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A Survey of Plants and Animals of Hill and Wendover Bombing Ranges, Western Utah

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A SURVEY OF PLANTS AND ANIMALS OF HILL AND WENDOVER BOMBING RANGES, WESTERN UTAH

by

Mary Sue Fisher

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of the requirements for the degree

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Mary Sue Fisher

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A SURVEY OF PLANTS AND ANIMALS OF HILL AND WENDOVER BOMBING RANGES, WESTERN UTAH

by

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Utah State University, 1978

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The United States Air Force was required by the Sikes Act (16 USC 670 *et seq.*) to operate Hill and Wendover Bombing Ranges under a Land and Wildlife Management Plan consistent with military objectives. A preliminary biological inventory was conducted to provide basic information necessary for preparation of an appropriate management plan. The inventory was conducted over a one year period utilizing 60 field days on the ground and 30 hours of flying time. A list of vertebrates present on the bombing ranges was formed by general observation of large mammals, birds and reptiles, and trapping of small mammals. A cover map was prepared from ground and aerial observations of vegetation, and aerial photographs. Recommendations for management included construction of raptor nesting platforms and permanent water sources for birds and mammals.

(77 pages)

INTRODUCTION

The Sikes Act (16 USC 670 *et seq.*) authorizes the Secretary of Defense to initiate a program of wildlife conservation on military reservations in accordance with a cooperative plan agreed upon by the Secretary of Defense, Secretary of Interior, and an appropriate state agency. Provisions are made for issuance of special hunting and fishing permits, conservation and management of migratory game birds, and funding for habitat improvement and protection of endangered species.

Wendover-Hill Range Complex (Hill and Wendover Bombing Ranges), a United States Air Force (USAF) bombing range in western Utah, has been operated without a specific Land and Wildlife Management Plan. To comply with the Sikes Act, the USAF agreed to provide funds for the U. S. Fish and Wildlife Service (USFWS) to prepare a Land and Wildlife Management Plan consistent with the military mission. A basic biological inventory is necessary before a management plan can be prepared. Although two environmental studies [*Wachinski*, 1972; *Stark, et al.*, 1975] were conducted on the bombing ranges, no comprehensive biological data had ever been compiled for the Range Complex. Therefore, an initial inventory of animal and plant populations of the bombing ranges was done by the Utah Cooperative Wildlife Research Unit (UCWRU) of Utah State University, under contract with the USFWS.

The inventory was designed to be general and extensive, being conducted periodically for one year: 60 days were spent in the field.

Access to all areas was restricted, except when accompanied by a military escort familiar with explosive ordnance. No access was allowed in areas being actively used for munitions testing. Most of the Range Complex, however, was accessible during survey periods.

In order to provide the basis for a management plan, four objectives were outlined:

1. Determine species of mammals and birds present during each season of the year.

2. Determine dominant vegetation and prepare an extensive cover map.

3. Complete review of pertinent literature.

4. Compile and analyze data collected and pertinent literature into a technical report useful in the preparation of a Land and Wildlife Management Plan for the bombing ranges.

REVIEW OF LITERATURE

Literature pertaining to the bombing ranges can be organized into three sections: 1) studies of areas of similar habitat; 2) studies of areas directly adjacent to the bombing ranges; 3) studies conducted on the bombing ranges. Pertinent research of mammals, birds and vegetation is reviewed for each section.

Studies in Areas of Similar Habitat

Wendover and Hill Bombing Ranges are located in the Great Salt Lake Desert, a drainage basin within the Great Basin area of Utah. Additional basins are Escalante Desert, Sevier Desert, White Valley, Tooele Valley, Rush Valley and Cedar Valley, all located south of the Great Salt Lake Desert [*Fautin*, 1946]. Although the basins are separated by mountain ranges, their habitats are similar.

Fautin [1946] described the individual biotic communities which constituted what he termed the Northern Desert Shrub Biome. This biome includes plant communities below the elevation of the pinyon (*Pinus* sp.)-juniper (*Juniperus* sp.) woodland. The area he studied most intensively was White Valley. He described the shadscale (*Atriplex confertifolia*) community as being widely distributed, adapted to xeric conditions and in impervious soils. The horsebrush (*Tetradymia glabrata*) community was limited to higher benchlands of valleys. The greasewood (*Sarcobatus vermiculatus*) community occupied valley floors with heavy clay soils. Communities of winterfat (*Ceratoides lanata*), black sage (*Artemisia nova*), big sagebrush

(*A. tridentata*), pickleweed (*Allenrolfea occidentalis*) and little rabbitbrush (*Chrysothamnus stenophyllus*) were also described. *Bolen* [1962] described plant communities of inland salt marshes in west-central Utah. He noted that vegetation of mountain slopes and gravelly uplands was typical of the cold desert shadscale association. He listed rabbitbrush, (*Chrysothamnus* spp.), ephedra (*Ephedra nevadensis*) and horsebrush (*Tetradymia spinosa*) as associated plants, and juniper (*Juniperus osteosperma*) as typical of steeper slopes.

Kearney, et al. [1914] studied the vegetation in Tooele Valley and described sagebrush (*Artemisia* spp.), gray molly (*Kochia americana*), shadscale, and greasewood-shadscale associations. Studies of the vegetation of Escalante Valley [*Shantz and Piemeisal*, 1940; *Gates*, 1956] and Curlew (located north of Great Salt Lake Desert) and Rush Valleys [*Gates*, 1956] describe vegetation communities similarly.

General vegetational studies of Utah describe plant communities of the Great Basin [*Shantz*, 1925; *Woodbury*, 1948; *Foster*, 1965 and 1968; *Flowers and Evans*, 1966; *Cronquist, et al.*, 1972]. In a study of flora of the Great Salt Lake region, *Flowers* [1934] concluded that the greasewood-shadscale association was the climax community. He noted that the shadscale association was found in Tooele Valley valleys bordering the Great Salt Lake Desert, and Curlew Valley.

Fautin [1946] listed animals found in the Northern Desert Shrub Biome. Mammals of "major influence" were coyotes (*Canis latrans*), kit foxes (*Vulpes macrotis*) and badgers (*Taxidea taxus*). Common small mammals were kangaroo rats (*Dipodomys ordii* and *D. microps*), pocket mice (*Perognathus longimembris*, *P. formosus*, *P.*

parvus), pocket gophers (*Thomomys bottae*), white-tailed antelope squirrels (*Ammospermophilus leucurus*), and Townsend's ground squirrels (*Spermophilus townsendii*). He also found chipmunks (*Eutamias minimus*), harvest mice (*Reithrodontomys megalotis*), kangaroo mice (*Microdipodops megacephalus*), grasshopper mice (*Onychomys leucogaster*), wood rats (*Neotoma lepida*), and jackrabbits (*Lepus californicus*). Sixty-one species of birds were identified by *Fautin* [1946], including the turkey vulture (*Cathartes aura*), sharp-shinned hawk (*Accipiter striatus*), Swainson's hawk (*Buteo swainsoni*), golden eagle (*Aquila chrysaetos*), bald eagle (*Haliaeetus leucocephalus*) and marsh hawk (*Circus cyaneus*). He associated mammals and birds with the vegetational communities in which they were observed.

Mammals found in western Utah by *Egoscue* [1961] include vagrant shrew (*Sorex vagrans*), Nuttall's cottontail (*Sylvilagus nuttallii*), Audubon's cottontail (*S. audubonii*), and mountain voles (*Microtis montanus*), in addition to those mammals found by *Fautin* [1946]. A study of rodents of shadscale and sagebrush associations of Raft River Valley of northern Utah and southern Idaho revealed the presence of deer mice, least chipmunks (*Eutamias minimus*), Ord's kangaroo rats (*Dipodomys ordii*), Great Basin pocket mice (*Perognathus parvus*), little pocket mice (*P. longimembris*), desert wood rats (*Neotoma lepida*), grasshopper mice, and Townsend's ground squirrels and white-tailed antelope squirrels [*Larrison and Johnson*, 1973].

Studies of some individual mammals and birds of western Utah also contain information useful to a general inventory. Research has been conducted on kit foxes [*Egoscue*, 1956, 1962, 1975; *McGrew*,

1976], coyotes [*Clark*, 1972; *Knudsen*, 1976; *Hibler*, 1977] badgers [*Lindzey*, 1971], jackrabbits [*Stoddart*, 1972; *Wagner and Stoddart*, 1972; *Gross, et al.*, 1974], cottontails [*Holt*, 1975], and ground squirrels [*Hansen*, 1954]. Studies of raptorial species in western Utah include research on golden eagles [*Camenzind*, 1968], ferruginous hawks (*Buteo regalis*) [*Weston*, 1968; *Howard*, 1975; *Howard and Wolfe*, 1976] and bald eagles [*Edwards*, 1969; *Platt*, 1976]. General studies of raptors include a survey of raptors in Curlew Valley [*Platt*, 1971], raptor breeding biology [*Smith and Murphey*, 1973] and raptor mortality in western Utah [*Ellis, et al.*, 1969].

