species depending on this ecosystem.
- **Maintain plant genetic diversity.** The goal of this objective is to prevent non-regional genotypes from being established as a result of lack of revegetation planning.
- **Protect unique ecological research opportunities.** The goal of this objective is to preserve research opportunities unique to the sagebrush steppe ecosystem on the INL. The most significant "unique ecological research opportunities" are related to the large, undeveloped, unfragmented sagebrush steppe found on the INL. These sagebrush attributes should be protected from adverse impacts thus preserving these opportunities.
- **Prevent invasion of non-native species including noxious weeds.** Ground disturbing activities, particularly in close proximity to or adjacent to seed sources exacerbate the invasion of noxious species. The goal of this objective is to prevent invasion of non-native and noxious biota due to the proposed action.
- **Prevent animal/vehicle conflicts.** With new roads, the probability of animal/vehicle collisions will increase and cause, not only damage to the natural resource, but human health and safety as well. The goal of this objective is to minimize or eliminate these conflicts.
- **Protect biodiversity.** The goal of this objective is to protect the biodiversity on the INL. Biodiversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Biodiversity is important to the health of the environment and is a basic concept to the goal of ecosystem approach.

1.3 Background

Because the proposed facilities will result in a substantial change in the amount of vehicle traffic in the project and access areas, it is expected that, in addition to the disturbance caused by the research activities, increased traffic in this area could cause an impact to ecological resources on the INL. The impacts of roads on terrestrial ecosystems, such as the sagebrush steppe on the INL, include direct habitat loss; facilitated invasion of weeds, pests, and pathogens, many of which are exotic (alien); and a variety of edge effects. Roads themselves essentially preempt wildlife habitat. Road construction or improvement also kills animals and plants directly, and may limit long-term site productivity of roadsides by exposing low nutrient subsoils, reducing soil water holding capacity, and compacting surface materials (Noss 1996).

Some species thrive on roadsides, but most of these are weedy species. In the Great Basin, rabbitbrush is usually more abundant and vigorous along hard-surfaced roads than anywhere else, because it takes advantage of the runoff water channeled to the shoulders. Many of the weedy plants that dominate and disperse along roadsides are non-native. In some cases, these species spread from roadsides into adjacent native communities. In much of the west, spotted knapweed has become a serious agricultural pest. This Eurasian weed invades native communities from roadsides (Noss 1996).

1.3.1 General effects of roads

Trombulak and Frisell (2000) identified seven general effects of roads. Some of these include modified animal behavior, such as altered reproductive rates and displacement, changes in physical geography, such as changes in surface runoff, erosion and sedimentation which effect aquatic and terrestrial animals, changes in populations due to direct kills, the spread of exotic species and increases in human ecological impacts.

Effects of roads can be immediate and localized or long-term and geographically widespread. Roads negatively impact a wide-variety of species but these impacts may not be noticed for eight to thirty years after the road has been built (Findlay and Bourdages 2000, Findlay and Houlahan 1997). In the long-term, roads tend to favor some species and discourage others, which can lead to a changes in species composition of ecosystems (Forman and Alexander 1998). Intricately connected to roads are the vehicles that travel them. Noise from vehicles has been shown to disturb wildlife, leading to relocation of wildlife populations (U.S. EPA 1971).

Roads often facilitate the dispersal of exotic species. Forcella and Harvey (1983) surveyed exotic species in Montana and related their abundance to frequency of road use. Parendes and Jones (2000) describe similar results, showing a higher abundance of exotic species along high and low use roads than abandoned roads. Many species such as spotted knapweed not only take advantage of the disturbed ground found alongside roadways, but are also dispersed by tires, mud and crevices in the undercarriage of vehicles (Marcus et al. 1998). Roads also affect the distribution and occurrence of insect species such as gypsy moths and tent caterpillars (Bellinger et al. 1989).

Roads impact wildlife in a variety of ways. Animals die in collisions with vehicles, change behavior to avoid disturbance, possibly abandoning preferred habitats. Roads spread noxious weeds, which displace native forage. Roads consume land so there is less range for animals to use. Roads also fragment habitat by breaking it up into smaller and smaller units of secure habitat (Thomson et al 2005).

To summarize from Trombulak and Frissell (2000), roads cause the following impacts:

Mortality from road construction. The actual construction of a road, from clearing to paving, will often result in the death of any sessile or slow-moving organisms in the path of the road. Obviously, vegetation will be removed, as well as any organisms living in that vegetation.

Mortality from collisions with vehicles. Road kill is the greatest directly human-caused source of wildlife mortality throughout the U.S. More than a million vertebrates are killed on our roadways every day.

Modification of animal behavior. The presence of a road may cause wildlife to shift home ranges, and alter their movement pattern, reproductive behavior, escape response and physiological state. When roads act as barriers to movement, they also bar gene flow where individuals are reluctant to cross for breeding.

Alteration of the physical environment. A road transforms the physical conditions on and adjacent to it, creating edge effects with consequences that extend beyond the white lines. Roads alter the following physical characteristics of the environment:
- Soil density - Soil becomes compacted and remains so long after a road is in use.
- Soil water content - Porosity of soil is reduced, allowing for less absorption of water.
- Dust - Passing cars will stir up dust from the road. Dust will settle on nearby plants, blocking photosynthesis. Amphibians are also affected by traffic dust.
- Pattern of run-off - Roads are often built with parallel ditching, which diverts rainwater run-off along roadways, rather than the natural flow pattern.

Alteration of the chemical environment. Maintenance and use of roads contribute at least five different general classes of chemicals to the environment:
- Heavy metals - gasoline additives.
- Salt - de-icing.
- Organic molecules - dioxins, hydrocarbons.
- Ozone - produced by vehicles.
- Nutrients – nitrogen.

Spread of exotics. Roads provide opportunities for invasive species by:
- providing habitat by altering conditions;
- stressing or removing native species; and
- allowing easier movement by wild or human vectors.

Increased use of areas by humans. Roads facilitate increased human access to formerly remote areas. In addition to the disturbance and pollution often associated with roads, roads increase the likelihood of additional, unplanned activities in the area.

Increased potential for additional development. Building and improving roads on the INL can provide a conduit for additional development along this new corridor increasing the impacts associated with habitat fragmentation, transportation, and facility development. Increased development also amplifies all aspects of human activity providing an additional source of adverse impacts to habitat, plants and wildlife.

1.3.2 Effects of roads on individual species

While the effects of roads and vehicles are wide-ranging, many of the scientific studies conducted have dealt with their effects on single populations. The effects of roads on wildlife range from extremely detrimental to neutral to beneficial.

Ungulates have varying levels of tolerance to roads. While elk and deer can adapt fairly well to busy highways, roads with continuous, slow moving traffic caused displacement and changes in range use (Burbridge and Neff 1976, Gruell et al. 1976, Edge and Marcum 1991). While larger animals tend to be displaced by roads, smaller animals tend to suffer different effects. Because smaller animals are less noticeable and slower-moving, direct kills from motorized vehicles are extremely common. For example, kills of desert tortoises and rattlesnakes by motorized vehicles are significant (Bury 1978, Berish 1998). In addition, even small roads block movement of small animals and populations are more easily cut off from each other (herpetofauna- DeMaynadier and Hunter 2000, DeMaynadier and Hunter 1995; small rodents- Oxley, et al. 1974, Wilkins 1982).

Birds are often used as indicators of ecological health due to the prominence of population records. Many studies have linked declines in bird populations to habitat fragmentation caused by roads (Keyser et al 1997, Jones et al. 2000, Boren et al 1999). Roads displace certain species of birds while attracting others (Kuitunen et al. 1998). For example, raptors may benefit from roads as they provide good hunting habitat (Dijak and Thompson 2000).

Some effects of roads such as soil compaction, changes in composition due to imported road surfaces, disturbed ground, and exhaust emissions and dustings greatly affect soil organisms. Haskell (2000) examined the occurrence of macroinvertebrates essential to soil nutrition processes and found them to decrease in areas adjacent to roads.

Mychorrhizae and other soil organisms eliminated through soil compaction are essential for protection against pathogens, and nutrient and water uptake (Amaranthus and Perry 1994). Changes at the soil community level are extremely important because they cause changes in essential processes that can propagate throughout an ecosystem, eventually altering other animal and plant communities. For example, changes in soil compaction, composition and soil flora and fauna have been shown to contribute to the alteration of plant communities alongside roads (Angold 1997, Sharifi et al. 1999, Adams et al. 1982).

1.3.3 Effects of roads on abiotic functioning of ecosystems

As noted above, roads can significantly affect abiotic processes in ecosystems. Roads can cause changes to soil structure, aridity, erosion, and hydrology. Road construction often results in an increase in surface water flows that can lead to erosion of soil surfaces (Harr et al. 1975, Jones et al. 2000, Jones and Grant 1996).

1.4 Survey Methods

Two approaches to surveying the project areas were employed. On the areas where direct disturbance is expected (upgrading roads, constructing new roads and laydown areas and the Test Bed itself), more intensive surveys were conducted. For the road corridors the routes were divided into 400 m (0.25 mi.) segments. Within each segment, we surveyed a band centered on the road to about 5 m (15 ft.) either side of the road centerline. At the end of each segment, we surveyed a 1000 m^2 (~0.25 acre) circular plot to determine vegetation community classes. At the Test Bed itself, the intensive survey area included the 137 m (450 ft) radius area that will be disturbed and an additional 61 m (200 ft) radius. In this area we surveyed transects with individuals spread about 5 m (16.4 ft.) apart.

We conducted a more generalized survey of an area 3.2 km (2 mi.) in radius centered on the Test Bed. These surveys were guided by reviewing aerial photos, topographic maps and previously collected data to determine areas that might contain habitat for sensitive species. Figure 2 shows the GPS track logs for those surveys.

2.0 Affected Environment

2.1 Plant Communities – R&D Range

Two distinct vegetation community types occur around the proposed R&D Range. One plant community type occurs on basalt outcroppings and in the shallow soils on ridges immediately adjacent to those outcroppings. The second plant community type occurs in the deep well-drained sandy soils in the basins and bowls around the basalt outcroppings. Additionally, nearly half of the two-mile radius survey area and nearly all of the intensive survey area burned in a 1999 wildfire; thus each of the vegetation communities are present in burned and unburned condition.

The vegetation communities of the burned portion of proposed test area are characteristic of excellent condition sagebrush steppe subsequent to wildland fire. The communities are dominated by native perennial grasses with abundant native perennial and annual forbs. Some resprouting shrubs are also present within the vegetation communities. Data from a recent fire ecology study in the area indicate that the cover and density of native grasses and forbs are similar to other burns of the same age and are similar to cover and density of those species in unburned areas on the same soil type (R.D. Blew unpublished data). Table 1 includes species density data for a fire recovery plot located 1.8 km (1.1 miles) from the Test Bed.

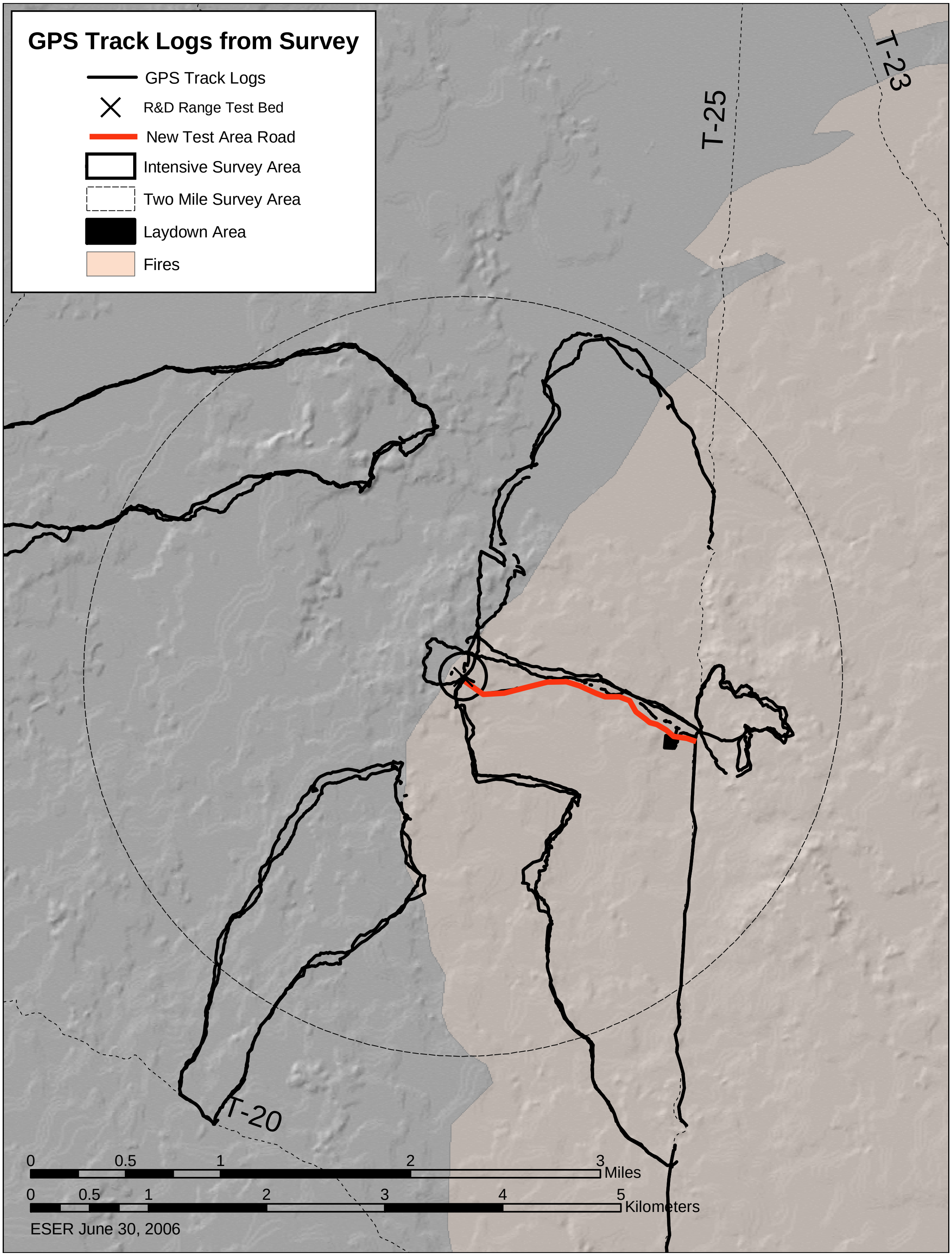


Figure 2. GPS tracklogs showing area surveyed for this evaluation.

Table 1. Plant densities (number of individuals per m^2) measured in 2003.

Native	
Shrubs	
Chrysothamnus viscidiflorus	0.3
Perennial Graminoids	
Achnatherum hymenoides	1.1
Elymus lanceolatus	26.2
Hesperostipa comata	3.7
Poa secunda	3.6
Perennial Forbs	
Crepis acuminata	0.4
Oenothera pallida	0.2
Phlox hoodii	0.1
Stephanomeria spinosa	0.5
Annual Forbs	
Descurainia pinnata	1.1
Introduced	
Annual Graminoids	
Bromus tectorum	0.3

In the burned area of the proposed test area, native perennial grasses that dominate the plant community on the ridges adjacent to basalt outcroppings include needle-and-thread grass (*Hesperostipa comata*), and Indian ricegrass (*Achnatherum hymenoides*). Sandberg bluegrass (*Poa secunda*) and bottlebrush squirreltail (*Elymus elymoides*) are also present in shallow soils on the ridges. Common perennial forbs on the basalt outcropping and on the adjacent ridges include; ballhead ipomopsis (*Ipomopsis congesta*), turpentine wavewing (*Pteryxia terebinthina*), and cushion buckwheat (*Eriogonum ovalifolium*). Native annual forbs common in this community type include nodding buckwheat (*Eriogonum cernuum*), flatspine stickseed (*Lappula occidentalis*), and Pinyon Desert cryptantha (*Cryptantha scoparia*). Broom snakeweed (*Gutierrez sarothrae*) and dwarf goldenbush (*Ericameria nana*) are abundant shrubs on outcroppings in this vegetation community, and green rabbitbrush (*Chrysothamnus viscidiflorus*) and gray horsebrush (*Tetradymia canescens*) are resprouting shrubs that occasionally occur along the ridges. Two species of non-native, weedy species, cheatgrass (*Bromus tectorum*) and musk thistle (*Carduus nutans*) also occur on the basalt outcroppings; cheatgrass can become quite abundant on some outcroppings.

The deep, sandy soils of the basins and bowls in the burned area are dominated by needle-and-thread grass, and thickspike wheatgrass (*Elymus lanceolatus*). Patches of Douglas' sedge (*Carex douglasii*) also occur occasionally throughout this community type. This plant community has a very high diversity of native perennial forbs. Abundant perennial forb species include; painted milkvetch (*Astragalus ceramicus*), lemon scurfpea (*Psoralidium lanceolatum*), sand dock (*Rumex venosus*), fernleaf biscuitroot (*Lomatium dissectum*), thorn skeletonweed (*Stephanomeria spinosa*), pale evening primrose (*Oenothera pallida*), and tapertip hawksbeard (*Crepis acuminata*). However, many additional forb species occur regularly and may be locally abundant. Introduced species are relatively rare in this plant community and occur only occasionally. Introduced species include Russian thistle (*Salsola kali*) and desert alyssum (*Alyssum desertorum*).