Basic checklists of both birds and mammals of Utah have been compiled and include taxonomy and distribution. *Barnes* [1927] prepared a list of mammals, as did *Durrant* [1952]. Lists of birds of Utah have been prepared by *Behle* [1944] and *Behle and Perry* [1975]. Dr. Fred L. Knopf, a graduate of Utah State University, prepared a list of birds seen on Gunnison Island (located in the Great Salt Lake, northeast of Hill Range) as part of a pelican study (pers. comm.).

Studies of Areas Adjacent to the Bombing Ranges

Land surrounding Hill Range and part of Wendover Range is managed by the Bureau of Land Management (BLM). The BLM has divided the land into five planning units (Fig. 1). Inventories and management plans have been prepared, or are in the process of being prepared, for all units. Information on climate, topography, soils, vegetational types, and economically important wildlife is included in inventory studies. Some vegetational types described are salt desert

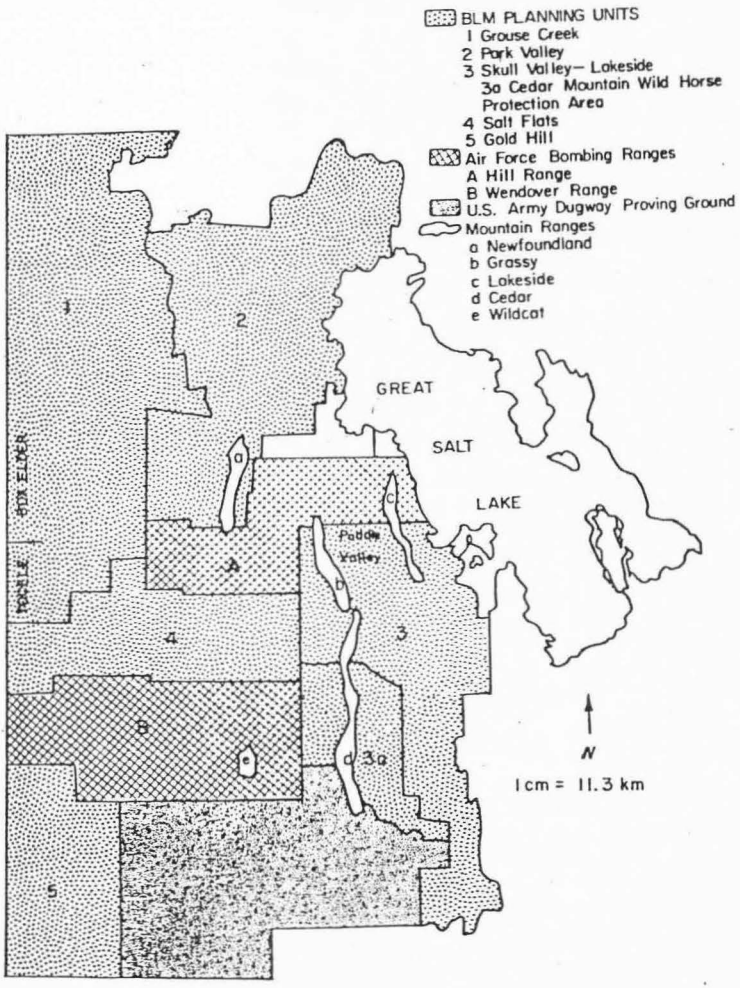

Figure 1. Northwestern Utah, showing BLM planning units, Hill and Wendover Bombing Ranges, Dugway Proving Ground, and associated mountain ranges.

shrub, sagebrush, juniper, and mountain brush. Some animal species listed are mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), coyote, feral horse (*Equus caballus*), chukar partridge (*Alectoris chukar*) and sage grouse (*Centrocercus urophasianus*).

Two projects were initiated in the Skull Valley-Lakeside Unit: 1) in 1972, the Utah Division of Wildlife Resources (DWR) and Brigham Young University (BYU) cooperated in construction of raptor nesting platforms in Puddle Valley, 2) in 1975, the DWR introduced 70 antelope, also in Puddle Valley (Fig. 1). In a preliminary environmental analysis, the DWR reported that vegetational associations of Puddle Valley were of the cold desert shrub type. Some animals observed were badgers, jackrabbits, white-tailed antelope squirrels, burrowing owls (*Speotyto cunicularia*) and golden eagles. Livestock (cattle and sheep) graze in Puddle Valley and surrounding mountains during winter.

The DWR conducted a study of biota in and around Great Salt Lake [*Rawley and Johnson*, 1974]. The study included observations of lake shoreline north and south of Hill Range. The shadscale-greasewood association was reported to be the dominant vegetational type of the shoreline. Animal species trapped in the area were deer mice, pocket mice, Ord's kangaroo rats and grasshopper mice. Chukars and mourning doves (*Zenaida macroura*) were observed in the lake area.

The southern 4.58 km of the Newfoundland Mountains are part of Hill Range. The DWR included a special study of the Newfoundland Mountains in a 1972 Big Game Range Inventory report [*Olson and Logan*, 1973]. Animals observed during the study were bobcats (*Lynx rufus*), coyotes, jackrabbits, chukars, golden eagles, great horned owls

(*Bubo virginianus*), ferruginous hawks, Swainson's hawks, American kestrels (*Falco sparvarious*) and prairie falcons (*F. mexicanus*). Greasewood and desert grasses were reported as dominant vegetational types for the southern Newfoundlands. Domestic sheep reportedly grazed the mountain range in winter. In 1975, a BLM aerial survey for raptor nests revealed three active prairie falcon nests in the southern Newfoundlands (Mike Leonard, BLM wildlife biologist, pers. comm.).

Flinders [1968] prepared a checklist of mammals of the southern Lakeside Mountains, as a result of a two year study. The checklist includes most species already mentioned in addition to long-tailed weasel (*Mustela frenata*) and small-footed myotis (*Myotis subulatus*). In a "hypothetical checklist", he suggests pygmy cottontail (*S. idahoensis*), mountain vole, and mountain lion (*Felis concolor*) as species possibly occurring in the Lakeside Mountains.

Wendover Range is partly bounded to the south by the U. S. Army Dugway Proving Grounds. Research has been done at Dugway by the University of Utah on ecology and epizoology of desert wildlife. Since 1952, a series of reports containing information about vegetation, birds, and small and large mammals has been produced. In one report, *Vest* [1962] described biotic communities in Dugway Valley. Vegetational types of the valley floor were barren salt flats, pickleweed, greasewood, shadscale, gray molly, budsage (*Artemisia spinescens*) and various interspersions. Mixed brush species and juniper-brush were characteristic of higher elevations. Mammals observed were associated with vegetational communities in which they were observed, and included typical desert rodents,

lagomorphs and carnivores. In a subsequent report, *Woodbury* [1964] included checklists of all known flora and fauna present in Dugway Valley. *Parker and Howell* [1959] reported eight species of rodents, three species of lagomorphs, five species of carnivores, and three avian species present in Dugway Valley. *Eco Dynamics, Inc.* [1972] conducted a nine year ecological study in western Utah in connection with the Department of Army Deseret Test Center. Population dynamics of rodents and lagomorphs present at the test center were included in addition to a list of all animals observed.

Studies Specific to the Bombing Ranges

Two biological studies have been conducted by the USAF on the bombing ranges. *Wachinski* [1972] prepared an Environmental Assessment (EA) for the bombing ranges, which were being proposed for continued use as munitions test ranges. Environmental impact was reported to consist of terrain disturbances and distribution of metal shell and bomb castings on and in the soil. As a part of the EA, a brief study of wildlife and vegetation was included, and identified plants and animals were listed. Environmental impact of explosive ordnance on plants was found to be two-fold: incendiary and chemical. Impact on wildlife was considered minimal.

Stark, et al. [1975] conducted a study on a site proposed for disposal of organic herbicide compounds by incorporation into the soil. Surveys of flora and fauna were made at various times during the study. Vegetation on the site was considered to be a climax community of shadscale and gray molly. Animals commonly observed were black-tailed jackrabbits, coyotes, horned larks (*Eremophila*

alpestris) and several raptorial species. A complete list of animals encountered and their distribution and abundance was included.

The Army Corps of Engineers conducted an impact study of the possible effects of pumping water from Great Salt Lake into the west desert [*Corps of Engineers*, 1976]. The level of the lake has risen since 1963 and private and other interests are concerned about economic impacts. Pumping water from the lake into the desert is an alternative being considered. The water would affect the area east and south of Newfoundland Mountains, much of which is on Hill Range. The impact report prepared by the Corps of Engineers maintains that most presently used targets and test pads would be inundated. Alternative target sites being considered would require acquisition of adjacent BLM land.

Summary

Research involving vegetation and animals of the Great Basin area of Utah is extensive and includes both specific and general results. Plant communities are well described in many studies and lists of mammals and birds have been prepared by several authors. According to available literature, vegetation communities of the Great Basin drainage areas are: 1) barren salt flats, 2) pickleweed association, 3) greasewood association, 4) shadscale association, 5) mixed brush, including sagebrush, horsebrush, rabbitbrush and winterfat. Various ecotones are often included in descriptions of community structure. Common mammals are coyotes, kit foxes, jackrabbits, cottontails, badgers, deer mice, pocket mice and kangaroo

rats. Birds often mentioned include golden eagles, red-tailed hawks (*Buteo jamaicensis*), marsh hawks and horned larks.