An extensive, but not exhaustive, species list including species from both community types in the burned and unburned areas can be seen in Table 2.

Table 2. Plant species list for the R&D Range. Data were collected in 2003 and 2005.

Current Scientific Name	Common Name	Family	Nativity	Duration	Growth Habit
Achnatherum hymenoides	Indian ricegrass	Poaceae	Native	Perennial	Graminoid
Agropyron cristatum	crested wheatgrass	Poaceae	Introduced	Perennial	Graminoid
Allium textile	textile onion	Liliaceae	Native	Perennial	Forb
Alyssum desertorum	desert alyssum	Brassicaceae	Introduced	Annual	Forb
Arenaria franklinii	Franklin's sandwort	Caryophyllaceae	Native	Perennial	Forb
Artemisia tridentata ssp. *tridentata*	basin big sagebrush	Asteraceae	Native	Perennial	Shrub
Astragalus calycosus	Torrey's milkvetch	Fabaceae	Native	Perennial	Forb
Astragalus ceramicus	painted milkvetch	Fabaceae	Native	Perennial	Forb
Astragalus filipes	basalt milkvetch	Fabaceae	Native	Perennial	Forb
Astragalus geyeri	Geyer's milkvetch	Fabaceae	Native	Annual	Forb
Astragalus lentiginosus	freckled milkvetch	Fabaceae	Native	Perennial	Forb
Bromus tectorum	cheatgrass	Poaceae	Introduced	Annual	Graminoid
Calochortus bruneaunis	Bruneau mariposa lily	Liliaceae	Native	Perennial	Forb
Carduus nutans	musk thistle	Asteraceae	Introduced	Perennial	Forb
Carex douglasii	Douglas' sedge	Cyperaceae	Native	Perennial	Graminoid
Castilleja angustifolia	Indian paintbrush	Scrophulariaceae	Native	Perennial	Forb
Chaenactis douglasii	Douglas' dustymaiden	Asteraceae	Native	Biennial	Forb
Chenopodium leptophyllum	narrowleaf goosefoot	Chenopodiaceae	Native	Annual	Forb
Chrysothamnus viscidiflorus	green rabbitbrush	Asteraceae	Native	Perennial	Shrub
Crepis acuminata	tapertip hawksbeard	Asteraceae	Native	Perennial	Forb
Cryptantha scoparia	desert cryptantha	Boraginaceae	Native	Annual	Forb
Delphinium andersonii	Anderson's larkspur	Ranunculaceae	Native	Perennial	Forb
Descurainia pinnata	western tansymustard	Brassicaceae	Native	Annual	Forb
Descurainia sophia	herb sophia	Brassicaceae	Introduced	Annual	Forb
Elymus elymoides	bottlebrush squirreltail	Poaceae	Native	Perennial	Graminoid
Elymus lanceolatus	streambank wheatgrass	Poaceae	Native	Perennial	Graminoid
Eriastrum wilcoxii	Wilcox's woollystar	Polemoniaceae	Native	Annual	Forb
Ericameria nana	dwarf goldenbush	Asteraceae	Native	Perennial	Shrub
Ericameria nauseosus	rubber rabbitbrush	Asteraceae	Native	Perennial	Shrub
Erigeron pumilus	shaggy fleabane	Asteraceae	Native	Perennial	Forb
Eriogonum cernuum	nodding buckwheat	Polygonaceae	Native	Annual	Forb
Eriogonum microthecum	slender buckwheat	Polygonaceae	Native	Perennial	Shrub
Eriogonum ovalifolium	cushion buckwheat	Polygonaceae	Native	Perennial	Forb
Gayophytum diffusum	spreading groundsmoke	Onagraceae	Native	Annual	Forb
Gayophytum ramosissimum	pinyon groundsmoke	Onagraceae	Native	Annual	Forb
Gilia leptomeria	sand gilia	Polemoniaceae	Native	Annual	Forb
Gutierrezia sarothrae	broom snakeweed	Asteraceae	Native	Perennial	Shrub
Hesperostipa comata	needle and thread grass	Poaceae	Native	Perennial	Graminoid
Ipomopsis congesta	ballhead ipomopsis	Polemoniaceae	Native	Perennial	Forb

Table 2. Plant species list for the R&D Range. Data were collected in 2003 and 2005. (continued)

Current Scientific Name	Common Name	Family	Nativity	Duration	Growth Habit
Iva axillaris	povertyweed	Asteraceae	Native	Perennial	Forb
Krascheninnikovia lanata	winterfat	Chenopodiaceae	Native	Perennial	Shrub
Langloisia setosissima	Great Basin langloisia	Polemoniaceae	Native	Annual	Forb
Lappula occidentalis	flatspine stickseed	Boraginaceae	Native	Annual	Forb
Leptodactylon pungens	prickly phlox	Polemoniaceae	Native	Perennial	Shrub
Leymus cinerus	basin wildrye	Poaceae	Native	Perennial	Graminoid
Lomatium dissectum	fernleaf biscuitroot	Apiaceae	Native	Perennial	Forb
Lupinus pusillus	rusty lupine	Fabaceae	Native	Annual	Forb
Lygodesmia grandiflora	largeflower skeletonplant	Asteraceae	Native	Perennial	Forb
Machaeranthera canescens	hoary aster	Asteraceae	Native	Perennial	Forb
Mentzelia albicaulis	whitestem blazingstar	Loasaceae	Native	Annual	Forb
Oenothera caespitosa	tufted evening-primrose	Onagraceae	Native	Perennial	Forb
Oenothera pallida	pale evening-primrose	Onagraceae	Native	Perennial	Forb
Opuntia polyacantha	pricklypear	Cactaceae	Native	Perennial	Shrub
Phacelia hastata	silverleaf phacelia	Hydrophyllaceae	Native	Perennial	Forb
Poa secunda	Sandberg bluegrass	Poaceae	Native	Perennial	Graminoid
Phlox hoodii	Hood's phlox	Polemoniaceae	Native	Perennial	Forb
Psoralidium lanceolatum	lemon scurfpea	Fabaceae	Native	Perennial	Forb
Pteryxia terebinthina	turpentine wavewing	Apiaceae	Native	Perennial	Forb
Rumex venosus	wild begonia	Polygonaceae	Native	Perennial	Forb
Salsola kali	Russian thistle	Chenopodiaceae	Introduced	Annual	Forb
Schoenocrambe linifolia	flaxleaf plainsmustard	Brassicaceae	Native	Perennial	Forb
Sisymbrium altissimum	tall tumblemustard	Brassicaceae	Introduced	Annual	Forb
Sphaeralcea munroana	white-stemmed globe-mallow	Malvaceae	Native	Perennial	Forb
Stanleya viridiflora	green princesplume	Brassicaceae	Native	Perennial	Forb
Stephanomeria spinosa	thorn skeletonweed	Asteraceae	Native	Perennial	Forb
Tetradymia canescens	spineless horsebrush	Asteraceae	Native	Perennial	Shrub
Thelypodium laciniatum	cutleaf thelypody	Brassicaceae	Native	Biennial	Forb
Tragopogon dubius	yellow salsify	Asteraceae	Introduced	Biennial	Forb

2.2 *Plant Communities – Road Upgrade*

Plant community descriptions for this ecological review of road upgrades were derived primarily from three sources that describe distinct community types encompassed within the larger, more general sagebrush steppe ecosystem on the INL. The references used to describe vegetation classes within the affected environment include the *INEEL Sagebrush Steppe Ecosystem Reserve Management Plan* (BLM 2003), *Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory* by Anderson et al. (1996), and *Vegetation Types and Surface Soils of the Idaho National Engineering Laboratory Site* by McBride et al. (1978). Plant community descriptions from the sources listed above were tailored to the vegetation communities that may be affected.

Vegetation plots were sampled approximately every 400 m (1300 ft.) along T-25 and the proposed test area access road. Plots were located on the east side of T-25 and in the center of the proposed access road, with the closest edge of the plot about 10 m from the road. One thousand square meters (0.25 acres) were surveyed in each circular plot for a complete species list and a rank of each species' importance within the plant community. The species ranking system used for this survey is shown in Table 3.

Table 3. Ranking system used for vegetation plot surveys.

Rank	Description
1	Dominant or co-dominant.
2	Abundant; comprising a substantial portion of live plant cover, but not dominant.
3	Common; easily found but not contributing a large portion of plant cover.
4	Rare, only a few individuals found within the plot.

A complete list of the species encountered within the plots surveyed along the roads can be found in Appendix A. Species nomenclature follows the National PLANTS Database (USDA – NRCS 2005).

The 32 vegetation plots sampled along the proposed routes were representative of six of the vegetation classes previously described on the INL. Each of the six vegetation classes is described below and includes characteristics specific to T-25 and the proposed access road.

Sagebrush Steppe. Sagebrush steppe communities in the area surveyed for the roads are generally dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*); however, they are occasionally dominated by Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), and may even be co-dominated by both subspecies. Communities dominated by Basin big sagebrush often occur as patches within extensive stands of Wyoming big sagebrush. The distribution and abundance of these two subspecies is related to soil depth and texture. Basin big sagebrush tends to dominate on deep, well drained, sandy soils, such as soils found on the lee side of lava ridges where sand accumulates. Conversely, Wyoming big sagebrush tends to dominate on fine-textured shallow soils. Native perennial grasses are typically more abundant in the understory of communities dominated by Wyoming big sagebrush than they are in the understory of communities dominated by Basin big sagebrush. Cheatgrass (*Bromus tectorum*) may be common in the understory of Basin big sagebrush stands, but tends to be quite rare in the understory of Wyoming big sagebrush stands. Aside from differences in grass abundance, communities dominated by either subspecies of big sagebrush can have similar understory species compositions. Common understory grasses include needle-and-thread grass (Hesperostipa comata), bottlebrush squirreltail (*Elymus elymoides*), Sandberg bluegrass (*Poa secunda*), thick-spiked wheatgrass (*Elymus lanceolatus*), and Indian ricegrass (*Achnatherum hymenoides*). Green rabbitbrush (*Chrysothamnus viscidiflorus*), prickly phlox (*Leptodactylon pungens*), spineless horsebrush (*Tetradymia canescens*), and spiny hopsage (*Grayia spinosa*) are frequently occurring shrubs within the sagebrush steppe community type. Broom snakeweed (*Gutierrezia sarothrae*) and dwarf goldenbush (*Ericameria nana*) are locally abundant on basalt outcroppings. Pricklypear (*Opuntia polyacantha*) may be locally abundant, and common forbs include Hood's phlox (*Phlox hoodii*), Douglas' dustymaiden (*Chaenactis douglasii*), tapertip hawksbeard (*Crepis acuminata*), freckled milkvetch (*Astragalus lentiginosus*), fernleaf biscuitroot (*Lomatium dissectum*), and hoary aster (*Machaeranthera canescens*).

Sagebrush/Rabbitbrush. Co-dominated by green rabbitbrush and Wyoming big sagebrush, these communities can have a species rich understory of perennial grasses and forbs. Winterfat (*Krascheninnikovia lanata*) occurs occasionally within this vegetation type, and spineless horsebrush occasionally becomes locally abundant. Common grasses in this community type include needle-and-thread grass, thick-spiked wheatgrass and bottlebrush squirreltail. Great Basin wildrye (*Leymus cinerus*) may be locally abundant, and Indian ricegrass occurs regularly, but usually in low densities. Forbs that frequently occur in sagebrush/rabbitbrush communities include Hood's phlox, ballhead gilia (*Ipomopsis congesta*), Wilcox's woollystar (*Eriastrum wilcoxii*), hoary aster, and Douglas' dustymaiden.

Rabbitbrush. Communities within this vegetation class are dominated by rabbitbrush and contain little, if any, sagebrush. Nearly all of the plots within this vegetation class have burned within the last ten years. Other resprouting shrubs such as winterfat and spineless horsebrush occur occasionally in this vegetation type. Bottlebrush squirreltail, Sandberg bluegrass, basin wildrye, needle-and-thread grass, and western wheatgrass (*Pascopyrum smithii*) occasionally co-dominated plots within this vegetation type. Forbs common to these communities include Hood's phlox, hoary aster, shaggy fleabane (*Erigeron pumilus*), Douglas' dustymaiden, tapertip hawksbeard, and ballhead gilia.

Native Grasslands. Communities within this vegetation class may vary considerably by species composition; however, they are all dominated by perennial grasses. Native grassland communities may be dominated by rhizomatous species, bunchgrasses, or a combination of both. Thick-spiked wheatgrass and western wheatgrass are common dominant rhizomatous species. Bunchgrass species that may dominant or co-dominate grasslands include needle-and-thread grass and Indian ricegrass. Additional grass species such as, bottlebrush squirreltail and Sandberg bluegrass are also abundant, but not dominant, in native grassland communities within the affected area. The grassland communities within the affected environment of the road upgrade proposed in this EA had burned within the last ten years. Unlike the native grassland communities across most of the site, the grassland communities along T-25 have a substantial amount of cheatgrass (*Bromus tectorum*), likely due to sandy soils and recent fires.

Shrubs often occur within grassland communities; however, shrub cover is generally sparse. Shrub species that frequently occur within this vegetation class include Wyoming big sagebrush, Basin big sagebrush, green rabbitbrush, and prickly phlox. Spineless horsebrush and shrubby buckwheat (*Eriogonum microthecum*) may also occur sporadically within grassland communities. Pricklypear is often locally abundant. Forbs that typically occur in grasslands include white-stemmed globe-mallow (S*phaeralcea munroana*), whitestem blazingstar (*Mentzelia albicaulis*), western tansymustard, and western stickseed (*Lappula occidentalis*).

Crested Wheatgrass. Crested wheatgrass (*Agropyron cristatum*) communities are strongly dominated by crested wheatgrass. The plot within the crested wheatgrass vegetation class is a result of crested wheatgrass invasion into other community types. Low species richness is a characteristic very typical of these communities. Green rabbitbrush and sagebrush may be locally abundant, but the presence of native grass species is rare. Forbs are generally restricted to weedy annuals such as, flatspine stickseed and desert cryptantha (*Cryptantha scoparia*). Native, perennial forbs that occasionally occur in low densities within this vegetation class include Hood's phlox and tapertip hawksbeard.

Annual/Playas/Disturbed Areas. These areas have experienced a great deal of past hydrologic disturbance due to flooding, soil disturbance associated with wild land fire control measures, or are areas adjacent to areas with substantial soil disturbance. Communities within this vegetation type are dominated by annual species including introduced species such as tall tumblemustard (*Sisymbrium altissimum*), herb sophia (*Descurainia sophia*), or cheatgrass. Cheatgrass dominated most of the plots within this vegetation type along the proposed access route. As with crested wheatgrass communities, this vegetation type is characterized by a lack of native grasses. However, these communities do tend to have a relatively diverse compliment of native forbs. Common native forbs in these communities include Douglas' dustymaiden, tapertip hawksbeard, and hoary aster. Low stature shrubs like prickly phlox and broom snakeweed may also be locally abundant in communities within this vegetation class.

The distribution of vegetation plots among vegetation classes for the proposed access route is shown in Table 4.

Table 4. The number of plots in each vegetation class.