THE STUDY AREA

The Wendover-Hill Range Complex is located in northwestern Utah. Hill Range, comprised of 1,420 km^2, is located in Box Elder and Tooele Counties, and Wendover Range, comprised of approximately 2,388 km^2, is located in Tooele County (Fig. 2).

Physical Description

The Great Salt Lake Desert is part of a large inland drainage basin. At one period in geologic time, this basin was a large freshwater lake, Lake Bonneville, which drained into the Pacific Ocean through the Columbia River System. Climatic changes eventually caused reduction of the lake level to the comparatively small Great Salt Lake, which has no drainage outlet. The desert soils consist of alluvial deposits from before, during and after the Lake Bonneville period.

Topography

Hill Range topography varies from barren mud flats to vegetated valley floors to mountain ranges (Fig. 3). Elevations range from 1,279 m to 1,833 m. Three mountain ranges impinge on the Hill Range: the southern tip of the Newfoundland Mountains, the northern Lakeside Mountains, and foothills of the Grassy Mountains. All three mountain ranges are oriented in a north-south direction. The Newfoundland Mountains are approximately 33.8 km long and from 4 km to 8 km wide.

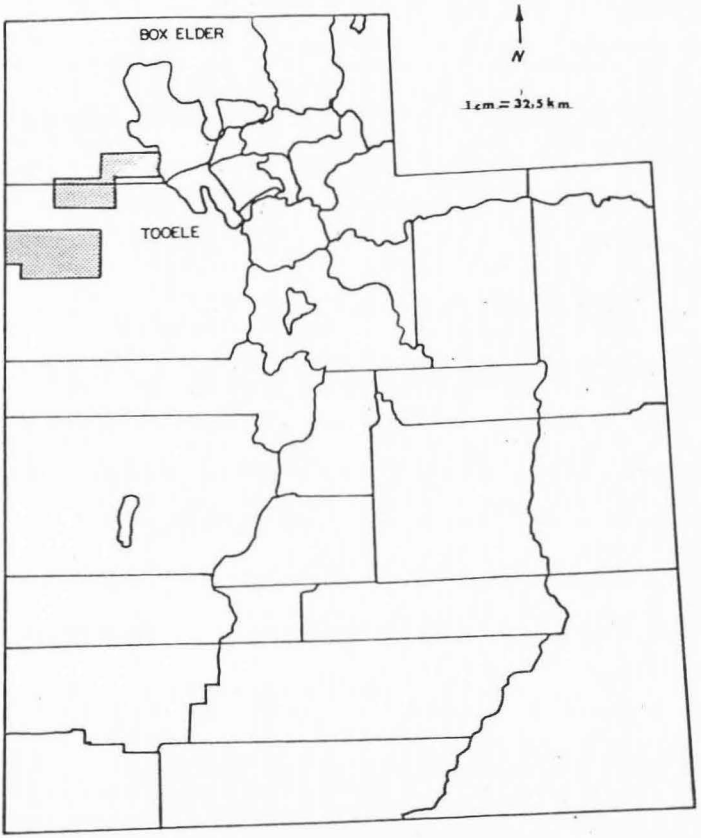

Figure 2. State of Utah, showing approximate location of Hill and Wendover Bombing Ranges.

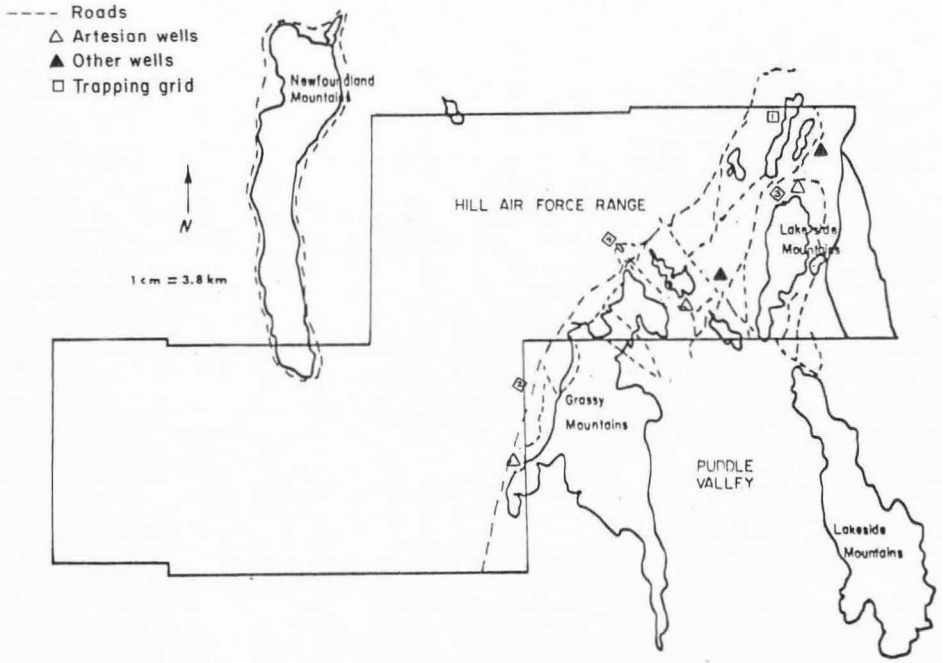

Figure 3. - Hill Air Force Range, western Utah, showing mountain ranges, roads (survey routes), trapping grids and wells.

The western side of the Newfoundlands is gently sloping, compared to steep cliffs on the eastern side. Rock formations were formed by several layers of sedimentary limestone [*Olson and Logan*, 1973]. The northern Lakeside Mountains were formed during the Paleozoic Era: folding is predominantly gentle and rocks are mostly dolomites with lesser amounts of sandstone, shale and quartzite [*Young*, 1953]. Grassy Mountains are similar in character to the Newfoundland and Lakeside Mountains. Alluvial fans are narrow and there are few outcrops of bedrock.

Valley floors are gently sloping and receive drainage from all sides. The salt flats are very level except for several isolated small hills. There is no slope gradient or drainage pattern in the salt flats: precipitation collects in small depressions, or stands on the soil surface until it evaporates or infiltrates into the soil.

Wendover Range is 75 percent mud flats: Wildcat Mountain and an associated hill are the only significant relief (Fig. 4). Mud flats and sand dunes are found at the base of Wildcat Mountain (elevation 1,611 m). Elevations of the mud flats range from 1,283 m to 1,303 m. The extreme west-central boundary of Wendover Range is adjacent to Blue Lake, a permanent marsh-lake area. It was formerly part of the bombing range, until 87.4 ha containing the lake and some marshland were deeded to the State of Utah in 1974. However, USAF land still incorporates some marshland.

Soil

General relief, soil texture and soil salt concentrations vary within vegetational communities of the Great Basin. Soils of valley

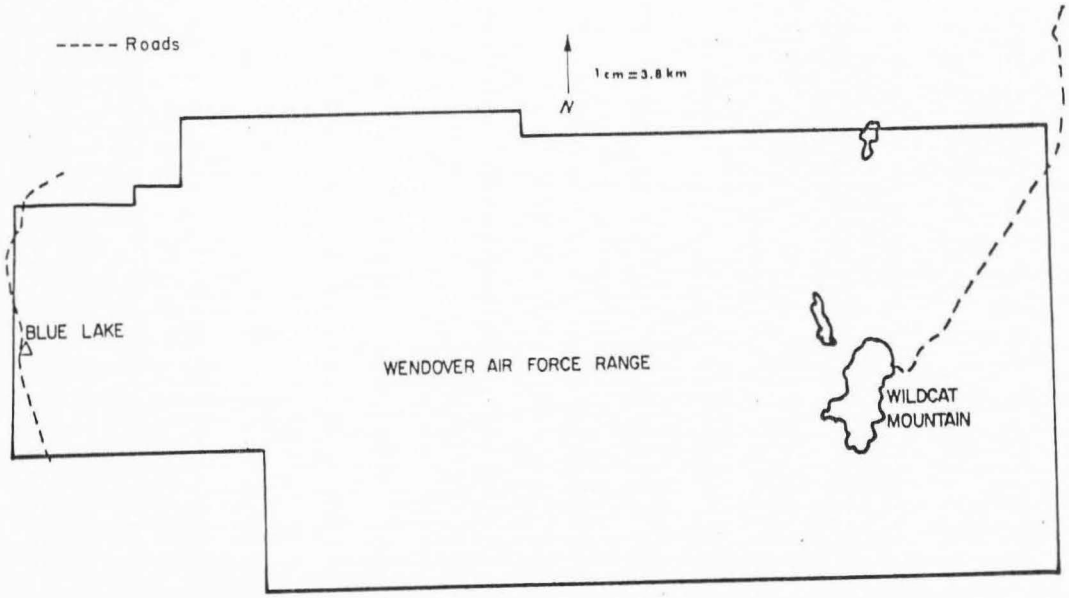

Figure 4. Wendover Air Force Range, western Utah, showing location of Wildcat Mountain and Blue Lake, and roads (survey routes). Eighty-seven hectares encompassing Blue Lake and some surrounding marshland were deeded to the State of Utah in 1974.

floors are primarily gray soils, while soils of the foothills, mountains and dunes are of a deeper loam [*Vest*, 1962]. Parent materials of soils of valley floors are either of sedimentary origin or alluvial outwash from adjacent mountain ranges [*Gates*, 1956]. Soils of the foothills and mountains are rocky and shallow (12.7 cm to 25.6 cm) and are predominantly gravelly, clay loam. Soil salt concentration is highest in valley floors, particularly mud flats, and varies with topography and soil texture [*Vest*, 1962].

Vest [1962] classified vegetational communities of Dugway Valley in relation to soil texture and concluded that soil texture influenced plant distribution. He reported that soils of the valley ranged from 90 percent sand to 80 percent clay. Intermediates included sandy loam, sandy-clay loam and clay loam. Soils of the salt flats are classified as being within the Playa soil group, characterized by high salt concentration and absence of profile development.

According to *Wachinski* [1972], soils of the Wendover-Hill Range Complex vary from undifferentiated rocks to northern gray desert soils in the mountains. Upper valley floors contain drained accumulations of alluvial fans, and playa of the lower valleys are composed of mineral laden soils.

Climate

The bombing ranges are in a semi-arid zone and precipitation throughout this zone is uniformly distributed over the year [*Gates*, 1956]. According to U. S. Climatological Records, about 60 percent of the precipitation falls as snow and 40 percent as rain.

U. S. Climatological Records for Wendover, Utah (located in

extreme west-central Utah), are available for the period 1931-1960. Average annual precipitation during this period was 119 mm: the mean during the wettest month being 17 mm and during the driest month, 7 mm. The maximum precipitation in 24 hours was 34 mm. The mean snowfall in January was 56 mm and the average seasonal total was 193 mm.

The average annual temperature during the 1931-1960 period in Wendover was 11.3°C, the highest being 44.4°C and the lowest, -28.7°C. The daily maximum and daily minimum for January were 2.24°C and -7.8°C, respectively, and for July, 33.3°C and 19.3°C, respectively.

History

The Great Salt Lake Desert was virtually unexploited prior to use by the Department of Defense (DOD). A few early explorations had been conducted by Kit Carson, John Fremont and Lunsford Hastings. In 1855, Hastings led the first wagon train across the mud flats, followed by the Donner-Reed party. Both parties suffered extensive losses and no wagon trains attempted to cross the mud flats again [*Kelly*, 1969].

Land within the Great Salt Lake Desert was acquired by the DOD in 1940 for use as a bombing and training field. The Department of Interior transferred 6,313 km^2 to the Air Corps and 9 km^2 were purchased from the State of Utah, Tooele County, and private holdings. An additional 1,060 km^2 was transferred to the DOD in 1941. A total of 14,164 km^2 were eventually acquired [*Arrington and Alexander*, 1963]. Changes in control occurred after World War II, with 2,309 km^2 being transferred to the U. S. Army as Dugway Proving Ground. The northern

section of land, Newfoundland Mountain Range, was redesignated as Hill Air Force Range in 1960 [*Wachinski*, 1972].

Present Status

Wendover-Hill Range Complex is presently used as a munitions test range, including rocket motor testing, munitions testing, and air-to-ground weapons delivery, using both live and inert ordnance [*Wachinski*, 1972]. The isolated and desolate nature of the area makes it ideal for use as a bombing range. *Wachinski* [1972] stated that the area is not suitable for farming, community development, mining, or hunting. However, grazing by domestic sheep occurs on parts of Hill Range during winter months: some incidental grazing occurs near the foothills of the Grassy Mountains, and localized grazing is allowed on the northeast corner of Hill Range and on the Newfoundland Mountains (Appendix A).

METHODS

The major objective of the study was to provide basic biological data to be useful in preparation of a Land and Wildlife Management Plan. Ground and aerial activities were limited in terms of time and support, necessitating a general study. Surveys were conducted to determine species of animals and plants present on the bombing ranges.

General Surveys

Ground surveys were conducted periodically between June 1976 and June 1977, including periods in every month except December (Table 1). Surveys conducted during daylight hours were concentrated within vegetated areas, although observation of mud flat habitat was also obtained. A jeep and four-wheel drive truck provided transportation during surveys. Observation and identification of animals were obtained with the use of 7×35 binoculars and a 15 to 40 power spotting scope. Observations were recorded with reference to date, associated habitat and location.

Surveys were accomplished by driving through study areas and stopping periodically to investigate specific habitats. General routes used are shown in Fig. 3 and Fig. 4. Routes through vegetated areas were surveyed during every field period, which usually consisted of a weekend. Utility poles along main roads were observed for raptors, and traditional raptor nest sites in abandoned observation towers, caves and on cliffs were checked periodically for signs of

Table 1. Number of days and locations of ground and aerial surveys conducted on Hill and Wendover Bombing Ranges in western Utah, 1976-1977.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Ground surveys													
Vegetated areas of Hill Range		6	3	3	1	3	3		13	3	10	1	10
Newfoundland Mountains				3	3								1
Blue Lake	1									1			
Wildcat Mountain		1								1			
Aerial surveys													
Vegetated areas of Hill Range		1					1				1	2	
Newfoundland Mountain		1					1				1	1	
Blue Lake		1											
Wildcat Mountain		1					1				1	1	

recent activity. Skeletal animal remains were collected and identified and animal tracks were identified when possible. Bird calls and songs positively identified were treated as observations.

Mountain ranges were surveyed on foot and occasionally with use of a jeep. An attempt was made to traverse all major draws and peaks one or more times during the study. Valley floors were walked and/or driven across. Blue Lake was surveyed, as well as adjacent marshes.

Vegetational composition for all areas was mapped according to major community types and associations [*Fautin*, 1946]. Aerial photographs of Hill Range aided in preparation of the vegetational cover map. Wendover Range vegetation was mapped from ground and aerial observations.

Nocturnal surveys were conducted by driving on main roads and walking in the main complex area (no one is allowed off main roads after dark). A portable four-power starlight scope was used to observe selected areas. Nocturnal sounds of animals, such as coyote howls, were treated as observations.

Helicopters were used on five occasions to conduct aerial surveys. Low altitude surveys encompassing the majority of the study area permitted observation of large mammals, raptors and vegetational composition. A total of 30 hours of flying time was utilized.

Air Force personnel were asked to note their observations of animals. Security police patrol main roads regularly and often participate in aerial patrols. Information gained from their observations of wildlife was regarded as general knowledge and treated as such.

Small Mammal Trapping

Sherman live traps and standard Victor mouse traps were used to trap small mammals. National single-door live traps were used to trap larger mammals. Traps were set systematically in various habitats and checked each morning and afternoon. Oatmeal and/or an oatmeal-peanut butter mixture was used as bait in Sherman traps and snap traps were baited with peanut butter. Either apples and lettuce or canned cat food was used to bait National traps.

Trapping was initiated in November and continued during every subsequent field period. An attempt was made to trap in all different vegetational types. All animals captured were positively identified and their location and associated habitat recorded.

Plant Collection

A representative sample of each plant species encountered was collected and identified at the Utah State University Intermountain Herbarium. The plant collection has been preserved at the UCWRU for future reference.

Population and Cover Estimates

A capture-mark-recapture method was used to attempt to estimate small mammal population size [*Taber and Cowan*, 1969]. Four 10 × 10 trapping grids were utilized with Sherman live traps placed 15 m apart. Two grids (Grid #1 and Grid #2) were set in early January, 1977 for nine and eight nights, respectively. Grid #3 and Grid #4 were set in late March, 1977 six and five days and nights, respectively. Each grid was

located in a different vegetational type: Grid #1, shadscale-cheatgrass (*Bromus tectorum*); Grid #2, shadscale; Grid #3, mixed shrub; Grid #4, shadscale-greasewood. Locations of grids are shown in Fig. 3.

Canopy cover in trapping grid areas was estimated as described by *Daubenmire* [1959]. Mean cover, standard deviation, and percent cover were estimated using a modified Daubenmire frame. A series of 20, 0.1 m^2, sample plots were placed systematically along three transects in each grid. Sample plots were placed every two or four paces at a 45° angle from the transect, alternating sides, to reduce bias.

The three transects in each grid were treated as a two-stage cluster sample [*Cochran*, 1963]: 1) each transect was randomly selected, and 2) sample plots were placed systematically along each transect. A grand mean and standard deviation between transects was estimated for each species from transect means alone [*Cochran*, 1963:276].

RESULTS

The major objectives of the study were to determine species of mammals and birds present on the bombing ranges, and to prepare a cover map. An extensive literature review was conducted to support and supplement findings of the study. Most species of mammals and birds identified during the study are included on biological checklists of the Great Basin. Vegetational structure is similar to that described in the literature for comparable areas within the Great Basin area of Utah.