Vegetation Classes	# of Plots
Sagebrush Steppe	3
Sagebrush/Rabbitbrush	1
Rabbitbrush	9
Native Grasslands	15
Crested Wheatgrass	1
Annuals/Playas/Disturbed Areas	3
Total	32

2.3 Soils

The soils in the area of the proposed test site are generally described as sands over basalt. Olson et al (1995) mapped the soils at the R&D Range as the Grassy Butte-Rock Outcrop Complex (Figure 3). This complex of soils includes a number of soil mapping units. Grassy Butte very stony loamy sand makes up about 30 % and the Rock Outcrop makes up about 20% of the area in this soil complex. The remaining 50 % of this soil complex

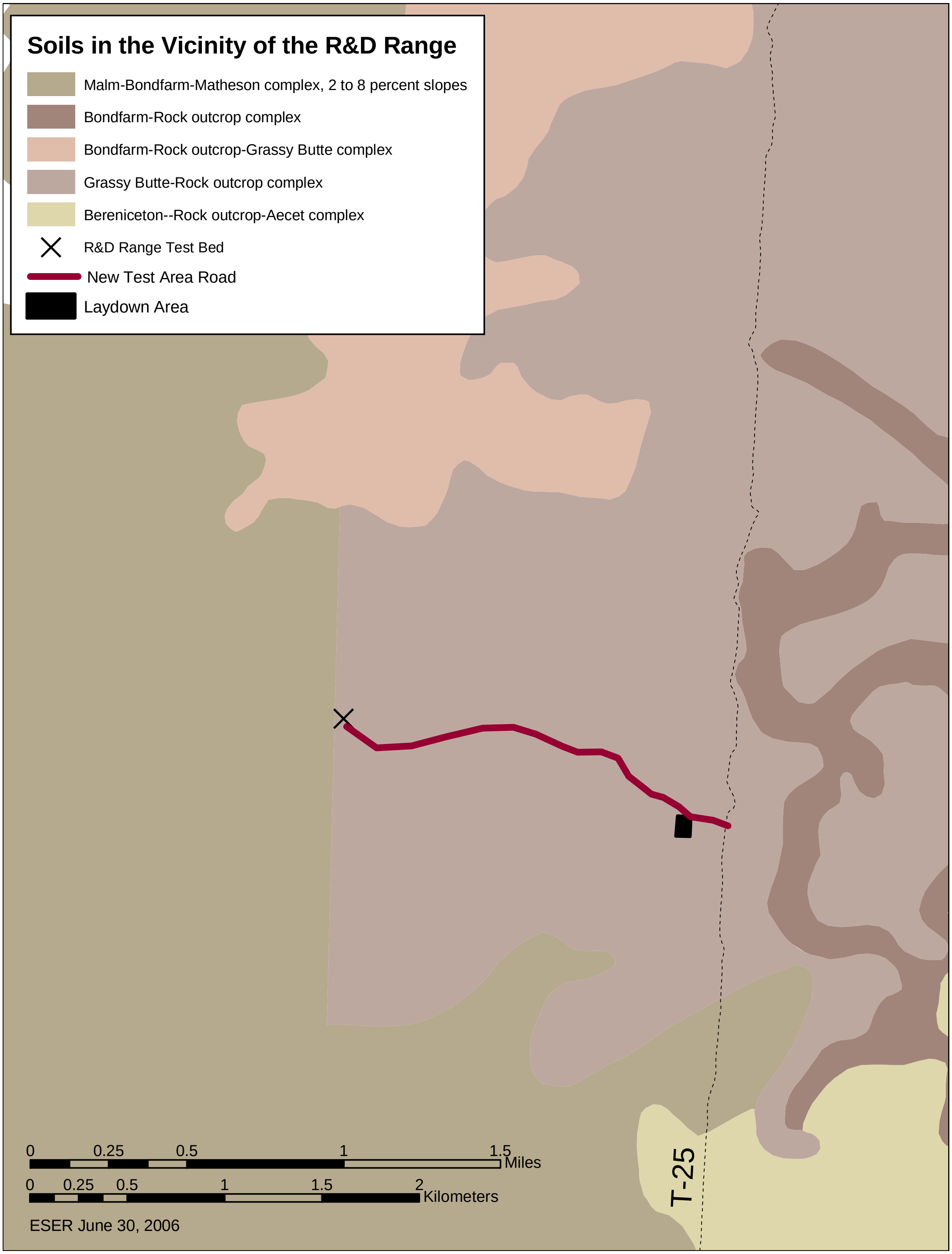


Figure 3. Soils in the vicinity of the R&D Range.

is made up of about equal parts of Grassy Butte 10 – 40 inches deep to bedrock, Grassy Butte 40 – 60 inches deep to bedrock, Matheson loamy sand, Bondfarm sandy loam, and Grassy Butte loamy sand. The soil at the Laydown area is most likely the Grassy Butte series. The new road likely intersects areas of Grassy Butte and Rock Outcrop. Based on topographic position, the Test Bed itself and much of the 200-m surrounding impacted area are likely Bondfarm sandy loam.

Both the Grassy Butte and the Bondfarm sandy loam have a very high hazard of soil blowing (wind erosion). The very high hazard of soil blowing imparts certain limitations to use of these soils (Olson et al, 1995). They are not suited to mechanical rangeland management treatments including seeding. These soils are classified as Land Capability Class VIIe and have very severe limitations that make them unsuitable for cultivation due to erosion. For example, the Grassy Butte soil may require that one-half of the area be replanted each year. This becomes important when considering restoration or long-term erosion control measures. Also, these soils have impaired trafficability (the capability of the terrain to bear traffic).

2.4 Invasive and Non-Native Species

A total of eleven Idaho Noxious Weeds have been identified on the INL. Of those, only musk thistle (*Carduus nutans*) and Canada thistle (*Cirsium arvense*) presently occur in the project area (Figure 4). In a literature survey, Pyke (1999) identified 46 exotic species that are weeds capable of invading sagebrush steppe ecosystems, with as many as 20 of these classed as highly invasive and competitive. Other significant non-native and/or invasive plants found on or near the proposed road corridors include cheatgrass, Russian thistle (*Salsola kali*), halogeton (*Halogeton glomeratus*), tumble mustard and crested wheatgrass.

Musk thistle and Canada thistle are both very common noxious weeds on the INL. Canada thistle appeared only once in the survey, along T-25. Canada thistle is extremely difficult to control in that it reproduces from both seed and rootstock (Sheley and Petroff 1999). Musk thistle is more readily controlled, but requires persistent management. Musk thistle was found within the intensive survey area at the Test Bed.

Non-native species also present a challenge in disturbed areas. They establish very quickly and successfully compete with the native species. Cheatgrass is present on most of the road segments and dominated in some areas along T-25. Figure 5 shows the relative abundance of cheatgrass in the vegetation plots surveyed along the proposed route and at the center point of the proposed Test Bed area. Halogeton is present on many of the road segments as well. These non-native annual species are very quick to colonize any new disturbance and are very difficult to eradicate once they are present. Most non-native annuals produce large amounts of seed every year and the seeds remain viable for long periods of time.

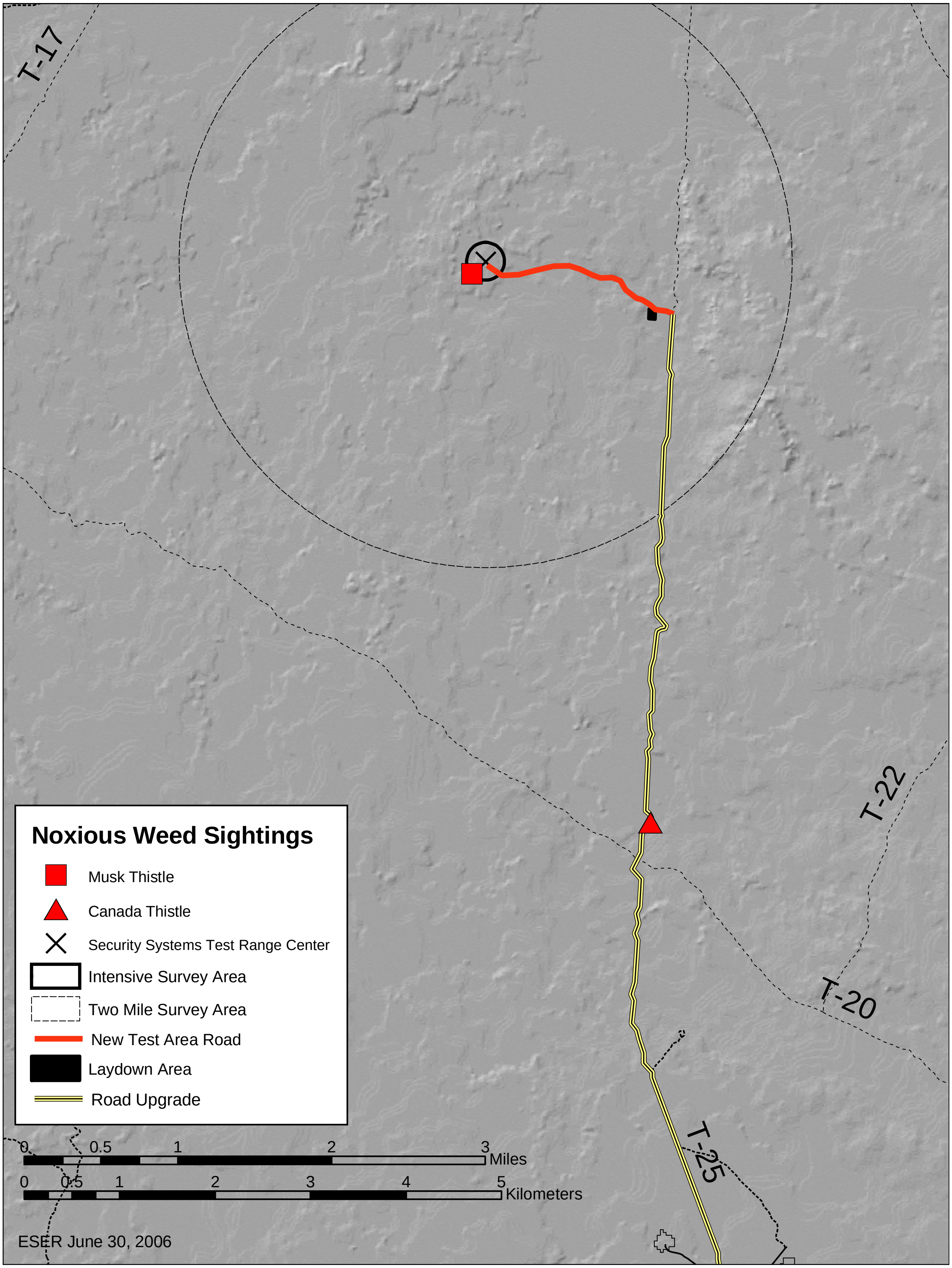


Figure 4. Noxious weed sightings in the proposed project area.

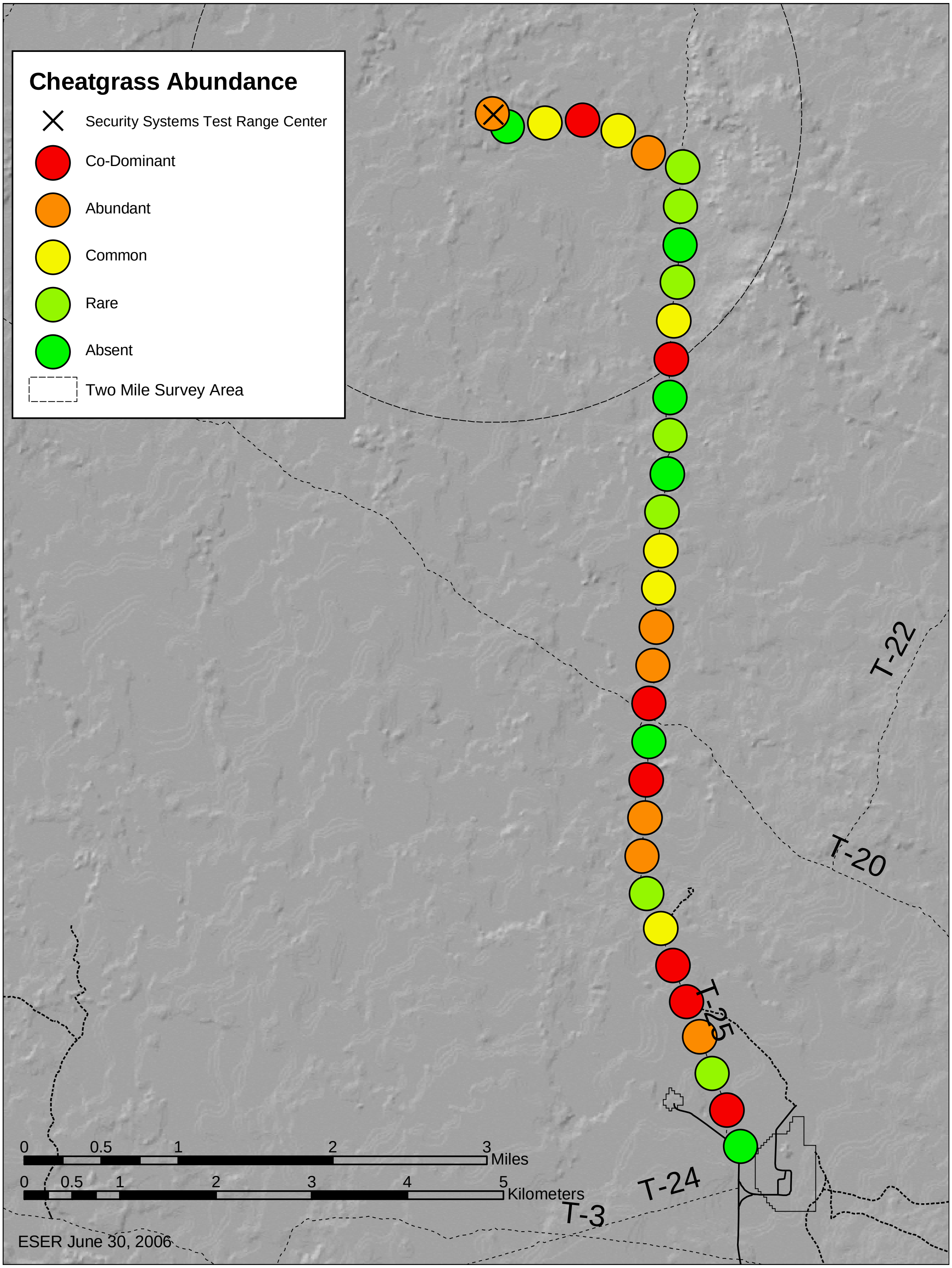


Figure 5. Relative abundance of cheatgrass (*Bromus tectorum*) in vegetation survey plots.

2.5 Sensitive Plant Species

A list of sensitive plant species that potentially occur within the area affected by the test range and the road upgrades was compiled using data from the Idaho CDC (2006). All sensitive species known to occur in Butte, Custer, Jefferson, Bonneville and Bingham counties were considered. Species with habitat requirements similar to the conditions occurring in and around the test area were included in Table 5. Sensitive species that were not included in Table 5 were discounted because the habitat around the test area was not suitable due to topography, soils, or climate. Table 5 lists sensitive plant species for which suitable habitat is present on or around the R&D Range.

Table 5. Sensitive species potentially occurring on or around the R&D Range and appropriate State of Idaho, U.S. Forest Service Region 4, and/or Bureau of Land Management Ranking.

Scientific Name	Common Name	State	USFS Reg. 4	BLM
Astragalus aquilonius	Lemhi milkvetch	GP3	S	TYPE 2
Astragalus ceramicus	painted milkvetch		W	
Astragalus diversifolius	meadow milkvetch	GP2	S	TYPE 3
Camissonia pterosperma	wing-seeded evening-primrose	S		TYPE 4
Eriogonum capistratum var. *welshii*	Welsh's buckwheat	GP2	S	TYPE 3
Ipomopsis polycladon	spreading gilia	2		TYPE 3
Silene scaposa var. *lobata*	Lost River silene	M		

Painted milkvetch (*Astragalus ceramicus*) is included in the quarterly list of species that U.S. Fish and Wildlife Service has requested INL to consider in project planning. This species was documented within the intensive survey area, within the 1.6 km (2 mi.) survey area, along a portion of T-25 that is proposed to be upgraded, and along the proposed test area access road (Figure 6). The last sensitive plant species survey conducted on the INL was completed over 25 years ago; thus, the current extent and status of painted milkvetch populations on the INL is unknown.

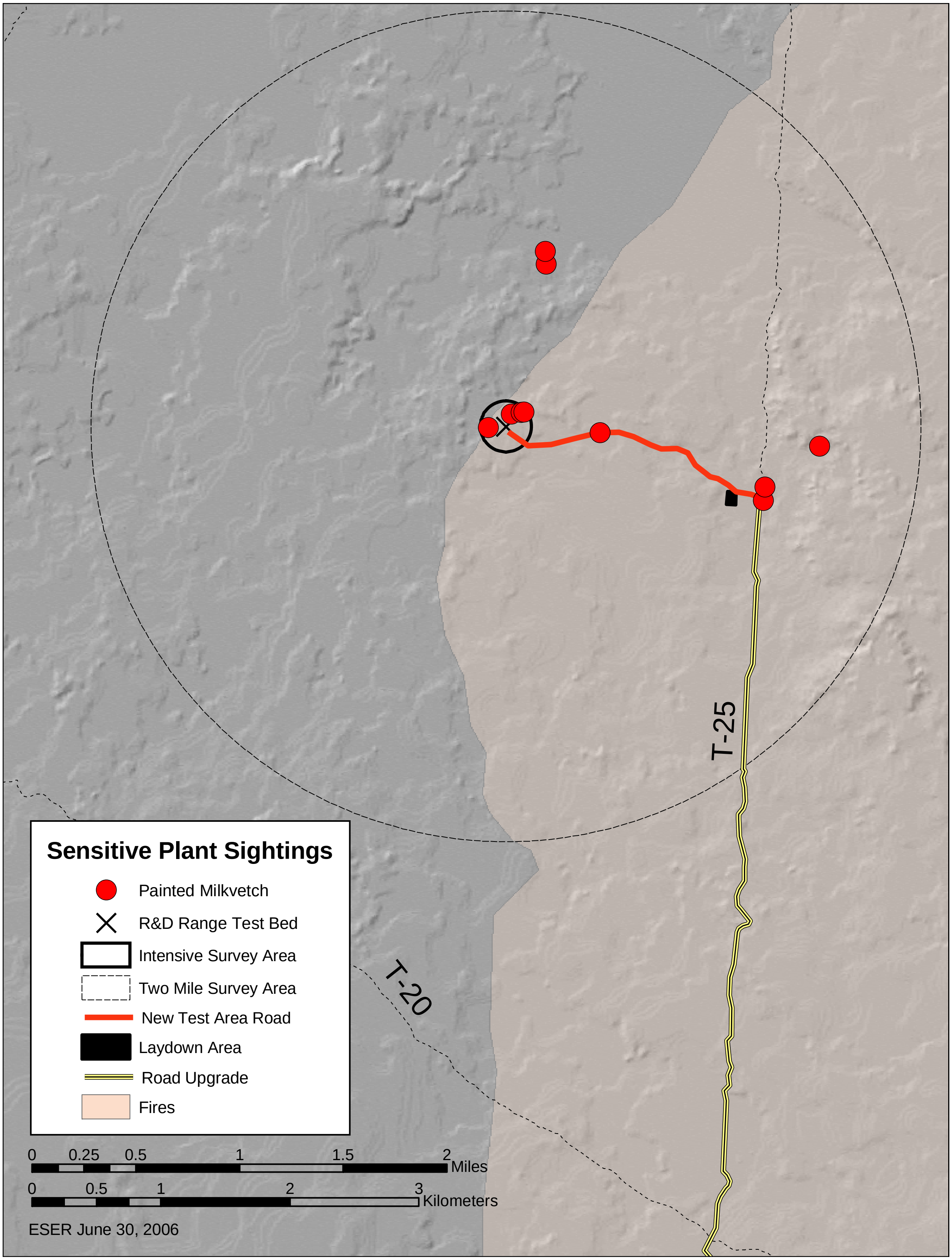


Figure 6. Sightings of painted milkvetch (*Astragalus ceramicus*) in the survey area.