General Surveys

Mammals and birds observed during 1976-1977 are shown in Table 2 and Table 3; scientific and common names of all species appear in Appendices B and C. Most mammals and birds observed were on Hill Range because most surveys were conducted there.

Large Mammals

Badgers were only occasionally observed, although evidence of their presence was common: diggings were abundant in all low-lying vegetated areas. Badgers were usually seen along roads near their dens.

Coyotes were heard or seen occasionally at night or during morning hours. All observations were of single coyotes, although USAF personnel reported seeing groups of three or more. No active coyote dens were located; however, USAF personnel reported seeing a

Table 2. Species of mammals observed on Hill and Wendover Bombing Ranges, western Utah, 1976-1977. Observations are shown with respect to habitat type and season of the year.

Species	Habitat Type[a]	Season Observed[b]
Badger	1, 2, 4	Sp, W
Coyote	1, 2, 4	Sp, S. F, W
Kit fox	1, 7	Sp, S, F, W
Townsend's ground squirrel	1, 4	Sp, W
White-tailed antelope squirrel*	3	Sp, W
Great Basin pocket mouse*	4, 5	Sp, W
Ord's kangaroo rat*	2, 3	W
Chisel-toothed kangaroo rat*	3, 4	Sp, W
Deer mouse*	1, 2, 3, 4, 5, 7	Sp, F, W
Pinon mouse*	4, 5	Sp
Desert woodrat*	4, 5	Sp, F, W
Black-tailed jackrabbit	1, 3, 4, 6	Sp, S, F, W
Cottontail	3, 4	Sp, S, F, W
Pronghorn	1, 4	Sp, S

[a]Habitats: 1=shadscale, 2=shadscale-cheatgrass, 3=greasewood-shadscale, 4=shadscale-mixed shrubs, 5=juniper-mixed shrubs, 6=sewage lagoon, 7=personnel buildings area

[b]Seasons: Sp=Spring (April-June), S=Summer (July-September), F=Fall (October-December), W=Winter (January-March)

*Species caught in live or kill traps: trapping was conducted during Fall, Winter, and Spring.

Table 3. Species of birds observed on Hill and Wendover Bombing Ranges, western Utah, during 1976-1977. Observations are shown with respect to habitat type, season of the year, and incidence of nesting.

Species	Habitat Type[a]	Season Observed[b]
Eared grebe	6	Sp
Snowy egret	1,3	Sp
Green-winged teal	6	Sp
Blue-winged teal	6	Sp
Cinnamon teal	1, 6	Sp
American wigeon	6	Sp
Ruddy duck	6	F
Red-tailed hawk*	1, 2, 3, 4	Sp, W
Rough-legged hawk	1, 2, 3, 4	F, W
Ferruginous hawk*	1, 2, 4	Sp
Golden eagle*	1, 2, 3, 4	Sp, S, F, W
Marsh hawk	1, 2, 3, 4, 6	Sp, S, F, W
Prairie falcon*	1, 2, 3, 4, 5, 7	Sp, S, F, W
American kestrel	1, 2, 3, 4	Sp, S, F, W
Chukar	2, 4, 5	Sp, S, W
American coot	6	Sp
Killdeer	2, 3, 6	Sp, W
Black-necked stilt	6	Sp
Wilson's phalarope	6	Sp
California gull	2, 3, 6, 7	Sp
Rock dove	7	Sp
Mourning dove	1, 2, 6, 7	Sp
Great horned owl	3, 5	S, F, W
Burrowing owl	1	Sp
Common nighthawk	7	Sp
Western kingbird	1, 2	Sp
Horned lark*	1, 2, 3, 4, 6	Sp, S, F, W
Violet-green swallow	6	Sp
Common raven*	1, 2, 3, 4	Sp, S, F, W
Mountain chickadee	5	F, W
Rock wren	3, 4, 5	Sp, S
Robin	3, 4	Sp, W
Mountain bluebird	1, 4	Sp, W
Loggerhead shrike	1, 3	Sp
Starling	1, 2, 3, 6, 7	Sp, W
Yellow warbler	6	Sp
Yellow-rumped warbler	5	Sp
House sparrow	3, 7	Sp
Western meadowlark	1, 2, 3, 4	Sp, S, F, W
Yellow-headed blackbird	6, 7	Sp
Red-winged blackbird	2, 6, 7	Sp, W
Brewer's blackbird	6, 7	Sp
Brown-headed cowbird	6, 7	Sp
Black-headed grosbeak	1	Sp
Vesper sparrow	1, 2, 3, 6	Sp
Lark sparrow	6	Sp
Black-throated sparrow	3, 4, 5	Sp
Gray-headed junco	5	Sp, F
Chipping sparrow	3	Sp
White-crowned sparrow	3, 6	Sp
Song sparrow	3, 6	

[a]Habitat type: 1=shadscale, 2=shadscale-cheatgrass, 3=greasewood-shadscale, 4=shadscale-mixed shrubs, 5=juniper-mixed shrubs, 6=sewage lagoon, 7=personnel buildings area

[b]Seasons: Sp=Spring (April-June), S=Summer (July-September), F=Fall (October-December), W=Winter (January-March)

*Species observed nesting

lactating female in the personnel (headquarters) area in Spring 1976.

Kit foxes were observed only in and around the personnel area of Hill Range. During June 1976, an active den was located approximately 30 m south of the headquarters area and less than 20 m east of the major access road. The kit foxes, while using this den, showed little fear of humans, often approaching personnel within two or three meters. During Winter 1977, several kit foxes used a den located in an unpaved parking area within the buildings area. Kit foxes were observed commonly throughout the headquarters area.

Pronghorn (antelope) observed on Hill Range are assumed to be part of a group of 70 released by the DWR in Puddle Valley. A maximum of six pronghorns were personally observed at any one time; USAF personnel reported seeing small herds of 15. No one reported observations of pronghorns on the bombing ranges during the winter.

Air Force personnel have observed feral horses on Wildcat Mountain of Wendover Range, both from the ground and from the air. A large herd of 87 or more horses were seen south of Wildcat Mountain on Dugway Proving Ground, during an aerial survey. During a ground survey of Wildcat Mountain in January, tracks from a group of seven horses were observed.

Small Mammals

Most small mammals observed were trapped in either kill or live traps (Table 2). Townsend's ground squirrels were not trapped but were observed in colonies along both paved and dirt roads. Very young Townsend's ground squirrels were first observed in late April. This species of ground squirrel is habitually dormant from early

Raptorial Birds

Nine species of raptors were observed on the bombing ranges, of which four were seen nesting. Locations of nests are shown in Figs. 5 and 6.

Red-tailed hawks were commonly observed during winter and spring. No successful nest was found on the bombing ranges, but a nesting pair was observed in the Grassy Mountains within three kilometers of Hill Range. A nesting attempt was observed on a building in the personnel area of Hill Range and the nest was defended by one red-tailed hawk for a short period. The nest was abandoned sometime during late March or early April, and when investigated, showed no sign of recent activity. Other nesting attempts by pairs of red-tailed hawks occurred on utility poles with twin crossbars: none of these attempts was successful.

Rough-legged hawks were commonly seen from November to late March. The ferruginous hawk was first observed in late April 1977. A pair of ferruginous hawks with a nest containing four eggs was observed on May 13. Another ferruginous hawk was seen on several occasions exhibiting defensive behavior in an area approximately 24 km from the nest mentioned above, but no nest was discovered.

Golden eagles were observed during almost every field trip, often in pairs and in the same areas. An active eagle nest was first located 30 May 1977. The nest was inaccessible without climbing equipment, so no information on clutch size could be obtained. However, the nest area was visited during subsequent field trips and an eagle was seen on each occasion as it left the nest. An eagle was observed on the nest during an aerial survey

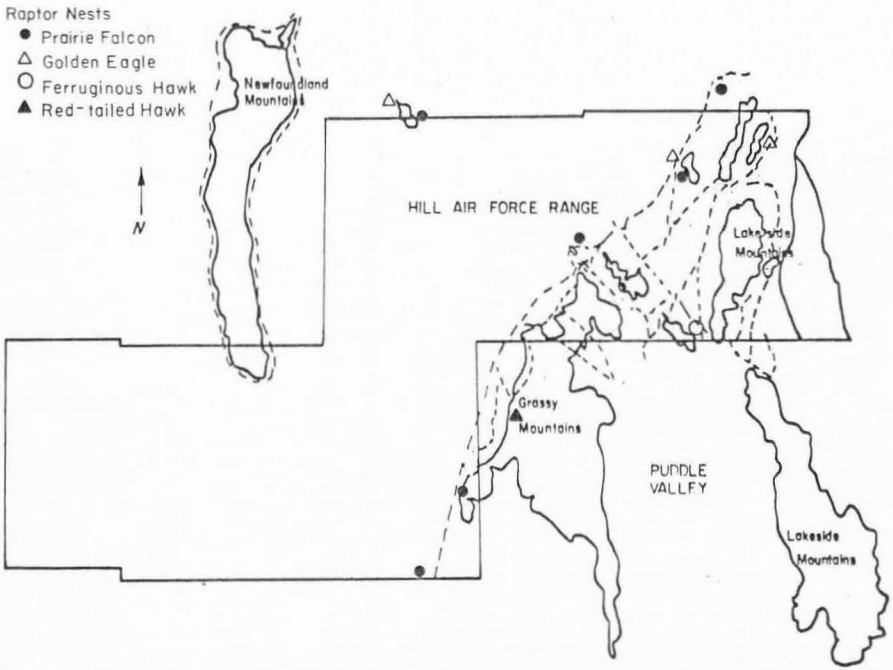

Figure 5. Hill Air Force Range, western Utah, showing approximate location of raptor nests thought to be active in Spring, 1977.