2.6 Ethnobotany

Vegetation plot data collected along T-25 and the proposed access road were analyzed for the frequency of occurrence of several species of ethnobotanical concern. Additionally, a vegetation plot was surveyed in the proposed laydown area and a vegetation plot was surveyed at the center of the proposed test range. A list of species thought to be of historical importance to local tribes was compiled from *Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory* by Anderson et al. (1996). The list includes those species documented to have been used by "indigenous groups of the eastern Snake River Plain," (Anderson et al. 1996). Table 6 lists those species of ethnobotanical concern observed in the vegetation survey plots.

Table 6. List of species of ethnobotanical concern occurring on vegetation plots surveyed in the affected area of the proposed road upgrades.

Current Scientific Name	Common Name	Uses
Achnatherum hymenoides	Indian ricegrass	food
Allium textile	textile onion	food, medicine, flavoring, dye
Artemisia tridentata	big sagebrush	food, medicine, cordage, clothing, shelter, fuel, dye
Bromus tectorum	cheatgrass	food
Carex douglasii	Douglas' sedge	food, medicine
Chaenactis douglasii	Douglas' dustymaiden	food, medicine
Chenopodium fremontii	Fremont's goosefoot	food
Chenopodium leptophyllum	narrowleaf goosefoot	food
Chrysothamnus viscidiflorus	green rabbitbrush	medicine, gum
Crepis acuminata	tapertip hawksbeard	food
Delphinium andersonii	Anderson's larkspur	medicine, dye
Descurainia pinnata	western tansymustard	food, medicine
Descurainia sophia	herb sophia	food, medicine
Ericameria nauseosus	rubber rabbitbrush	medicine, gum
Elymus elymoides	bottlebrush squirreltail	food
Elymus lanceolatus	streambank wheatgrass	food
Eriogonum ovalifolium	cushion buckwheat	medicine
Erigeron pumilus	shaggy fleabane	medicine, arrow tip poison
Gutierrezia sarothrae	broom snakeweed	medicine
Hesperostipa comata	needle and thread grass	food
Lappula occidentalis	flatspine stickseed	food
Lactuca serriola	prickly lettuce	food, medicine
Lepidium perfoliatum	clasping pepperweed	food, medicine
Leymus cinerus	basin wildrye	food, manufacture
Lomatium dissectum	fernleaf biscuitroot	food, medicine
Lomatium foeniculaceum	desert biscuitroot	food, medicine
Lygodesmia grandiflora	largeflower skeletonplant	food, gum
Mentzelia albicaulis	whitestem blazingstar	food
Oenothera caespitosa	tufted evening-primrose	food, medicine

Table 6. List of species of ethnobotanical concern occurring on vegetation plots surveyed in the affected area of the proposed road upgrades. (continued)

Current Scientific Name	Common Name	Uses
Oenothera pallida	pale evening-primrose	food, medicine
Opuntia polyacantha	pricklypear	food
Packera cana	wooly groundsel	medicine, gum
Phacelia hastata	silverleaf phacelia	food
Poa secunda	Sandberg bluegrass	food, medicine
Pteryxia terebinthina	turpentine wavewing	food
Ranunculus glaberrimus	sagebrush buttercup	food, medicine
Rumex venosus	veiny dock	food, medicine
Salsola kali	Russian thistle	food
Sisymbrium altissimum	tall tumblemustard	food
Sphaeralcea munroana	white-stemmed globe-mallow	food, medicine, manufacture
Sporobolus cryptandrus	sand dropseed	food
Stephanomeria spinosa	thorn skeletonweed	food, gum
Taraxacum officinale	common dandelion	food, medicine
Tragopogon dubius	yellow salsify	food, medicine, gum

Twenty five species of ethnobotanical concern were documented in the vegetation survey plot at the center of the test area, and sixteen species were documented in the plot surveyed at the laydown area. With the exception of *Lygodesmia grandiflora*, most of the species found in the plots at the center point and laydown area are common across the INL. *Lygodesmia grandiflora* can be found elsewhere on the INL, but its populations are much more restricted in abundance and distribution than the other species of ethnobotanical concern found in those plots. The frequency of occurrence of species of ethnobotanical concern in the 32 plots surveyed along the proposed access route is shown in Table 7. As with the species of ethnobotanical concern found at the center point and laydown area, many of the species found in the survey plots along the road are commonly found and widely distributed across the INL. Species with relatively lower abundances and more restricted distributions, both along the route and across the INL include; *Allium textile*, *Carex douglasii*, *Delphinium andersonii*, *Lomatium foeniculaceum*, *Lygodesmia grandiflora*, *Oenothera pallida*, *Packera cana*, *Ranunculus glaberrimus*, *Sporobolus cryptandrus*, and *Stephanomeria spinosa*.

Table 7. Frequency of occurrence (as a percentage) of species of ethnobotanical interest in vegetation survey plot along T-25 and the proposed access road.

Current Scientific Name	Frequency
Achnatherum hymenoides	84.38
Allium textile	9.38
Artemisia tridentata	34.38
Bromus tectorum	81.25
Carex douglasii	3.13
Chaenactis douglasii	34.38
Chenopodium fremontii	3.13
Chenopodium leptophyllum	28.13

Table 7. Frequency of occurrence (as a percentage) of species of ethnobotanical interest in vegetation survey plot along T-25 and the proposed access road. (continued)

Current Scientific Name	Frequency
Chrysothamnus viscidiflorus	100.00
Crepis acuminata	75.00
Delphinium andersonii	9.38
Descurainia pinnata	43.75
Descurainia sophia	40.63
Ericameria nauseosus	15.63
Elymus elymoides	46.88
Elymus lanceolatus	65.63
Eriogonum ovalifolium	40.63
Erigeron pumilus	43.75
Gutierrezia sarothrae	28.13
Hesperostipa comata	78.13
Lappula occidentalis	68.75
Lactuca serriola	3.13
Lepidium perfoliatum	15.63
Leymus cinerus	25.00
Lomatium dissectum	37.50
Lomatium foeniculaceum	3.13
Lygodesmia grandiflora	6.25
Mentzelia albicaulis	62.50
Oenothera caespitosa	15.63
Oenothera pallida	18.75
Opuntia polyacantha	87.50
Packera cana	3.13
Phacelia hastata	34.38
Poa secunda	56.25
Pteryxia terebinthina	6.25
Ranunculus glaberrimus	3.13
Rumex venosus	9.38
Salsola kali	43.75
Sisymbrium altissimum	71.88
Sphaeralcea munroana	78.13
Sporobolus cryptandrus	3.13
Stephanomeria spinosa	18.75
Taraxacum officinale	3.13
Tragopogon dubius	25.00

2.7 Wildlife Use

Scientists on the INL have been collecting wildlife data for more than 30 years and have recorded a total of 219 vertebrate species (Reynolds et al. 1986) occurring on the INL, many of which are directly associated with sagebrush steppe habitat. After the fire that occurred during 1999 in the proposed project area, the habitat changed from a dominant sagebrush ecosystem to dominant grassland system which contained a scattering of sagebrush plants and lava outcroppings. This changed how wildlife utilizes the immediate area. Although species such as the pygmy rabbit (*Brachylagus idahoensis*), sage sparrow (*Amphispiza bilineata*), and Brewer's sparrow (*Spizella breweri*), which are basically dependent upon sagebrush, species that thrive in grasslands such as elk (*Cervus elaphus*), mountain cottontail (*Sylvilagus nuttallii*), horned larks (*Eremophila alpestris*), and vesper sparrows (*Pooecetes gramineus*), predominate. Sagebrush dependent species, such as the sage grouse, continue to flourish in the surrounding sagebrush areas and may occur in these adjacent grasslands.

Species that permanently reside in the proposed project area include small and medium sized mammals [e.g. bushy-tailed woodrat (*Neotoma cinerea*), Ord's kangaroo rat (*Dipodomys ordii*), black-tail jackrabbit (*Lepus californicus*), mountain cottontail, long-tailed weasel (*Mustela frenata*), badger (*Taxidea taxus*)], and reptiles [sagebrush lizard (*Sceloporus graciosus*) and gopher snake (*Pituophis catenifer*)]. These species have small home ranges, limited mobility, or a social structure that restricts movement.

The western rattlesnake (*Crotalus viridis*), gopher snake (*Pituophis catenifer*), northern sagebrush lizard (*Sceloporus graciosus graciosus*), short-horned lizard (*Phrynosoma douglasii*) were observed using rocky outcroppings that surround the proposed project area. Great Basin rattlesnakes are listed as protected non-game wildlife by the State of Idaho (Idaho CDC 2005). In addition, they also provide information on ecosystem health on the INL (Jenkins and Peterson In press). Great Basin rattlesnakes require winter habitats that allow them to go underground to depths below the frost line. On the INL these habitats are typically associated with volcanic features such as craters, cones, and lava tubes. The presence of rattlesnakes and gopher snakes suggests that a snake hibernaculum (wintering area) is present in the general area. Two species considered uncommon on the INL, leopard lizards (*Gambelia wislizenii*) and desert striped whipsnakes (*Masticophis taeniatus*) have only been found in this general area of the INL (Linder and Sehman 1978) and were not observed during our survey. All Idaho reptiles and amphibians (except bullfrog) are classified as protected non-game species. This designation is held at the state level to help protect populations (IDFG 2005).

Several species of small mammals were observed using the proposed project area. These include, black-tailed jackrabbit, mountain cottontail, Townsend's ground squirrel (*Spermophilus townsendii*), bushy-tailed woodrat, Ord's kangaroo rat, deer mouse (*Peromyscus maniculatus*), and montane vole (*Microtus montanus*). Although these species are not listed on any sensitive list, they do provide a food resource for many that are such as prairie falcon (*Falco mexicanus*), ferruginous hawk (*Buteo regalis*), bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*). These small mammal species also provide a major prey base for coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) using the proposed project area.

Many species use the proposed project area in a transitory manner. Species that use the area in this manner are in search of prey or forage, areas to reproduce, or shelter from the elements. All bird and big game species use the area in this manner. Although sage grouse primarily use sagebrush dominated areas, droppings observed in the surveyed area suggest that they frequent the proposed project area. Nests of sagebrush obligate birds located in the area include sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), and sage thrasher (*Oreoscoptes montanus*) (Figure 7). Other species of birds observed using the area include horned lark, western meadowlark (*Sturnella neglecta*), vesper sparrow, grasshopper sparrow (*Ammodramus savannarum*), loggerhead shrike (*Lanius ludovicianus*), rock wren (*Salpinctes obsoletus*), common nighthawk (*Chordeiles minor*), red-tailed hawk (*Buteo jamiacensis*), ferruginous hawk, prairie falcon, and common raven (*Corvus corax*), each of which are protected under the Migratory Bird Protection Act. Although ferruginous hawks were not observed nesting within 3.2 km (2 mi) of the proposed area they have been documented using nests that are currently occupied by red-tailed hawks (Figure 8). Unoccupied nests and use of nests by other raptor or corvid species does not eliminate nesting activity in future years by ferruginous hawks. Bald eagles have been observed using the general area during the winter and golden eagles have been observed using the area throughout the year.

Pygmy rabbits are sagebrush obligate species and have recently been petitioned for protection under the Endangered Species Act. Pygmy rabbits depend on sagebrush for cover and forage. Once sagebrush is removed from an area pygmy rabbits disappear (Green and Flinders 1980, Katzner et al 1997). Populations of pygmy rabbits on the INL may be relatively stable because much of the site remains undisturbed; however, little is currently known about the status of pygmy rabbit populations on the INL. Pygmy rabbit occurrence was assessed based on the presence of pygmy rabbit sign (i.e., sightings of rabbits, burrows, and/or scat) and the presence of suitable sagebrush habitats. Although our survey located only one potential pygmy rabbit site many more locations might exist since our surveys were not conducted under conditions conducive to observing pygmy rabbit sign. If a more accurate assessment of pygmy rabbit occurrence is desired, surveys should be conducted during the winter when there is adequate snow cover to allow for the identification of tracks.

Both elk and pronghorn (*Antilocapra americana*) were observed using the proposed project area during the survey. Big game surveys conducted every winter and summer indicate that all big game species use the proposed project area throughout the year (Figure 9). Elk and pronghorn benefit from fires due to the increased herbaceous vegetation production. A research study conducted on the INL (Comer 2000) found that elk used the general area that includes the proposed project area for calving purposes. Also, pronghorn have been observed using the area for fawning. The INL provides critical winter range for both elk and pronghorn with numbers reaching 1,000 and >3,000, respectively. It is estimated that more than 100 elk and approximately 500 pronghorn summer on the INL. Large herds numbering more than 130 individuals have been observed using the proposed project area during different times of the year.

Even though nocturnal species such as bats are difficult to locate during daytime surveys, past studies (Haymond 1998) indicate bats use the INL throughout the year. The western small-footed myotis (*Myotis ciliolabrum*) is considered the most abundant bat on the INL during the spring and summer roosting in sagebrush, junipers, buildings, and rocky outcroppings. Townsend's big eared bat (*Corynorhinus townsendii*), a BLM sensitive species (BLM 2003) has been documented roosting in caves and lava tubes throughout the INL (Earl and Morris 1995) as recently as 2003 (Earl 2003).

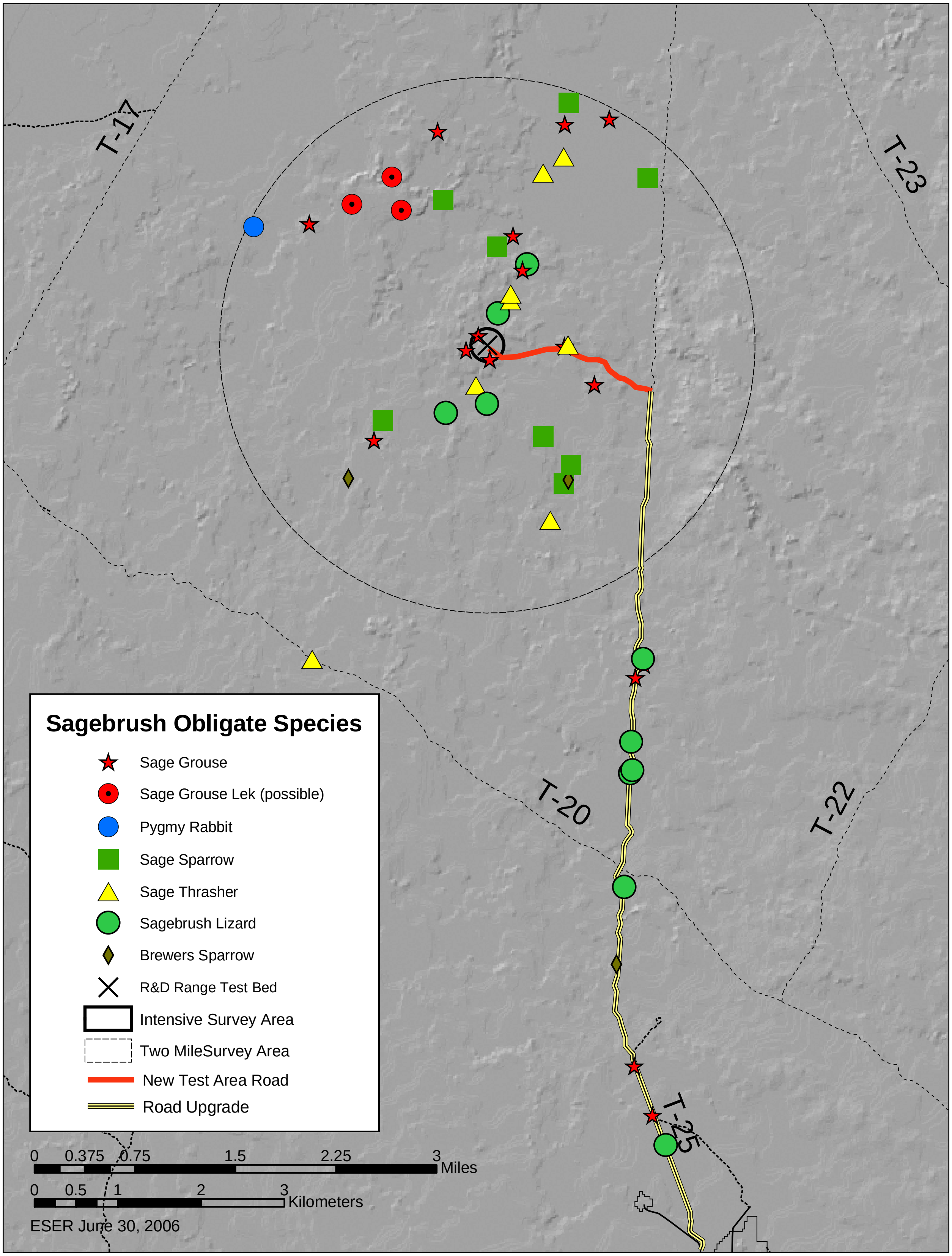


Figure 7. Sagebrush obligate species found at the R&D Range and access roads.

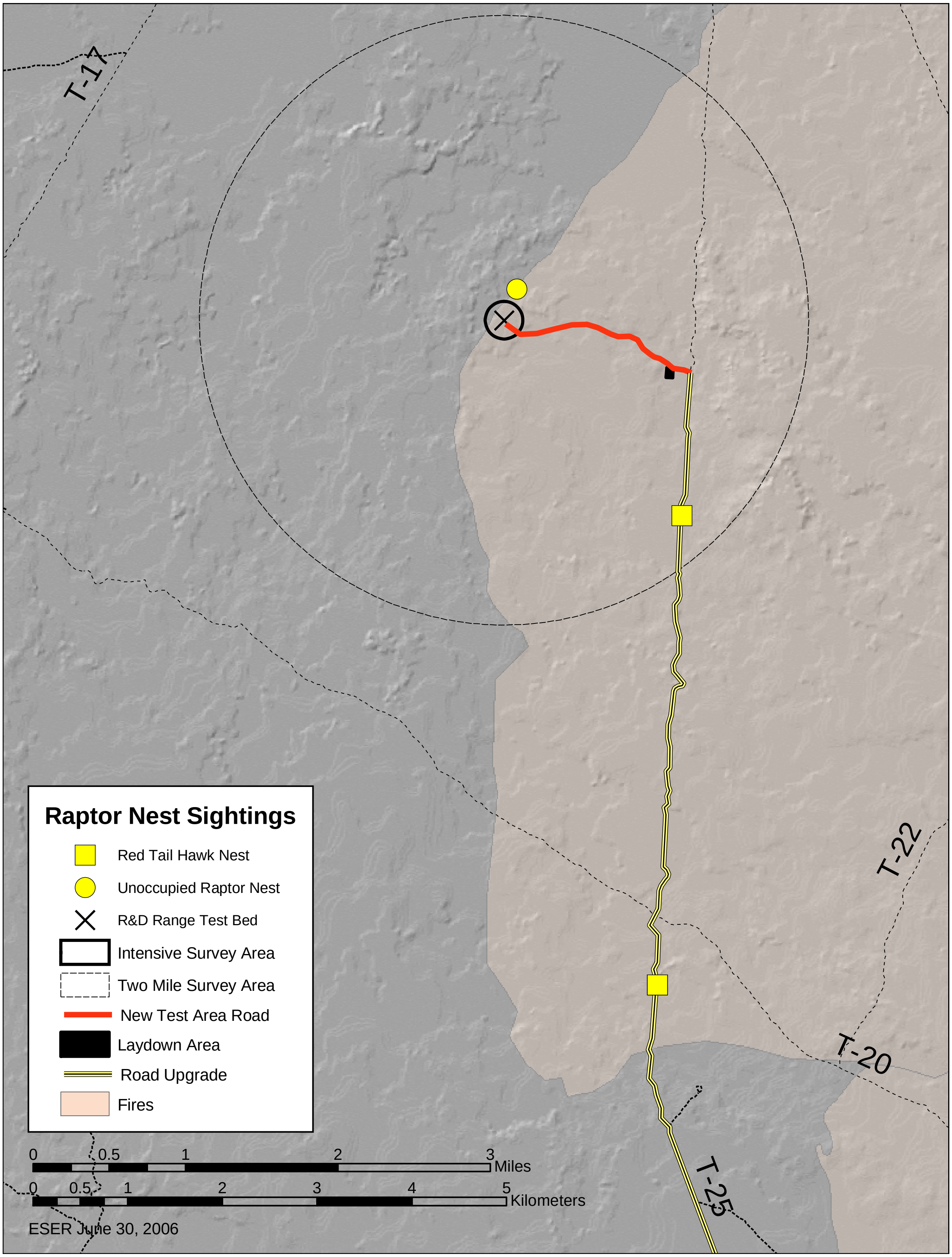


Figure 8. Raptor nests observed during the survey.

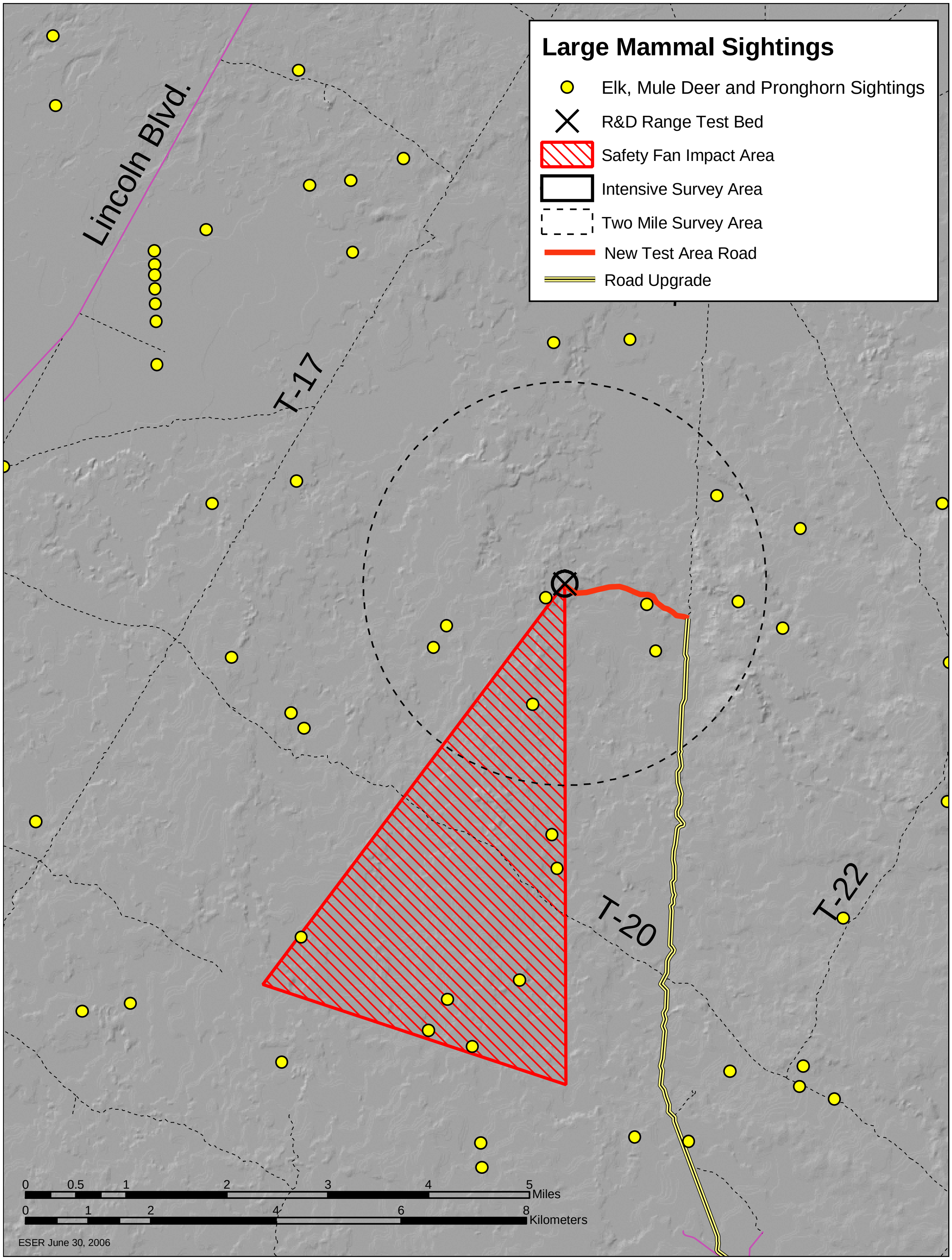


Figure 9. Large mammal sightings from aerial surveys 2003 through 2005.

2.8 National Environmental Research Park

The INL is also the site of the Idaho National Environmental Research Park (NERP). The NERP program was established by Congress in the early 1970s. The Idaho NERP was chartered in 1975. The National Environmental Research Parks are field laboratories set aside for ecological research, for study of the environmental impacts of energy developments, and for informing the public of the environmental and land-use options open to them. According to the NERP Charter, those goals have been articulated in the National Environmental Policy Act, the Energy Reorganization Act, the Department of Energy Organization Act, and the Non-nuclear Energy Research and Development Act. The public's concern about environmental quality was translated through NEPA into environmental goals and the NERP provides a land resource for the research needed to achieve those goals. The NERP Charter allows that while execution of the program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas must be given careful consideration in any site-use decisions.

The primary objectives for research on the NERP are to develop methods for assessing the environmental impact of energy development activities, to develop methods for predicting and mitigating those impacts. The NERP achieves these objectives by facilitating use of this outdoor laboratory by university and government researchers. Several research and monitoring projects have study sites in the vicinity of the proposed facility and roads (Figure 10).

The Long-Term Vegetation Transects (LTV) were established in 1950 and have been read on a regular basis since then. The data from these transects represents one of the longest rangeland vegetation databases in the western U.S. The plots are currently (2006) being surveyed. Several LTV plots are in the vicinity of the proposed road alternatives.

A recent research project studying vegetation recovery following wildland fire established plots near the proposed road corridors. The plots were established with the expectation of being used as a long-term monitoring plot for assessing vegetation recovery following fire. Some of these plots are very near T-25 north of MFC.

A new study just underway in 2006 to study the population biology of sagebrush has plots just within or on the periphery of the 8 km (5 mi.) exclusion area.

In 2004, researchers from Utah State University initiated a research project to study fine-scale movement patterns of coyotes. As part of this study, 30 adult coyotes were fitted with VHF telemetry radio collars. Some of these animals were also fitted with collars that record GPS locations. The home range of some of these animals includes the proposed test site. The eight-kilometer (five-mile) exclusion zone includes much of the general study area for that project.

In addition to the NERP activities described above, additional DOE-sponsored ecological monitoring is conducted near the proposed test site (Figure 10). Two Breeding Bird Survey routes on the INL are in the vicinity of the proposed project. One route follows

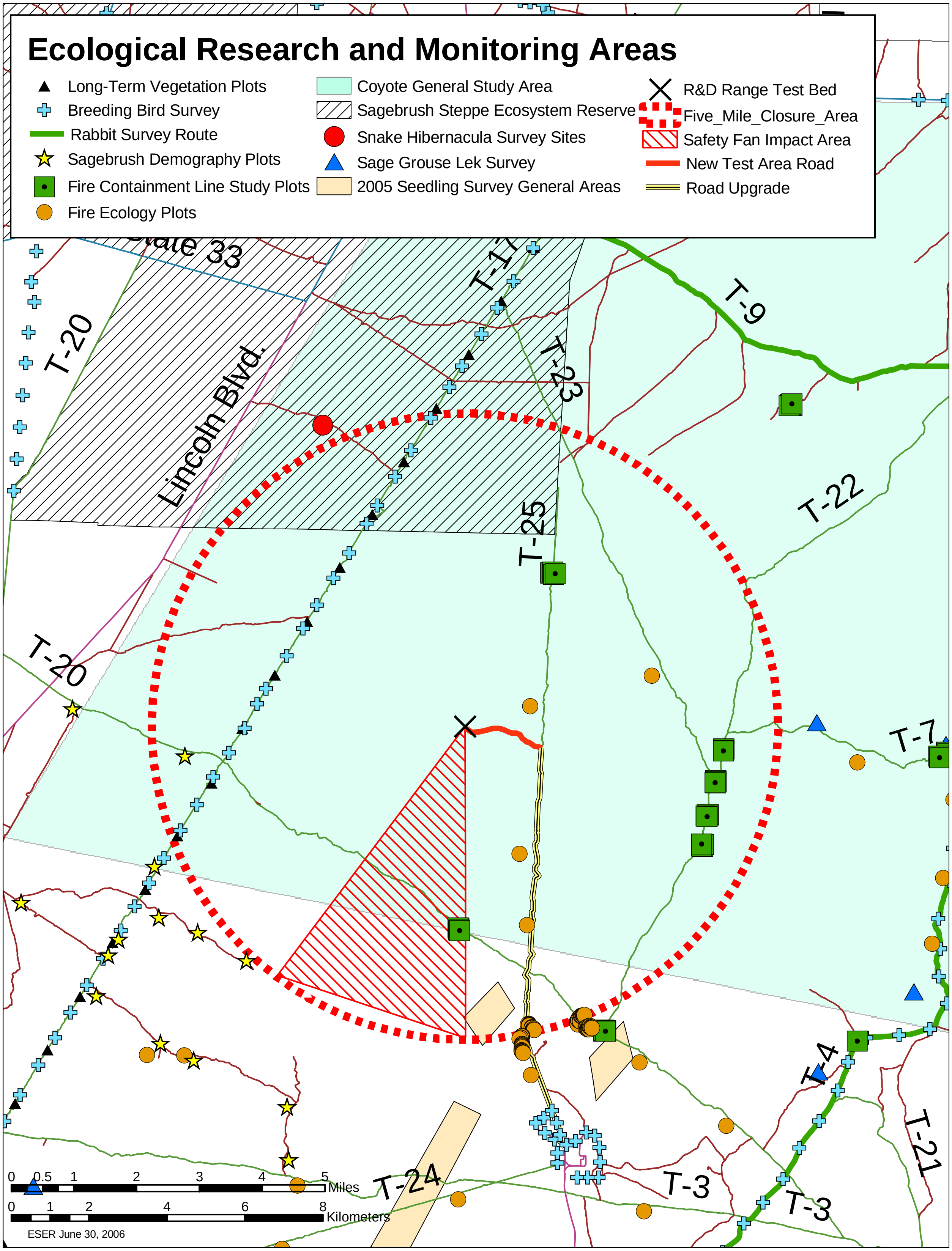


Figure 10. NERP ecological research and monitoring plots and study areas in the vicinity of the R&D Range.

the fence line around MFC, and the other follows T-17 from PBF to Highway 28. These routes are surveyed during June each year.

Surveys for large mammals, primarily elk, pronghorn and mule deer are conducted in January and July each year. These surveys are conducted using fixed-wing aircraft flying 90 m (300 ft) above the ground. The surveys are conducted on north-south transects one-half mile apart and cover the proposed test area.

The eight-kilometer (five-mile) exclusion area also includes a portion of the Sagebrush Steppe Ecosystem Reserve (SSER). The SSER was established in 1999 by Secretary of Energy Bill Richardson for the purpose of conservation of native plant communities and to provide for the study of an undisturbed sagebrush steppe ecosystem.

3.0 Environmental Consequences and Mitigative Measures

3.1 Vegetation

An area of approximately 137 m (450 feet) in radius from the center of the test location would be mowed to reduce the possibility of starting a wildland fire. Mowing, especially during the dormant season, should have little if any direct impact on the native vegetation present at the proposed site. This assumes that care is taken to not disturb soil while mowing the proposed site. Direct loss of native plants is expected in the 18-m (60-ft) radius area due to soil disturbance associated with the blast. Likewise, direct loss of vegetation will result from soil disturbance associated with traffic on and near the test site and on the road leading to the test area. This loss might be mitigated through revegetation of the disturbed areas.

Road improvements will increase soil disturbance and vegetation community fragmentation. Increased soil disturbance will likely lead to associated increases in weedy non-native species and the potential to displace natives in the communities adjacent to the upgraded road. The prevalence of needle-and-thread grass as a community dominant or co-dominant in plots along the route is indicative of sandy soils along that route. Because sandy soils tend to have less structure and, therefore, are more easily displaced, the invasibility of those soils can be quite high, as evidenced by the substantial amount of cheatgrass already present there.

3.2 Sensitive Plant Species

The primary impacts of the proposed test range and associated road upgrades on painted milkvetch populations are related to habitat fragmentation and the risk of invasive species. Because the current status of the populations is unknown, we cannot quantify how disturbance may affect population sustainability. Painted milkvetch populations occupy soils that are at very high risk of cheatgrass invasion by either fire or soil disturbance. Cheatgrass invasion would adversely affect painted milkvetch populations. Thus, limiting soil disturbance and fire risk, and quickly revegetating any disturbed areas would be critical to minimizing impacts of the proposed test area and road upgrades on these plant populations.

3.3 Ethnobotany

The impacts of the proposed activities at the test range and the impacts of upgrading the road will likely be greater on less common species than they would be on abundant species. Frequently occurring species are generally quite abundant; thus, removing several individuals will not greatly affect the larger population. Populations of species with more isolated distributions, however, are much more sensitive to the loss of several individuals.

Because the soil disturbance and risk of non-native species invasion will impact populations of species of ethnobotanical concern, the most effective mitigative measure to protect those populations is to minimize the amount of soil disturbed. Potential impacts to populations of plant species of ethnobotanical concern may also be mitigated through revegetation of areas impacted by soil disturbance. Seed or seedlings are commercially available for some of the species listed in Table 2, so those species may be directly replanted; so long as care is taken to choose appropriate subspecies and cultivars. The use of a diverse mix of native species in revegetation efforts will be important if species of concern, for which seed or stock is not available, are to re-establish voluntarily. Finally, weed control will be critical to facilitate reestablishment of native communities, including species of ethnobotanical concern.

3.4 Soils

Soil disturbance will result in a direct loss of native vegetation and will provide opportunities for invasive and other non-native plants to become established. In the proposed project, soil would be disturbed in an area approximately 18 m (60 ft) in radius and 1.2-1.8 m (4-6 ft) deep after each large test. The explosion would cause soils to form in a lip around the 18-m (60-ft) crater.