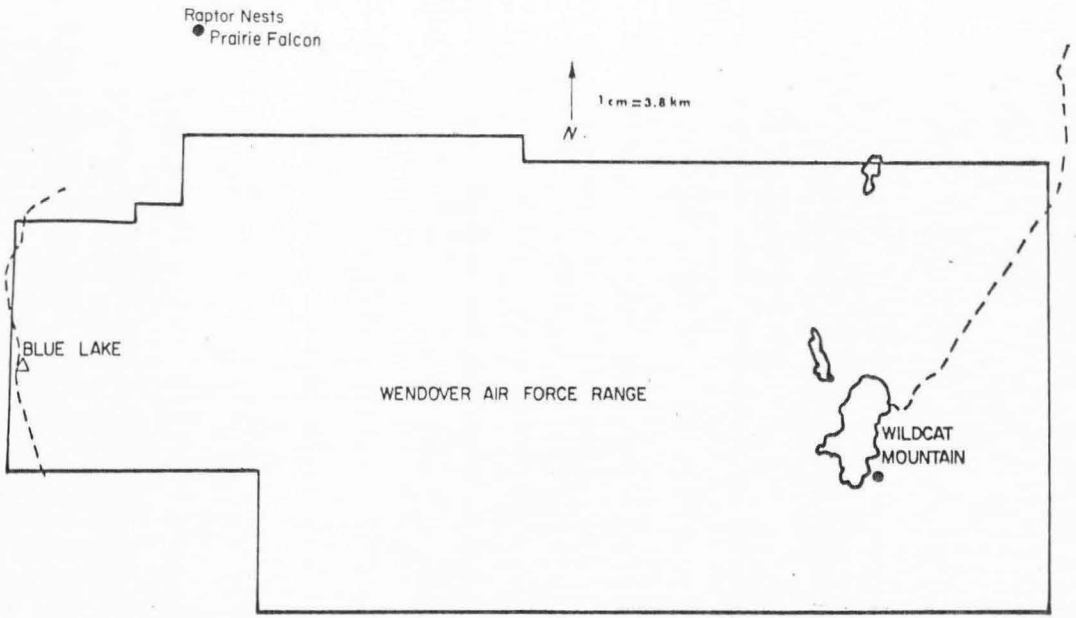

Figure 6. Wendover Air Force Range, western Utah, showing approximate location of active raptor nests in Spring, 1977.

in April, and on June 15, Captain Gotcher, a helicopter pilot, saw on the nest a young eagle, which did not fly at the approach of the helicopter but was otherwise active. Two other apparently active eagle nests were observed during an aerial survey 27 April 1977. One was visited again during a subsequent aerial survey on May 6 and no sign of recent activity could be found. The other nest was not visited again and thus its status was undetermined. Several other pairs of eagles were observed from the helicopter and from the ground, but no additional nests were discovered.

Marsh hawks were seen during all times of the year, but no nests were found. Usually marsh hawks observed were females, although males were seen occasionally. Pairs of males and females were rarely observed.

Prairie falcons were commonly observed all times of the year. At least five active nests were present on Hill Range during Spring 1977, two of which were located from the ground. Captain Gotcher located a nest on May 6 containing four eggs, and on June 8, he observed four nestlings in the nest for the first time. On June 14, Captain Gotcher found another nest, which contained one nestling and an adult prairie falcon. A prairie falcon was seen to respond both aggressively and vocally near cliffs approximately three kilometers north of Hill Range, suggesting the presence of a nest nearby. One active nest was located on Wildcat Mountain of Wendover Range during an aerial survey, in addition to several unoccupied prairie falcon scrapes.

American kestrels were observed occasionally during both ground and aerial surveys. No nests were located, although kestrels were

present on both bombing ranges during the nesting season.

Great horned owls were seen only a few times. On two occasions, a great horned owl was flushed from a juniper tree during the day, and one was heard before daylight on the Newfoundland Mountains. Owls were seen at night also, although the species could not be identified positively. A burrowing owl was observed on one occasion, as it flushed from a burrow beside the road. It flew a short distance and lit on the ground in the shadscale. The owl was flushed several times and it always remained in the vicinity.

Other Birds

Two small sewage settling ponds near the personnel area provided habitat for several avian species. Eleven species observed on the bombing ranges were seen only at these ponds. Twelve additional species were observed at the ponds as well as other habitats. A total of 26 passerine species were seen on Hill Range, some only on one or two occasions. One, a red-breasted nuthatch, was found dead in a cave near a shadscale-mixed brush vegetational type. Two species were observed nesting: the common raven and the horned lark. Ravens were commonly seen, often in pairs and occasionally in groups of 15 or more. A raven nest with young was observed from a short distance, at which time the adult ravens became very agitated, but not aggressive. Horned larks were also commonly seen many times throughout the year, and appear to be the most common avian species. A horned lark nest with four eggs was found beneath a shadscale bush.

Reptiles

Some reptile species were commonly seen during the summer, the

most common being the side-blotched lizard (*Uta stansburiana*). Other species of lizards observed were the collared lizard (*Crotaphytus collaris*), desert horned lizard (*Phrynosoma platyrhinos*), short-horned lizard (*P. douglassi*), and western whiptail (*Cnemidophorus tigris*). Two species of snakes were observed: the western rattlesnake (*Crotalus viridis*) and gopher snake (*Pituophis melanoleucus*).

Plant Communities

Plant communities were similar to those plant communities described by others as being typical of the Northern Desert Shrub Biome [*Fautin*, 1946; *Vest*, 1962]. A complete list of plants encountered during 1976-1977 including common and scientific names is in Appendix D. Large areas of mud flats were devoid of vegetation on both Hill and Wendover Ranges. There were also large areas adjacent to the barren mud flats where pickleweed occurred in scattered hummocks, in varying degrees of density. Greasewood and Nuttall's saltbush occasionally grew on the mounds of pickleweed. The greasewood-shadscale community occurred in areas slightly higher in elevation than pickleweed, in soils that were less saline. In some areas, greasewood grew in almost pure stands; usually it was interspersed with shadscale, Nuttall's saltbush, and seepweed and spiny horsebrush. Vegetated dunes were present in some areas, most noticeably west of the Newfoundland Mountains. Greasewood was present on the dunes, in addition to four-wing saltbush, green rabbitbrush, big rabbitbrush and spiny horsebrush.

The shadscale community was widespread and occurred in conjunction with different species in different areas. There were large areas

where it occurred almost entirely by itself, gray molly being the only other species present. In areas of higher elevation, it occurred with cheatgrass, which is an invading annual of disturbed areas. At the bases of the mountains and on dry hillsides, shadscale occurred with mixed brush species, including budsage, winterfat, sagebrush, horsebrush and ephedra. Perennial grasses were common among the shrubs and included bullgrass and Indian ricegrass.

The juniper-mixed brush community occurred only in the Lakeside Mountains of Hill Range. A variety of shrubs were present along with juniper and included big sagebrush, big rabbitbrush, winterfat and shadscale. Perennial grasses growing in the Lakesides included bullgrass, wildrye, galleta and Sandberg bluegrass.

General cover maps of Hill and Wendover Bombing Ranges are presented in Appendix E and Appendix F.

Population Estimates of Mammals

An attempt was made to estimate small mammal population size using a capture-recapture method. However, data collected were insufficient to analyze statistically. A total of two deer mice was captured on Grid #1 in 900 trap nights, with no recaptures. Three mice were caught on Grid #2 in 800 trap nights, with one recapture. Grid #3 and Grid #4, run for 600 and 500 trap days and nights, respectively, were somewhat more successful. Numbers of captures of individual animals are presented in Table 4. Two species, deer mice and chisel-toothed kangaroo rats, were caught in Grid #3; three species, deer mice, chisel-toothed kangaroo rats and white-tailed antelope squirrels, were caught in Grid #4. Traps were set day and night, and deer mice

Table 4. Species of mammals and numbers of individuals caught in trapping grids (100 traps per grid) on Hill Air Force Range, western Utah. Grid #1 and Grid #2 were run in early January, 1977, Grid #3 and Grid #4 were run in late March, 1977

	Deer mice	Chisel-toothed kangaroo rat	White-tailed antelope squirrel
Grid #1[a]	2	-	-
Grid #2[b]	3	-	-
Grid #3[c]	18	5	-
Grid #4[d]	1	4	4

[a]Traps run for 900 trap nights

[b]Traps run for 800 trap nights

[c]Traps run for 600 trap days and nights

[d]Traps run for 500 trap days and nights

and kangaroo rats were caught at night, while ground squirrels were caught during the day.