Soil disturbance should also be anticipated due to vehicle traffic to and on the proposed test site. This is due to the limited trafficability attributed to these particular soil types (Olson et al. 1995). These soils, and the potential for impact by vehicles, exist at the proposed test area and along a substantial portion of the route to the proposed site (Figure 3). ATVs can have similar impacts on these sand soils. Limiting the amount of traffic to the project site and restricting traffic to the project site itself will reduce the size of the area of disturbed soil.

Planning and site preparation that minimizes soil disturbance will limit the impacts to soil and vegetation, and greatly reduce the efforts required for revegetation and weed management. Management practices that should be used include:

- Designation of roadways, parking and laydown areas and restricting traffic to those areas.
- Limiting the amount of traffic allowed access to, and on, the project site.
- Limiting re-grading of soil to the crater itself.

Because of the high hazard for wind erosion in these soils, a plan should be developed and implemented to provide some sort of cover on all areas with disturbed soil. Fugitive dust and blowing sand can be expected otherwise and cause potential off-site impacts downwind of disturbed areas.

Much of the proposed route for the new road segment passes through highly erodible soils. Extensive portions of the proposed route are situated such that they run perpendicular to the terrain contours. It is likely that these portions of the road will erode and down-cut under certain types of precipitation events such as that associated with significant thunderstorms and rain-on-snow events. Re-aligning the road to follow contours and avoid the lower topographic positions would limit the erosion and reduce the long-term maintenance costs for this road.

3.5 Invasive and Non-Native Species

Soil disturbance is a primary contributor to the spread of invasive plants. Invasive and non-native plants are present on the much of T-25, the new road route and the Test Bed itself, and could be spread by mowing, blading, and any other means used to remove the vegetation to support construction of the road and facilities. Seed dispersal may be minimized in a number of ways. First seed dispersal may be minimized by disturbing as little area as possible along the road corridors and the Test Bed, whether that disturbance is mowing, blading, etc. Second, the timing is critical to seed dispersion. Most invasive and non-native species produce large numbers of seed. If the disturbance does not occur during peek seed dispersal, it will help reduce the number of viable seed on the ground. This will limit spread of weeds into areas presently not infested. Failure to limit seed dispersal from these areas will likely increase the level of effort necessary for revegetation and weed management. Given the proposed schedule for activity to begin in late summer, the probability for seed dispersal onto the project site and roads is high, as is the likelihood of off-site transport of weed seeds. It is highly likely that the Test Bed and the berm created as a backstop for the projectile tests will be prone to weed invasion.

A plan should be developed and implemented to prevent weed invasions on the Test Bed and berm. See PLN-611 (*Sitewide Noxious Weed Management*) and ICP/EXT-04-00654 (*Balance of INL Cleanup Integrated Weed Management Plan*) for guidance.

3.6 Wildlife Impacts and Mitigation

The impact of the proposed action would result in 1) unavoidable loss of ground-dwelling wildlife species and associated habitat, 2) displacement of certain wildlife species from the cleared area, 3) an increase in the potential for collisions between wildlife and motor vehicles (we anticipate this impact to be minimal due to the slow travel speeds required on the roads to the R&D Range), and 4) increased interactions between wildlife and project personnel. Mitigation measures can lessen the impacts on wildlife. Mitigation techniques include, but are not limited to, seasonal timing of activities, lower speed limits, fencing, warning signs, reflectors, ultrasonic warning whistles, habitat alteration, hazing animals from the road and Test Bed, and awareness programs.

Noise affects wildlife differently from humans and the effects of noise on wildlife vary from serious to nonexistent in different species and situations (Larkin 1996). The potential exists for large blasts to displace wildlife from the area.

Greater sage grouse – Although the 1999 burn resulted in a significant long-term impact on nesting habitat, sage grouse still occupy areas of dominant sagebrush adjacent to the proposed test site during winter and spring (Figure 11). It is likely they use the proposed test site in a transitory manner year round. Disturbances associated with the proposed action have the potential to temporarily displace sage grouse during winter and spring. Winter and spring are critical survival and reproductive periods, respectively, for sage grouse. Potential impacts of the proposed action on sage grouse that use the area can be minimized by maintaining vehicular speeds of less than 24 kph (15 mph) on all access roads to the R&D Range and conducting activities outside of the critical winter and spring seasons. Finally, clearing vegetation on the R&D Range within 3.2 km (2 mi) of nesting habitat may increase use of the area by breeding sage grouse by providing them an ideal area for breeding displays during the spring. If this occurs, time-of-day and seasonal restrictions will need to be implemented.

Ferruginous hawk – Ferruginous hawks are highly sensitive to human-induced disturbance during incubation (Bechard and Schmutz 1995) and nest abandonment from human disturbance documented in several areas (e.g., Fitzner et al 1977, Smith and Murphy 1973, Smith and Murphy 1978). In Idaho, White and Thurow (1985) found a significant difference in nest desertion between nests with created disturbance designed to simulate human activities and control, undisturbed nests. The Bureau of Land Management has documented nest abandonment after a single visit by researchers and consider nest abandonment a potentially "severe population limiting factor" (Snow 1974). Based on habitat requirements for this species and the presence of nests, the potential exists for them to occur in the project area. The influx of humans to the area in spring will likely displace nesting ferruginous hawks. If displacement of incubating or young-rearing ferruginous hawks from nests result in nest abandonment or in loss of eggs or nestling birds, it would constitute a significant short-term impact. These impacts can be minimized by eliminating human activity and blasting during the nesting period if ferruginous hawks are confirmed nesting. Surveys for nesting ferruginous hawks should be conducted late May to early June to determine nesting activity.

Elk – The general elk hunt for unit 63 (which includes 0.8 km (0.5 mi) within the INL boundary) occurs from August 1 through December 31. The hunting season causes increased movement of elk resulting in increased potential for vehicular collisions. To avoid vehicular collisions with this species, particularly during this period, speed limits need to remain less than 24 kph (15 mph) on all access roads. There is also the potential of these animals moving onto surrounding agricultural areas as a result of noise and human activity. These impacts can be minimized through close coordination with Idaho Department of Fish and Game.

Burrowing animals - The construction of a berm has the potential to provide habitat for species otherwise not observed in the immediate project area. Small mammals such as Townsend’s ground squirrel and Ord’s kangaroo rat will likely use the berm for burrowing activities. The berm also has the potential to draw other larger animals in search of food and/or shelter. These animals might include badgers or coyotes. Burrowing owls do not construct their own burrow, might find unoccupied burrows or

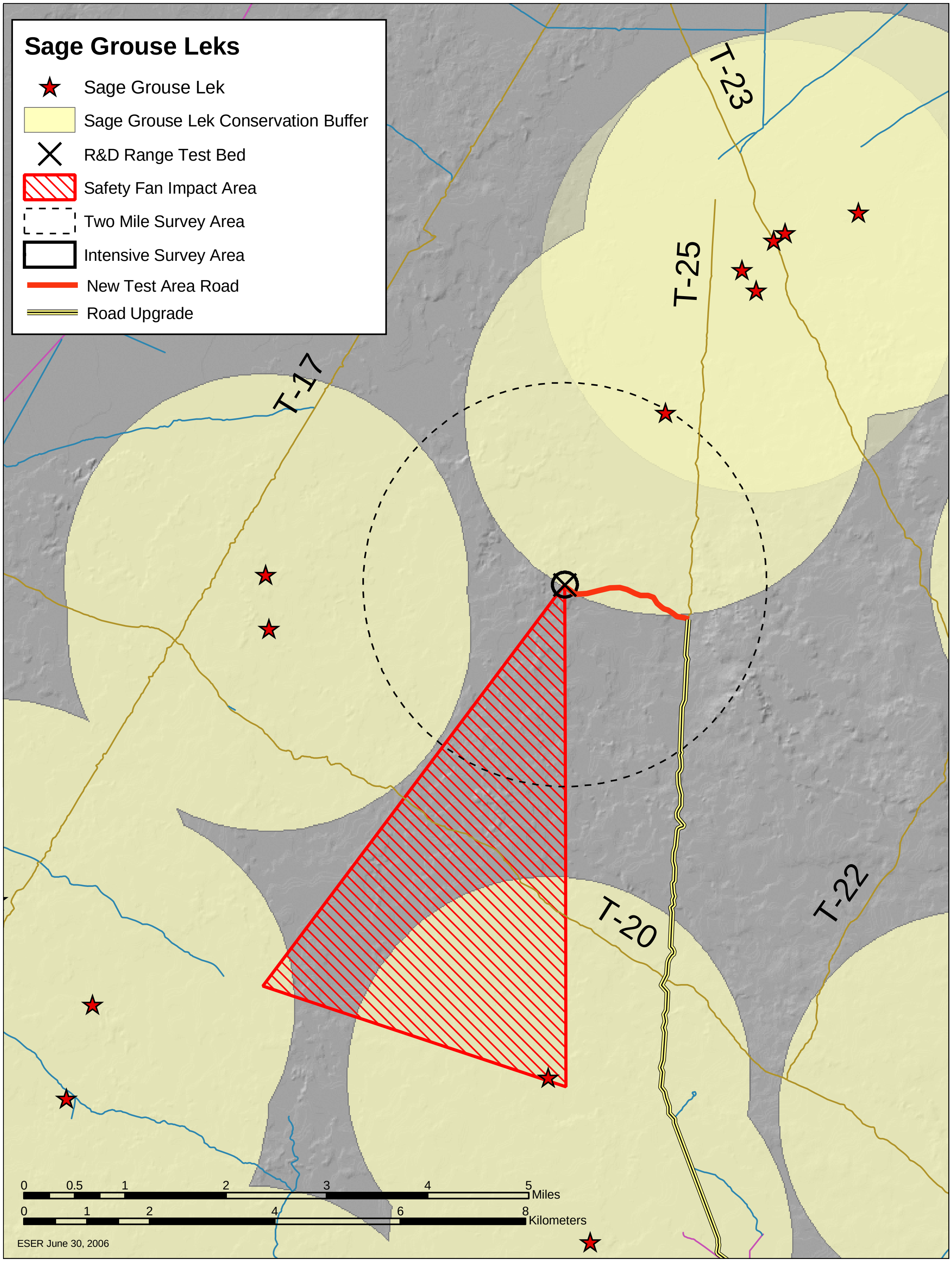


Figure 11. Locations of known sage grouse leks and the two-mile conservation buffer around each.

digging suitable habitat for nesting activities. Surveys for burrowing activities should be conducted every spring to determine use by these species.

Breeding Seasons - The proposed project area provides important breeding habitat to many species during the spring, thus seasonal restrictions should be imposed in order to prevent any detrimental effects to breeding populations. The following are times when specific animals are breeding, nesting, or birthing.

- Sage Grouse - February 15 - June 30
- Passerines - April 15 - June 30 (a few nest until Sept 1)
- Raptors - February 1 - July 1
- Snakes - August - September
- Pygmy rabbits - February - July
- Big Game - May - June

The Migratory Bird Treaty Act protects migratory birds, their nests and eggs. If any activity having the potential to disturb nests, including mowing, is to occur between March 1 and September 1, a nesting bird survey will need to be conducted before the activity begins. Work could be delayed if nests are discovered.

Speed Limits - Wildlife strikes by vehicles are a frequent occurrence on many roads. Mortality can be greatly reduced by reducing speeds (<24pkh; <15 mph) and awareness of the presence of any animal that might frequent the area. If a wild animal is observed in the road, vehicles should stop and wait until the animal leaves the road, encourage it to move on by driving forward SLOWLY, or stop and take measures to safely move the animal from the road.

3.7 Habitat Fragmentation

Habitat Fragmentation will result from the proposed road improvement and construction to the test area and disturbance of the test. Infrastructure affects natural systems in both direct and indirect ways. The physical presence of roads and disturbances in the landscape creates new habitat edges, alters hydrological dynamics, and disrupts other ecosystem processes and habitats. Road maintenance and traffic contaminate the surrounding environment with a variety of chemical pollutants and noise. In addition, infrastructure and traffic impose dispersal barriers to most non-flying terrestrial animals, and vehicle traffic causes the death of millions of individual animals per year. The various biotic and abiotic factors operate in a synergetic way across several scales, and cause not only an overall loss and isolation of wildlife habitat, but also splits up the landscape in a literal sense (Seiler 2001).

Roads fragment plant and animal populations (Noss 1996). Habitat fragmentation is the process whereby a large, continuous area of habitat is both reduced in area and divided into two or more fragments (Wilcove et al. 1996; Schonewald-Cox and Buechner 1992; Reed et al. 1996; Theobald 1998). Fragmentation can occur when area is reduced to only a minor degree if the original habitat is divided by roads, canals, fire lanes, or other barriers to free movement of species (Primack 1998).

Habitat fragmentation leads to increasing edge effects, loss of species diversity, alterations in natural disturbance regimes, and alterations in ecosystem functioning (Caling and Adams 1999). Habitat fragments differ from original habitat in two important ways: 1) fragments have a greater amount of edge for the area of habitat, and 2) the center of each fragment is closer to the edge (Primack 1998).

Changes in the microenvironment at the fragment edge can result from habitat fragmentation. Some of the more important edge effects include microclimate changes in light, temperature, wind, humidity, decreased soil moisture, and incidence of fire (Shelhas and Greenberg 1996; Laurance and Bierregaard 1997; Reed et al. 1996). Each of these edge effects can have a significant impact upon the vitality and composition of species in the fragment and increased wind, lower humidity, and higher temperatures make fires more likely (Primack 1998). Edges produced by roads can also increase nest parasitism by brown-headed cowbirds (*Molothrus ater*). Brown-headed cowbirds, the only obligate brood parasite in North America, feed primarily in open areas, but use perches to watch for nest building activities. Edge habitats are perfect for their needs (Brittingham and Temple 1983) and it has been demonstrated on the INL that brood parasitism increases on edges and in fragmented habitats (Belthoff and Rideout 2000).

Fragmentation affects animal populations in a variety of ways, including decreased species diversity and lower densities of some species in the resulting smaller patches (Reed et al. 1996). Some species of animals refuse to cross barriers as wide as a road. For these species, a road or fire line effectively cuts the population in half. A network of roads or firelines fragments the population even further (Noss 1996). For example, fragmentation of sagebrush communities poses a threat to populations of pygmy rabbits (*Brachylagus idahoensis*) because dispersal potential is limited (Weiss and Verts 1984) due to the willingness of rabbits to cross open areas. In addition to direct loss of shrub habitats, responses of shrub-obligate species of wildlife will be related to dispersal capabilities and populations may not persist in landscapes of increasingly fragmented patches of sagebrush after disturbance (Braun et al. 1976; Knick and Rotenberry 1995; Knick and Dyer 1997).

Sage grouse (*Centrocercus urophasianus*), sagebrush obligates, are totally dependent on sagebrush habitat (Benson et al. 1991) and removal of sagebrush has a negative impact on the value for winter habitat (Gates 1983). Good winter range provides sage grouse with access to sagebrush under all snow conditions. Sage grouse only eat sagebrush during the winter and often use relatively open habitats with 10-25 percent sagebrush canopy cover and an average height of 25-35 cm (9.8-13.8 in) above the snow. The quality and quantity of breeding and winter habitat have declined during the 1980's and 1990's because of prolonged drought, fires, and agricultural development. Vast areas that were once sagebrush/bunchgrass habitats are now dominated by cheatgrass (*Bromus tectorum*), and have little or no sagebrush overstory. These factors make population recovery difficult. Sage grouse that occur on the INL are considered both migratory and non-migratory with some moving 100 km (62 mi) or more between seasonal ranges. Sage grouse have a relatively low reproductive rate compared to other game bird species so populations do not recover very fast following optimal conditions (Schroeder 1999).

Roads fragment plant populations and facilitate the spread of invasive animals, insects and plants. Many of the weedy plants that dominate and disperse along roadsides are exotics. In some cases, these species, such as cheatgrass, spread from roadsides into adjacent native communities (Noss 1996). Exotic species disrupt natural ecosystem processes and the species that depend on them. Exotic plants have been shown to replace native under story vegetation, inhibit seed regeneration, and change soil nutrient cycling. Some weeds can cause higher erosion rates or change fire regimes.

In shrub-steppe ecosystems, invading weeds, which were usually non-mycorrhizal, disrupted succession of native species, 99 percent of which were mycorrhizal–dependent. Also, fires have become more common and extensive in sagebrush ecosystems invaded by cheatgrass (Billings 1994). Presence of cheatgrass along edges (roads) may allow it to invade adjacent habitats, increasing the likelihood of fire spread into nearby sagebrush patches, further fragmenting the ecosystem (Knick and Rotenberry 1997).

Disturbance from roads can increase the distance between remaining shrub patches that provide seed sources (Knick and Rotenberry 1997). The dominant shrub on the INL, big sagebrush (*A. tridentata*), does not resprout from crown or roots following fire (Young and Evans 1978). Thus, natural regeneration of these shrublands could be severely limited by availability and dispersion of seed sources. Dispersal of sagebrush is primarily wind driven and occurs largely within 30 m (98 ft) of the seed source (Young and Evans 1989).

Studies concerning roads and their influence on habitat fragmentation offer sufficient reason for adopting a precautionary stance toward road issues (Brittingham and Temple 1983). Roads precipitate fragmentation by dissecting previously large habitats into smaller ones. As the density of roads in landscapes increases, these effects increase as well. Even though roads occupy a small fraction of the landscape in terms of land area, their influence extends far beyond their immediate boundaries (Reed et al. 1996).