Estimates of Cover

Vegetation was sampled in each of the four trapping grids. Estimates of mean cover, standard deviation and percent cover are shown in Table 5. All live vegetation was included in samples, in addition to apparently dead shrubs which may often be dormant. Ground between shrubs in Grid #1 was almost completely covered by dead cheatgrass, an annual, which was not sampled. Some cheatgrass occurred in Grid #3, while none was present in Grid #2 or Grid #4.

Shadscale appeared to be the dominant species of the live shrubs, with respect to percent cover, in all grids. Total cover in all grids was sparse, the highest being in Grid #3, with 23.9 percent, and the lowest Grid #1, with 5.3 percent. Diversity was highest in Grid #3 and Grid #4, each with five species occurring in the sample plots, and lowest in Grid #1, with shadscale being the only living plant species sampled.

Table 5. Estimates of mean cover, standard deviation, and percent cover for each plant species sampled, in each trapping grid. Data collected on Hill Air Force Range, western Utah, May, 1977.

	$\bar{\bar{y}}$ [a]	SD($\bar{\bar{y}}$) [b]	CV [c]	Cover(%)
Grid #1				
Standing dead	21.3	10.0	47.2	2.1
Shadscale	33.3	7.3	20.8	3.3
Grid #2				
Standing dead	22.9	6.8	29.8	2.3
Shadscale	174.2	10.0	5.7	17.4
Gray molly	1.7	1.1	65.9	0.2
Grid #3				
Standing dead	29.1	2.3	8.0	2.9
Shadscale	92.5	23.6	25.5	9.2
Grasses	54.6	21.1	38.7	5.5
Budsage	47.1	14.6	30.9	4.7
Winterfat	12.1	5.5	53.5	1.2
Grid #4				
Standing dead	53.8	21.0	39.0	5.4
Shadscale	30.8	1.7	5.4	3.1
Greaseweed	26.3	15.6	59.5	2.6
Seepweed	3.2	2.0	64.6	0.3
Spiny horsebrush	15.4	14.8	96.0	1.5

[a] $\bar{\bar{y}}$: the grand mean, or the mean of the individual transect means, in cm^2

[b] SD($\bar{\bar{y}}$): the standard deviation of the grand mean

[c] CV: the coefficient of variation, or the standard deviation divided by the mean, multiplied by 100

DISCUSSION

General Results

Hill and Wendover Bombing Ranges are located in an area where animal and plant populations are somewhat limited because of xeric conditions. Very little biological research had been conducted in the area occupied by the bombing ranges in the past, even before acquisition by DOD. However, areas of similar habitat both north and south of the Range Complex have been studied and results indicated that a significant diversity of animal and plant life could exist on the bombing ranges. Results of the present biological inventory have confirmed these speculations.

Although the study was limited with respect to number of field days, fourteen species of mammals positively identified were observed, and convincing evidence of an additional three species was found. Fifty-two species of birds were identified, six of which were observed nesting. Other species probably nesting include marsh hawk, American kestrel, chukar, great horned owl, burrowing owl, common nighthawk, loggerhead shrike, starling, house sparrow, western meadowlark, vesper sparrow, lark sparrow, and black-throated sparrow. These species were present during the nesting season and some were observed singing.

It is likely that other species of both mammals and birds exist on the bombing ranges during some part of their annual cycle. A list of mammal species (Appendix G) which may be present on the bombing

ranges but were not observed during this study has been prepared based on records of other workers [*Fautin*, 1946; *Durrant*, 1952; *Egoscue*, 1961; *Flinders*, 1968].

The Range Complex, being a restricted area, serves as a refuge for birds and mammals. No hunting or other public use is allowed and possession of guns is limited to security police. Military activities probably adversely affect wildlife only to a small degree, because disturbing activities are concentrated in comparatively small areas. Some results of the presence of the Air Force benefit wildlife. Utility poles provide perches for raptors and some small birds. Artificial nest sites are provided by buildings, abandoned observation towers, and other structures. The sewage settling ponds provide resting and feeding habitat for some waterfowl and shorebirds, and nesting habitat for some passerines. The ponds are a source of drinking water for birds and mammals; other water sources are overflow from the main water storage tank in the personnel area and water collecting areas created by roads and other earth-moving activities.

Adverse effects of military activities do exist and the extent of the effect is difficult to assess. A large area of approximately 518 ha east of the Lakeside Mountains is frequently completely burned because of military use (see Appendix E). Vegetation composition is thus altered, as cheatgrass is a common invader after an area is burned, and is often more successful than native vegetation. Wildlife diversity may be limited in the burned area, although little data were collected there, since travel was restricted to roads.

Conflicts of military interests and wildlife activities occur but not commonly. For example, badgers have undermined roads and

buildings in some areas, necessitating a control program (carried out by the DWR). Electrocution of a significant number of eagles has occurred, a problem which has been treated twice, once with construction of perches above insulators (Fig. 7), and, when electrocutions continued, removal of perches and remounting of insulators below crossbars (Fig. 8).

For the most part, the military reservation and wildlife coexist and even derive some mutual benefit, the wildlife through presence of additional habitat and resources, and protection, and military personnel through aesthetic value of wildlife. Most permanent personnel respect the native wildlife and appear to have an active interest in its preservation.

Results of Population Estimates

Trapping grids constituted a very small part of a very large area. Therefore, results of trapping and of vegetation sampling cannot be extrapolated to apply to the whole area encompassed by the bombing ranges. However, trapping areas were chosen to represent different habitats and some comparison between them may have been possible if trapping success had been better. Poor trapping success in grids may be the result of several factors. Firstly, cold weather and snow during the trapping period of early January may have had an effect. Although deer mice are active throughout the year, they are probably less active during cold nights and may travel in tunnels beneath the snow. Mice caught in Grid #2 were caught on the last two nights of trapping when the temperature was higher and the snow had melted. Secondly, prebaiting might have increased trapping success

Figure 7. Electric utility pole with perches constructed by the USAF, being used by a red-tailed hawk. Note insulators mounted *above* cross-bars. (Photograph taken on Hill Air Force Range, western Utah).

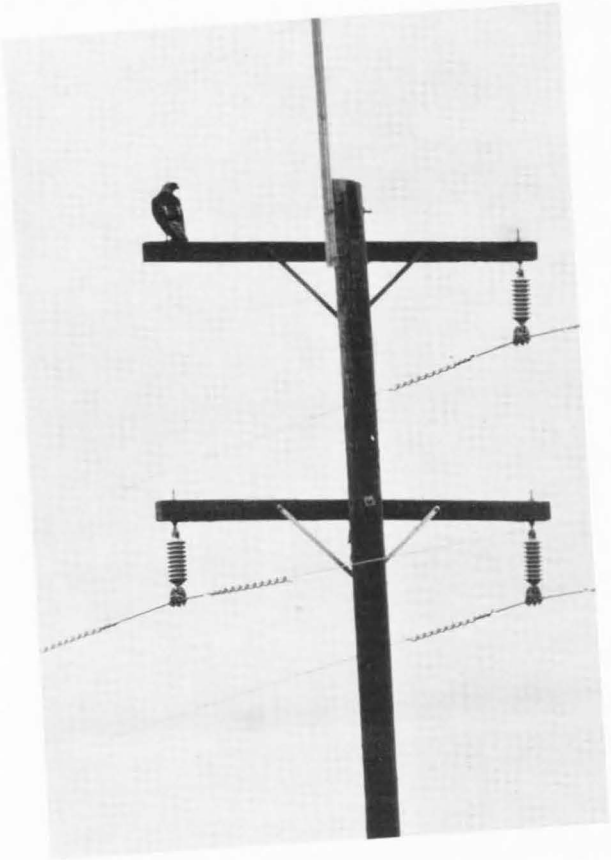

Figure 8. Red-tailed hawk on an electric utility pole modified by the USAF so that the insulators are mounted *below* the cross-bars. Perches have been removed. (Photograph taken on Hill Air Force Range, western Utah).

on Grid #3, since six new mice were caught on the sixth (last) night of trapping. If trapping could have been extended to nine or ten nights, success may have increased. Thirdly, there may simply be low populations of rodents. This is always possible, and, in areas where vegetation is sparse, is a reasonable theory. However, in Grid #3 and Grid #4 where vegetation was not sparse, some other factor, such as cold weather or low response to bait is a more plausible explanation.

Diversity of vegetation in the different grids appears to be the most obviously contrasting element. Grids 3 and 4 were more diverse, and additional species not occurring in sample plots were present, whereas no additional species were seen in Grids 1 and 2. More deer mice were caught in Grid #3 than the other grids, but factors surrounding each trapping session were so different (*e.g.*, weather, number of trap nights) that meaningful comparisons are difficult to make. Percent cover was also highest in Grid #3 and this may be a factor in mouse population density: the additional cover may provide suitable habitat for a greater number of mice.