3.8 Ecological Monitoring and NERP Research Activities

There is the potential for impact to other research and monitoring activities in the vicinity of the proposed project site. This includes ongoing ecological monitoring and research conducted by the ESER Program and academic researchers. The potential for impact may be in the form of direct damage to plots, alteration of natural animal behaviors being investigated, and/or potential loss of access to the area for data collection.

Most of these potential impacts can be avoided by implementing a few administrative controls. Travel should be strictly limited to the designated areas. Project managers should coordinate their activities with ESER personnel to avoid conflicts with long-term scheduled monitoring activities such as the Breeding Bird Survey, Long-Term Vegetation

Survey, Rabbit Survey, Big Game Surveys, Sage Grouse Surveys and other data collection activities.

For some large-scale projects studying animal behavior or movement patterns such as the coyote project previously described, there is a potential for impacts. Utah State University researchers conducting the coyote project have indicated that development of a long-term or permanent test site for similar activities in this area would likely cause them to move their research program somewhere other than the Idaho NERP (Mike Jaeger, Utah State University, pers. comm.).

There is the potential for ESER field workers to be in or near the area at the time of the proposed explosives activities. Recent experience with notification of field workers about explosives activity on the INL has been found to be deficient. ESER personnel brought this to the attention of the Idaho Occupational Safety and Health Council June 15, 2005. This potential for risk can be reduced by utilizing the INL Field Worker Notification process prior to each blast to warn field workers.

3.9 Cumulative Impacts

Historically, cumulative impacts have not been addressed in INL NEPA documents. However, NEPA indicates these impacts should be considered and there is extensive literature discussing the potential short-term and long-term impacts of road building. In addition to the direct impacts from the road, the existence of a new road would likely increase the need for infrastructure and will encourage future development, thus creating additional cumulative impacts.

While NEPA does not explicitly mention indirect and cumulative impacts, NEPA makes it the responsibility of the Federal government to "include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on the environmental impact of the proposed action [and] adverse environmental effects which cannot be avoided should the proposal be implemented." [42 U.S.C. 4332(C)].

The Council of Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA [40 CFR 1500-1508] clarify the requirements by defining direct effects, indirect effects, and cumulative effects.

- **Direct Effects.** Those effects caused by the action and occurring at the same time and place. [40 CFR 1508.8].
- **Indirect Effects.** Those effects caused by the action and occurring later in time or farther removed in distance, but still reasonably foreseeable. Indirect effects may include effects related to induced changes in the pattern of land use and related effects on air and water and other natural systems, including ecosystems. [40 CFR 1508.8].
- **Cumulative Impacts.** Those impacts on the environment, which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from

individually minor but collectively significant actions taking place over a period of time. [40 CFR 1508.7].

Even though we cannot quantify the potential cumulative impacts to ecological resources, it is possible to do a qualitative assessment of what those impacts might be. The proposed R&D Range is located near the center of what remains of the large, undisturbed central core area of the INL. The southern boundary of that undisturbed core area is now, arguably, set by the new road that will connect MFC with PBF. The boundary on the west is generally marked by Lincoln Boulevard, INTEC, CFA and PBF. Recent activities associated with the development of the CITRC have strengthened the effectiveness of the boundary in that area. The proposed development of a new reactor facility in that general area would move that boundary in still further north. The proposed R&D Range will cause a significant reduction in the size and connectivity of that undisturbed core area.

It is reasonable to expect that the upgrade of T-25 north from MFC as proposed in this project will result in additional future activities along that road. These activities will bring new disturbances along the road, strengthening the impacts of that road on habitat fragmentation and loss. It is also reasonable to expect more habitat loss and fragmentation by construction of new facilities along that route.

As stated previously, the resources to develop a quantitative assessment of cumulative impacts to ecological resources are not yet available at the INL. However, as new developments occur on the INL, as good condition sagebrush steppe habitat and populations of sagebrush obligate species continue to decline all across the West and as the risk of being required to manage for those species continues to increase, it will become increasingly more important that cumulative impacts on the INL be quantified. Being able to quantify cumulative impacts and plan INL developments to minimize those impacts will reduce the likelihood of impacts to the INL mission due to requirements for conservation management of ecological resources.

3.10 Mitigation Strategy

Throughout this report, a number of mitigative actions have been suggested. The following list summarizes those suggested actions.

- Limit the size of areas where vegetation will be removed and soil disturbed.
- Limit increased risk of wildland fire.
- Provide some sort of ground cover on all areas soil has been disturbed.
- Restore and revegetate impacted areas.
- Implement a weed management plan.
- Re-align new road to limit soil erosion due to runoff.
- Set speed limits on access roads at 24 kph (15 mph).
- Set time-of-day and seasonal restrictions as necessary.
- Annual surveys for nesting birds, especially ferruginous hawks and burrowing owls.

The most substantial impact to ecological resources due to the proposed action will likely be due to the daily presence of people and vehicles at the R&D Range and on the access road. One possible strategy to mitigate this potential impact is to use the R&D Range only for those activities for which the INL does not currently have a suitable facility. For example, the Dynamic Processing Area can handle a maximum test of 2,000 lbs NEW. The proposed action plans to conduct tests in the range of 3,000 to 10,000 lbs NEW only once or twice per year. Very large tests (10,000 to 20,000 lbs NEW) are proposed only once every five years. Smaller tests (<3,000 lbs NEW) are proposed on a weekly or monthly basis. By moving the majority of the activities to previously established facilities, many of the potential impacts described in this analysis can be greatly reduced.

3.11 Effects on INL Natural Resource Management Objectives

To summarize the evaluation of consequences of the proposed activity on ecological resources, we have analyzed the impact of the action on each of the INL natural resource management objectives. To do this, we prepared a narrative synthesis of the data collected in the field surveys related to each of the resources as described above and of information regarding the status of those resources on the INL collected as part of other research or monitoring programs as they relate to the natural resource management objectives. That narrative synthesis follows below.

- **Reduce the need for land rehabilitation.** This objective cannot be met with the proposed action. The areas used for the proposed facility and access roads will cause disturbance that will eventually require some level of rehabilitation/revegetation.
- **Protect threatened, endangered and sensitive species (this includes State of Idaho designated species) and their habitat.** During our survey we found sensitive species that may be harmed by the proposed project. Although direct impact to individuals cannot be mitigated, decreasing the risk of indirect impacts can be achieved by implementing the mitigation strategy described above.
- **Protect sage grouse and other sagebrush-obligate species and their habitat.** Sage grouse and other sagebrush obligate species are likely to be temporarily displaced due to the activity. Employing the mitigation strategy above will limit that impact.
- **Prevent habitat loss and fragmentation.** The proposed action will result in direct habitat loss and cause substantial fragmentation in what is presently a large, relatively undisturbed portion of the INL. By moving smaller tests to other facilities on the INL and reducing the frequency of human activity and vehicle traffic at the R&D Range, this impact will be reduced but not eliminated.
- **Protect culturally significant flora and fauna.** There will be direct loss of some individuals as a result of the activity. Mitigating through weed management and appropriate revegetation will limit the impact.
- **Maintain a large undeveloped, sagebrush steppe ecosystem.** This objective cannot be met. As described above, the proposed R&D Range will be near the center of the largest, mostly undisturbed area of sagebrush steppe on the INL.
- **Maintain plant genetic diversity.** It is possible to meet the objective of preserving plant genetic diversity by using only locally collected plant materials for use in any revegetation effort required during the life of this project. This would include locally collected seed or use of transplanted "wildings."
- **Protect unique ecological research opportunities.** Because the unique ecological research opportunities provided by the INL is the large, undeveloped, unfragmented sagebrush steppe ecosystem, the proposed action will change those characteristics and

will not meet this resource objective. Because developing the R&D Range and access roads fragments and brings other potential impact to this otherwise undeveloped area, selecting this alternative will not meet the requirements of this resource objective. This impact can be minimized by using the R&D Range only for large tests that cannot be accommodated elsewhere on the INL as described above.

- **Prevent invasion of non-native species including noxious weeds.** The proposed action on the INL will cause disturbance to soils and vegetation communities that will open the door to invasive species. The most cost effective way to prevent invasive species following a disturbance such as is proposed, is to successfully revegetate those disturbed areas with desirable vegetation. However, because of the sand soils encountered on the new access road and on the Test Bed itself that are known to be difficult to revegetate, it is unlikely that mitigation will be successful in those areas. This statement should not be taken to mean that the soils elsewhere on the INL will be substantially easier to revegetate. Revegetation in any desert environment should not be considered as trivial.
- **Prevent animal/vehicle conflicts.** Large mammals are known to use the area proposed for the R&D Range frequently. Because of the increased use of T-25 under the preferred alternative, it will likely increase the potential for animal/vehicle conflicts. However, it is our opinion that implementation of the mitigation strategy described earlier in this report will reduce animal/vehicle conflicts.
- **Protect biodiversity.** Because of the direct loss of habitat and the increased potential for introducing invasive species into an otherwise undeveloped area on the INL, this objective cannot be met under the preferred alternative. These impacts can be reduced by implementing the mitigation strategy described above.

Literature Cited

Adams, J. A., H. B. Johnson, A. S. Endo, L. H. Stolzy, and P. G. Rowlands. 1982. Controlled experiments on soil compaction produced by off-road vehicles in the Mojave Desert, California. Journal of Applied Ecology 19:167-175.

Amaranthus, M. P., and D. A. Perry. 1994. The functioning of ectomycorrhizal fungi in the field: linkages in space and time. Plant and Soil 159:133-140.

Anderson, J.E., K.T. Ruppel, J.M. Glennon, K.E. Holte, and R.C. Rope. 1996. Plant communities, ethnoecology, and flora of the Idaho National Engineering Laboratory. ESRF-005. Idaho Falls, 111pp.

Angold, P. G. 1997. The impact of a road upon adjacent heathland vegetation: effects on plant species composition. The Journal of Applied Ecology 34:409-417.

Bechard, M.J., and J.K. Schmutz. 1995. Ferruginous Hawk (*Buteo regalis*). *In* The Birds of North America, No. 172 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists Union, Washington, D.C.

Bellinger, R. G., F. W. Ravlin, and M. L. McManus. 1989. Forest edge effects and their influence on gypsy moth egg mass distribution. Environmental Entomology 18:840-843.

Belthoff, J. R. and C. W. Rideout. 2000. Effects of Habitat Fragmentation on Shrub-steppe Birds in Southeastern Idaho. 2000 Interim Report, Boise State University, Boise, Idaho.

Benson, L. A., C.E. Braun, and W. C. Leininger. 1991. Sage grouse response to burning in the big sagebrush type. In: Comer, Robert D.; Davis, Peter R.; Foster, Susan Q.; [and others], eds. Issues and technology in the management of impacted wildlife: Proceedings of a national symposium; 1991 April 8-10; Snowmass Resort, CO. Boulder, CO: Thorne Ecological Institute: 97-104.

Berish, J. E. D. 1998. Characterization of rattlesnake harvest in Florida. Journal of Herpetology 32:551-557.

Billings, W. D. 1994. Ecological impacts of cheatgrass and resultant fire on ecosystems in the western Great Basin. pp. 22-30 in Proceedings - Ecology and Management of Annual Rangelands. S. B. Monsen and S. G. Kitchen eds. INT-GTR-313. USDA Forest Service. Intermountain Research Station.

Boren, J. C., T. Criner, D. M. Engle, M. W. Palmer, and R. E. Masters. 1999. Land use change effects on breeding bird community composition. Journal of Range Management 52:420-430.

Braun, C. E., M. F. Baker, R. L. Eng, J. S. Gashwiler and M. H. Schroeder. 1976. Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88: 165-171.

Brittingham, M. C. and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? Bioscience 33: 31-35.

Burbridge, W. R., and D. J. Neff. 1976. Coconino National Forest--Arizona Game and Fish Department cooperative roads-wildlife study. Pages 44-57 in S.R. Hieb editor. Proceedings of the Elk-Logging-Roads Symposium. Moscow, Idaho. December 16-17, 1976. Forest, Wildlife and Range Experiment Station University of Idaho, Moscow, ID.

Bureau of Land Management, U.S. Department of the Interior. 2003. INEEL Sagebrush Steppe Ecosystem Reserve Management Plan. EA-ID-074-02-067, Idaho Falls, ID, 72 pp.

Bury, R. B. 1978. Desert tortoises and off-road vehicles: do they mix? Page 126 in Desert Tortoise Council Proceedings, 1978, Symposium 1-3 April 1978, Las Vegas, Nevada. Desert Tortoise Council, San Diego, CA.

Caling, T. M. and R. Adams. 1999. Ecological Impacts of Fire Suppression Operations in a Small Vegetation Remnant. Proceedings of the Australia Bushfire Conference, Albury Australia, July 1999.

Comer, M. J. 2000. Elk population characteristics and habitat use in southeastern Idaho. M.S. Thesis, University of Idaho, Moscow, Idaho USA.

DeMaynadier, P. G., and M. L. Hunter, Jr. 1995. The relationship between forest management and amphibian ecology: a review of the North American literature. Environmental Reviews 3:230-261.

DeMaynadier, P. G., and M. L. Hunter, Jr. 2000. Road effects on amphibian movements in a forested landscape. Natural Areas Journal 20:56-65.

Dijak, W., and F. Thompson. 2000. Landscape and edge effects on the distribution of mammalian predators in Missouri. Journal of Wildlife Management 64:209-216.

DOE (U.S. Department of Energy), 1997, Idaho Operations Office, Comprehensive Facility and Land Use Plan, DOE-ID-10514.

DOE (U.S. Department of Energy), 2003, Idaho Operations Office, Idaho National Engineering and Environmental Laboratory Wildland Fire Management Environmental Assessment, DOE/EA-1372, April 2003.

Earl, S. 2003. Idaho Cave Survey Report. Unpublished.

Earl, S., and R. C. Morris. 1995. A survey of 14 caves on the Idaho National Engineering Laboratory. ESRF-006 58pp.

Edge, W. D., and C. L. Marcum. 1991. Topography ameliorates the effects of roads and human disturbance on elk. Pages 132-137 in A.G. Christensen, L. J. Lyon, and T. N. Lonner, compilers. Proceedings of a symposium on elk vulnerability. Montana State University, Bozeman. April 10-12, 1991. Mountain Chapter of the Wildlife Society.

Findlay, C. S., and J. Bourdages. 2000. Response time of wetland biodiversity to road construction on adjacent lands. Conservation Biology. 14:86-94.

Findlay, C. S., and J. Houlahan. 1997. Anthropogenic correlates of species richness in southeastern Ontario wetlands. Conservation Biology 11:1000-1009.

Fitzner, R.E., D. Berry, L.L. Boyd, and C.A. Rieck. 1977. Nesting of Ferruginous Hawks (*Buteo regalis*) in Washington 1974-75. Condor 79:245-249.

Forcella, F., and S. J. Harvey. 1983. Eurasion weed infestation in western Montana in relation to vegetation and disturbance. Madrono 30:102-109.

Forman, R. T. T., and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Reviews of Ecology and Systematics 29: 207-231.

Gates, R. J. 1983. Sage Grouse, Lagomorph and Pronghorn use of a Sagebrush-Grassland Burn Site on the Idaho National Engineering Laboratory. M. S. Thesis, Montana State University, Bozeman, Montana. 135 pages.

Green, J. S. and J. T. Flinders. 1980. Habitat and dietary relationships of the pygmy rabbit. Journal of Range Management 33(2): 136-142.

Gruell, G. E., J. G. Roby, K. Becker, and R. Johnson. 1976. Gross venture cooperative elk study, June 1975-November 1975. Progress report. Bridger-Teton National Forest and Wyoming Game and Fish Department.

Harr, R. D., W. C. Harper, and J. T. Krygier. 1975. Changes in storm hydrographs after road building and clear-cutting in the Oregon Coast Range. Water Resources Research 11:436-444.

Haskell, D. G. 2000. Effects of forest roads on macroinvertebrate soil fauna of the southern Appalachian Mountains. Conservation Biology 14: 57-63.

Haymond, S. 1998. Summer Habitat Use by three vespertilionid bats in sagebrush-steppe in Southeastern Idaho. Thesis. Brigham Young University, Provo, UT. 31pp.

Idaho CDC. 2006. Idaho Conservation Data Center, Idaho Department of Fish and Game. http://fishandgame.idaho.gov/cms/tech/CDC/. Accessed on June 1, 2006.

Idaho State Department of Fish and Game. 2005. Protecting Idaho's Amphibians and Reptiles. www.fishandgame.idaho.gov/cms/wildlife/nongame/protectamprep.cfm.

Jenkins, C. L. and C. R. Peterson. In press. A trophic based approach to the conservation biology of rattlesnakes: Linking landscape disturbance to rattlesnake populations. In. W. K. Hayes, K. R. Beaman, S. P. Bush, M. D. Cardwell editors, Biology of the Rattlesnakes.

Jones, J. A., and G. E. Grant. 1996. Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon. Water Resources Research 32:959-974.

Jones, K. B., A. C. Neale, M. S. Nash, K. H. Riitters, J. D. Wickham, R. V. O'Neill and R. D. Van Remortel. 2000. Landscape correlates of breeding bird richness across the United States mid-Atlantic region. Environmental Monitoring and Assessment 63: 159-174.

Katzner, T. E., K. L. Parker, and H. H. Harlow. 1997. Metabolism and thermal response in winter-acclimatized pygmy rabbits (Brachylagus idahoensis). Journal of Mammology 78(4):1053-1062

Keyser, A. J. G. E. Hill, and E. C. Soehren. 1997. Effects of forest fragment size, nest density, and proximity to edge on the risk of predation to ground-nesting passerine birds. Conservation Biology 12: 986-994.

Knick, S. T. and D. L. Dyer. 1997. Distribution of black-tailed jackrabbit habitat determined by Geographical Information Systems in southwestern Idaho. J. Wildlife Manage. 61: 75-86.

Knick, S. T. and J. T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9: 1059-1071.

Knick, S. T. and J. T. Rotenberry. 1997. Landscape characteristics of disturbed shrubsteppe habitats in southwestern Idaho. Landscape Ecology 12: 287-297.

Kuitunen, M., E. Rossi, and A. Stenroos. 1998. Do highways influence density of land birds? Environmental Management 22:297-302.

Larkin, R.P. 1996. Effects of military noise on wildlife: a literature review. Center for Wildlife Ecology. Illinois Natural History Survey. 607 E. Peabody Drive, Champaign, Illinois 61820.

Laurance, W. F. and R. O. Bierregaard, Jr. (eds.). 1997. Tropical Forest Remnants: Ecology, Management and Conservation of Fragmented Communities. The University of Chicago Press, Chicago.

Linder, A. D., and R. W. Sehman. 1978. The herpetofauna of the Idaho National Engineering Laboratory Site. J. Idaho Acad. Sci. 13:47-50.

Marcus, W. A., G. Milner, and B. Maxwell. 1998. Spotted knapweed distribution in stock camps and trails of the Selway-Bitterroot Wilderness. Great Basin Naturalist 58:156-166.

McBride, R., N. R. French, A. H. Dahl, and J. E. Demeter. 1978. Vegetation types and surface soils of the Idaho National Engineering Laboratory Site. IDO-12084, Idaho Operations Office, U.S. Department of Energy, Idaho Falls, ID, 29pp.

Noss, R. F. 1996. The ecological effects of roads. Road-Ripper's Handbook, ROAD-RIP, Missoula, MT.

Noss, R. F., E. T. Laroe III, and J. M. Scott, 1995, Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. U.S. Department of the Interior, National Biological Service, Biological Report 28, February. 60pp.

Olson, G. L., D. J. Jeppesen and R. D. Lee. 1995. The Status of Soil Mapping for the Idaho National Engineering Laboratory. INEL-95/0051. Lockheed Idaho Technologies Co., Idaho Falls, Idaho.

Oxley, D. J., M. B. Fenton and G. R. Carmody. 1974. The effects of roads on populations of small mammals. Journal of Applied Ecology 11:51-59.

Parendes, L. A., and J. A. Jones. 2000. Role of light availability and dispersal in exotic plant invasion along roads and streams in the H. J. Andrews Experimental Forest, Oregon. Conservation Biology 14:64-75.

Primack, R. B. 1998. Essentials of Conservation Biology, Second Edition. Sinauer Associates, Inc., Sunderland, Massachusetts.

Pyke, D. A. 1999. Invasive Exotic Plants in Sagebrush Ecosystems of the Intermountain West. In Proceedings: Sagebrush Steppe Ecosystems Symposium. Bureau of Land Management Publication No. BLM/ID/PT-001001+1150, Boise, Idaho, USA.

Reed, R. A., J. Johnson-Barnard and W. L. Baker. 1996. Contribution of roads to forest fragmentation in the Rocky Mountains. Conservation Biology 10: 1098-1107.

Reynolds, T. D., J. W. Connelly, D. K. Halford and W. J. Arthur. 1986. Vertebrate Fauna of the Idaho National Environmental Research Park. Great Basin Naturalist, 46 (3): 513-527.Roland, J. 1993. Large-scale forest fragmentation increases the duration of tent caterpillar outbreak. Oecologia 93:25-30.

Saab,V. and T.D. Rich, 1997, Large-scale conservation assessment or neotropical migratory landbirds in the Interior Columbia River Basin. USDA Forest Service, Pacific Northwest Research Station, General Technical Report. PNW-GTR-389. Portland Oregon.

Schonewald-Cox, C. M. and M. Buechner. 1992. Park protection and public roads. In P. L. Fiedler and S. K. Jains (eds.), Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management, pp. 373-396. Chapman Hall, New York.

Schroeder, M. A. 1999. Population Ecology and Habitat Needs. In Northern Sage Grouse Status Conference Proceedings, January 14-15, 1999, Boise, Idaho.

Seiler, A. 2001. Ecological Effects of Roads. Grimsö Wildlife Research Station, Dept. of Conservation Biology, University of Sweden Agricultural Sciences, S-730 91 Riddarhyttan, Sweden.

Sharifi, M. R., A. C. Gibson, and P. W. Rundle. 1999. Phenological and physiological responses of heavily dusted creosote bush *(Larrea tridentata)* to summer irrigation in the Mojave Desert. Flora 194:369-378.

Sheley, R. and J. K. Petroff. 1999. Biology and Management of Noxious Rangeland Weeds. Oregon State University Press, Corvallis, Oregon, USA.

Shelhas, J. and R. Greenberg (eds.). 1996. Forest Patches in Tropical Landscapes. Island Press, Washington, D. C.

Smith, D.G., and J.R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham University Science Bulletin. Biol. Service 13: 1-76.

Smith, D.G., and J.R. Murphy. 1978. Biology of the Ferruginous Hawk in Central Utah. Sociobiology 3: 79-95.

Snow, C. 1974. Habitat management series for unique or endangered species: Ferruginous Hawk. U.S. Dept. of Int. Tech. Note No. 255. Bureau of Land Management., Denver CO.

Theobald, D. M. 1998. Tools Available for Measuring Habitat Fragmentation. Presented at the Colorado Chapter of the Wildlife Society Annual Meeting, January 22, 1998, Grand Junction, Colorado.

Thomson, J. L., T. S. Schaub, N. W. Culver, and P. C. Aengst. 2005. Wildlife at a Crossroads: Energy Development in Western Wyoming. The Wilderness Society, February 2005.

Trombulak, S. C. and C. A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology, Pages. Volume 14 (1): 18-30.

USDA-NRCS. 2005. The PLANTS Database, Version 3.5 (http://plants.usda.gov). Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

U. S. Environmental Protection Agency. 1971. Effects of noise on wildlife and other animals. U. S. Environmental Protection Agency, Off Noise Abate. Control NTID300.5.

Weiss, N. T. and B. J. Verts. 1984. Habitat and distribution of pygmy rabbits (*Sylvilagus idahoensis*) in Oregon. Great Basin Naturalist 44(4): 563-571.

White, C.M., and T.L. Thurow. 1985. Reproduction of Ferruginous Hawks exposed to controlled disturbance. Condor 87: 14-22.

Wilcove, D., M. J. Bean, R. Bonnie and M. McMillan. 1996. Rebuilding the Ark: Toward a More Effective Endangered Species Act for Private Land. Environmental Defense Fund, Washington, D. C.

Wilkins, K. T. 1982. Highways as barriers to rodent dispersal. Southwestern Naturalist 27:459-460.

Young, J. A. and R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. J. of Range Manage. 31: 283-289.

Young, J. A. and R. A. Evans. 1989. Dispersal and germination of big sagebrush (*Artemisia tridentata*) seeds. Weed Science 37: 201-206.

Glossary Terms

Detectability: The ability to discover the existence or presence of something.

Ethnobotany: The study of plants as they pertain to an indigenous culture.

Ethnoecology: The study of the natural environment as it pertains to an indigenous culture.

Habitat fragmentation: A splitting of contiguous areas into smaller and increasingly dispersed fragments.

Hibernacula: A protective structure in which an organism remains dormant for the winter.

Home range: The geographic area to which an organism normally confines its activity.

Lek: An area where male grouse congregate for breeding purposes.

Non-game species: Animals which are not normally hunted, fished, or trapped.

Roost: A place on which birds rest or sleep.

Sagebrush obligate species: A species that is only able to exist or survive in sagebrush habitat.

Sympatric: Species or other taxa with ranges that overlap.

Transitory: Existing or lasting only a short time; short-lived or temporary.

Wilding: Individual plants that are removed from nearby natural communities and immediately transplanted onto a disturbed site.

Appendix A: Plant Species List

Table A-1. Plant species found in survey plots

Species Code	Current Scientific Name	Common Name	Family	Nativity	Duration	Growth Habit
achy	*Achnatherum hymenoides*	Indian ricegrass	Poaceae	Native	Perennial	Graminoid
agcr	*Agropyron cristatum*	crested wheatgrass	Poaceae	Introduced	Perennial	Graminoid
alde	*Alyssum desertorum*	desert alyssum	Brassicaceae	Introduced	Annual	Forb
alte	*Allium textile*	textile onion	Liliaceae	Native	Perennial	Forb
arfr	*Arenaria franklinii*	Franklin's sandwort	Caryophyllaceae	Native	Perennial	Forb
arfr2	*Artemisia frigida*	prairie sagewort	Asteraceae	Native	Perennial	Shrub
artrt	*Artemisia tridentata* ssp. *tridentata*	basin big sagebrush	Asteraceae	Native	Perennial	Shrub
artrw	*Artemisia tridentata* ssp. *wyomingensis*	Wyoming big sagebrush	Asteraceae	Native	Perennial	Shrub
asag	*Astragalus agrestis*	purple milkvetch	Fabaceae	Native	Perennial	Forb
asca	*Astragalus calycosus*	Torrey's milkvetch	Fabaceae	Native	Perennial	Forb
asce	*Astragalus ceramicus*	painted milkvetch	Fabaceae	Native	Perennial	Forb
asfi	*Astragalus filipes*	basalt milkvetch	Fabaceae	Native	Perennial	Forb
asle	*Astragalus lentiginosus*	freckled milkvetch	Fabaceae	Native	Perennial	Forb
aspu	*Astragalus purshii*	woollypod milkvetch	Fabaceae	Native	Perennial	Forb
brte	*Bromus tectorum*	cheatgrass	Poaceae	Introduced	Annual	Graminoid
cado	*Carex douglasii*	Douglas' sedge	Cyperaceae	Native	Perennial	Graminoid
cete	*Ceratocephala testiculata*	curveseed butterwort	Ranunculaceae	Introduced	Annual	Forb
chdo	*Chaenactis douglasii*	Douglas' dustymaiden	Asteraceae	Native	Biennial	Forb
chfr	*Chenopodium fremontii*	Fremont's goosefoot	Chenopodiaceae	Native	Annual	Forb
chle	*Chenopodium leptophyllum*	narrowleaf goosefoot	Chenopodiaceae	Native	Annual	Forb
chvi	*Chrysothamnus viscidiflorus*	green rabbitbrush	Asteraceae	Native	Perennial	Shrub
crac	*Crepis acuminata*	tapertip hawksbeard	Asteraceae	Native	Perennial	Forb
crci	*Cryptantha circumscissa*	cushion cryptantha	Boraginaceae	Native	Annual	Forb
crin	*Cryptantha interrupta*	Elko cryptantha	Boraginaceae	Native	Perennial	Forb
crsc	*Cryptantha scoparia*	desert cryptantha	Boraginaceae	Native	Annual	Forb
dean	*Delphinium andersonii*	Anderson's larkspur	Ranunculaceae	Native	Perennial	Forb
depi	*Descurainia pinnata*	western tansymustard	Brassicaceae	Native	Annual	Forb
deso	*Descurainia sophia*	herb sophia	Brassicaceae	Introduced	Annual	Forb
elel	*Elymus elymoides*	bottlebrush squirreltail	Poaceae	Native	Perennial	Graminoid
ella	*Elymus lanceolatus*	streambank wheatgrass	Poaceae	Native	Perennial	Graminoid
erce	*Eriogonum cernuum*	nodding buckwheat	Polygonaceae	Native	Annual	Forb
ermi	*Eriogonum microthecum*	slender buckwheat	Polygonaceae	Native	Perennial	Shrub
erna	*Ericameria nauseosus*	rubber rabbitbrush	Asteraceae	Native	Perennial	Shrub
erna2	*Ericameria nana*	dwarf goldenbush	Asteraceae	Native	Perennial	Shrub
erov	*Eriogonum ovalifolium*	cushion buckwheat	Polygonaceae	Native	Perennial	Forb
erpu	*Erigeron pumilus*	shaggy fleabane	Asteraceae	Native	Perennial	Forb
erwi	*Eriastrum wilcoxii*	Wilcox's woollystar	Polemoniaceae	Native	Annual	Forb
gadi	*Gayophytum diffusum*	spreading groundsmoke	Onagraceae	Native	Annual	Forb
gusa	*Gutierrezia sarothrae*	broom snakeweed	Asteraceae	Native	Perennial	Shrub
hagl	*Halogeton glomeratus*	saltover	Chenopodiaceae	Introduced	Annual	Forb
heco	*Hesperostipa comata*	needle and thread grass	Poaceae	Native	Perennial	Graminoid
ipco	*Ipomopsis congesta*	ballhead ipomopsis	Polemoniaceae	Native	Perennial	Forb
krla	*Krascheninnikovia lanata*	winterfat	Chenopodiaceae	Native	Perennial	Shrub
laoc	*Lappula occidentalis*	flatspine stickseed	Boraginaceae	Native	Annual	Forb

Table A-1. Plant species found in survey plots (continued)

Species Code	Current Scientific Name	Common Name	Family	Nativity	Duration	Growth Habit
Lase	*Lactuca serriola*	prickly lettuce	Asteraceae	Introduced	Annual	Forb
lase2	*Langloisia setosissima*	Great Basin langloisia	Polemoniaceae	Native	Annual	Forb
leci	*Leymus cinerus*	basin wildrye	Poaceae	Native	Perennial	Graminoid
lepe	*Lepidium perfoliatum*	clasping pepperweed	Brassicaceae	Introduced	Annual	Forb
lepu	*Leptodactylon pungens*	prickly phlox	Polemoniaceae	Native	Perennial	Shrub
lodi	*Lomatium dissectum*	fernleaf biscuitroot	Apiaceae	Native	Perennial	Forb
lofo	*Lomatium foeniculaceum*	desert biscuitroot	Apiaceae	Native	Perennial	Forb
luar	*Lupinus argenteus*	silvery lupine	Fabaceae	Native	Perennial	Forb
lupu	*Lupinus pusillus*	rusty lupine	Fabaceae	Native	Annual	Forb
lygr	*Lygodesmia grandiflora*	largeflower skeletonplant	Asteraceae	Native	Perennial	Forb
maca	*Machaeranthera canescens*	hoary aster	Asteraceae	Native	Perennial	Forb
meal	*Mentzelia albicaulis*	whitestem blazingstar	Loasaceae	Native	Annual	Forb
oeca	*Oenothera caespitosa*	tufted evening-primrose	Onagraceae	Native	Perennial	Forb
oepa	*Oenothera pallida*	pale evening-primrose	Onagraceae	Native	Perennial	Forb
oppo	*Opuntia polyacantha*	pricklypear	Cactaceae	Native	Perennial	Shrub
paca	*Packera cana*	wooly groundsel	Asteraceae	Native	Perennial	Forb
pasm	*Pascopyrum smithii*	western wheatgrass	Poaceae	Native	Perennial	Graminoid
pecy	*Penstemon cyaneus*	blue penstemon	Scrophulariaceae	Native	Perennial	Forb
phha	*Phacelia hastata*	silverleaf phacelia	Hydrophyllaceae	Native	Perennial	Forb
phho	*Phlox hoodii*	Hood's phlox	Polemoniaceae	Native	Perennial	Forb
phlo	*Phlox longifolia*	longleaf phlox	Polemoniaceae	Native	Perennial	Forb
pose	*Poa secunda*	Sandberg bluegrass	Poaceae	Native	Perennial	Graminoid
psla	*Psoralidium lanceolatum*	lemon scurfpea	Fabaceae	Native	Perennial	Forb
ptte	*Pteryxia terebinthina*	turpentine wavewing	Apiaceae	Native	Perennial	Forb
ragl	*Ranunculus glaberrimus*	sagebrush buttercup	Ranunculaceae	Native	Perennial	Forb
ruve	*Rumex venosus*	veiny dock	Polygonaceae	Native	Perennial	Forb
saka	*Salsola kali*	Russian thistle	Chenopodiaceae	Introduced	Annual	Forb
sial	*Sisymbrium altissimum*	tall tumblemustard	Brassicaceae	Introduced	Annual	Forb
scli	*Schoenocrambe linifolia*	flaxleaf plainsmustard	Brassicaceae	Native	Perennial	Forb
spcr	*Sporobolus cryptandrus*	sand dropseed	Poaceae	Native	Perennial	Graminoid
spmu	*Sphaeralcea munroana*	white-stemmed globe-mallow	Malvaceae	Native	Perennial	Forb
stsp	*Stephanomeria spinosa*	thorn skeletonweed	Asteraceae	Native	Perennial	Forb
teca	*Tetradymia canescens*	spineless horsebrush	Asteraceae	Native	Perennial	Shrub
taof	*Taraxacum officinale*	common dandelion	Asteraceae	Introduced	Perennial	Forb
tofl	*Townsendia florifer*	showy Townsend daisy	Asteraceae	Native	Annual	Forb
trdu	*Tragopogon dubius*	yellow salsify	Asteraceae	Introduced	Biennial	Forb