SUMMARY

The USAF was required by the Sikes Act (16 USC 670 *et seq.*) to operate the Hill-Wendover Range Complex under a Land and Wildlife Management Plan consistent with military objectives. A preliminary biological inventory was conducted to provide basic information necessary for preparation of an appropriate management plan. The inventory was conducted over a one year period utilizing 60 field days on the ground and 30 hours of flying time. Access to all areas was restricted except when accompanied by a military escort familiar with explosive ordnance.

Major objectives of the study were to determine species of mammals and birds present on the bombing ranges, and to prepare a general cover map. Mammals observed during all seasons of the year were coyotes, kit foxes, black-tailed jackrabbits, and cottontails. Other mammals seen included badgers, white-tailed antelope and Townsend's ground squirrels, kangaroo rats, and pronghorns. Raptors observed during the study were red-tailed hawks, rough-legged hawks, ferruginous hawks, golden eagles, marsh hawks, prairie falcons, American kestrels, great horned owls, and burrowing owls, of which four species were observed nesting. Commonly observed passerines included horned larks, ravens, rock wrens, starlings and western meadowlarks. Vegetational types were typical of the Northern Desert Shrub Biome described by *Fautin* [1946]. Mountain vegetation was characteristically composed of shadscale and mountain brush, including sagebrush and rabbitbrush. Only the Lakeside Mountains of Hill

Range contained juniper. Shadscale and several species of shrubs (*e.g.*, sagebrush, winterfat, ephedra, and horsebrush) were typical of upper valley floors. Lower valley floors were covered with shadscale and gray molly or shadscale and cheatgrass or shadscale alone. Some lowlying areas contained greasewood or greasewood and shadscale, which also occurred near the edge of the mud flats. Pickleweek grew to the very edge of barren mud flats, in some areas, extensively. A cover map showing general plant community structure was prepared from ground and aerial observations and aerial photographs.

RECOMMENDATIONS

A Land and Wildlife Management Plan can be designed to enhance an area in order to increase species diversity and density, or simply to ensure that existing habitat is preserved and thus species present are not eliminated or reduced in numbers. Hill and Wendover Bombing Ranges encompass a habitat in which available water is a significant limiting factor to wildlife. Addition of permanent water sources would enhance the area to some degree but would probably not attract a significant number of new species. Pronghorns introduced into Puddle Valley by the DWR are dependent on water and have been observed in the vicinity of the main water storage tank, where excess water is periodically allowed to overflow. It is possible that pronghorns would use available forage on Hill Range if several permanent water sources were constructed and maintained. Other wildlife present in the area would benefit also and new species may be attracted to the immediate vicinity of water.

There are several possible alternatives in types of water developments. Check dams constructed in areas of run-off could provide at least temporary water sources. There are old artesian wells on Hill Range that no longer operate (Fig. 3); these wells could be rennovated or rebuilt in the same area. There is also a pump and holding tank that may be useable, and a government well used by sheepherders (Fig. 3). Gallinaceous guzzlers have been used successfully to provide a permanent water source for upland game birds in many places in the arid West. Guzzlers collect rain

water and once filled, remain at least half full throughout the year. Directions for building guzzlers and reports on their success are numerous [*Glading*, 1943; *Gullion*, 1954; *Campbell*, 1960; *Yoakum and Dasmann*, 1969]. Modification of guzzlers so that they may be used by large mammals will be necessary, but should not be difficult.

Raptor populations may be limited on Hill Range by scarcity of suitable nest sites. Raptors have been observed attempting to nest on utility poles. Air Force personnel have not allowed completion of these nests because of the hazard of electrocution of the birds. It is possible that abundant prey and lack of suitable nest sites encourage the birds to attempt to nest on power poles. Construction of nests on other man-made structures, *e.g.*, buildings and abandoned observation towers, have been successful. Artificial nesting platforms constructed in various areas would provide suitable nesting sites and possibly reduce incidences of nesting attempts on power poles. Nesting platforms have been constructed for osprey (*Pandion haliaetus*) [*Postupalsky and Stackpole*, 1974] and for everglade kites (*Rostrhamus rociabilis*) [*Sykes and Chandler*, 1974]. The DWR constructed nesting platforms for eagles and hawks and included building specifications in an environmental analysis [*Warburton*, 1972].

Two other aspects should be considered in the preparation of a management plan. Firstly, Donald A. Smith, Director of the DWR, stated that the DWR is interested in obtaining the additional marshland around Blue Lake that is controlled by the Air Force. If this marshland were tranferred to the DWR, they could include it in their own management plan for Blue Lake, which was obtained through a land

tranfer in 1974. Secondly, the fact that sheep graze on the Newfoundland Mountains and the northeast part of Hill Range should be taken into account if any range improvement practices are implemented. Although not recommended as a high priority management project, range improvement through burning and replanting is a possibility [*Yoakum and Dasmann*, 1969].

In general, the Land and Wildlife Management Plan (to be prepared by the USFWS) can be reasonably simple. There is no hunting or other recreation allowed on the bombing ranges, which simplifies any management plan. Development of water sources in the form of check dams, wells, and/or gallinaceous guzzlers, and construction of raptor nesting platforms are two major improvements that are recommended. Both of these projects could be implemented with minimal effort and the consequences should not cause interference with military activities. Other ideas for improvement of habitat for birds and mammals may be formed by the USFWS as the writers of the management plan become more involved.

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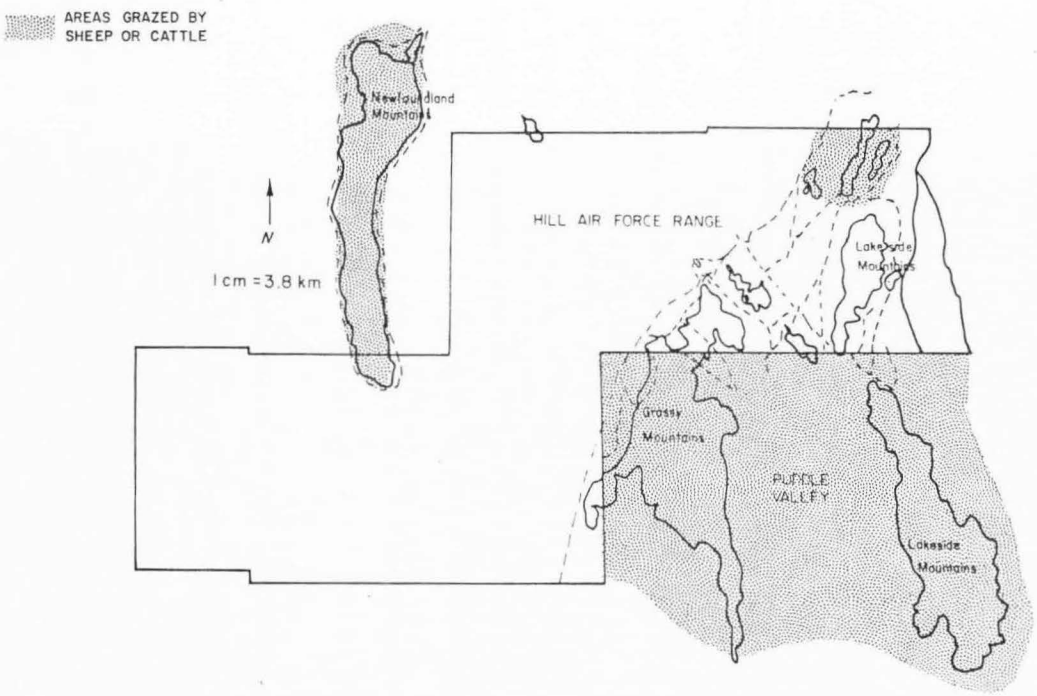
APPENDICES



Appendix A. Map of Hill Air Force Range, western Utah, showing general areas grazed by sheep and/or cattle during Winter, 1976-1977. Areas within Hill Range boundary lines are grazed by sheep.

Appendix B. Common and scientific names of mammalian species observed on Hill and Wendover Bombing Ranges, 1976-1977. Nomenclature follows *Hall and Kelson* [1959].

Order LAGOMORPHA

Family Leporidae
Lepus californicus black-tailed jackrabbit
* *Sylvilagus* spp. cottontail

Order RODENTIA

Family Sciuridae
* *Ammospermophilus leucurus* white-tailed antelope squirrel
Spermophilus townsendii Townsend's ground squirrel
Family Geomyidae
Thomomys sp. pocket gopher
Family Heteromyidae
Perognathus parvus Great Basin pocket mouse
* *Dipodomys ordii* Ord's kangaroo rat
Dipodomys microps chisel-toothed kangaroo rat
Family Cricetidae
Peromyscus maniculatus deer mouse
Peromyscus truei pinon mouse
Neotoma lepida desert wood rat

Order CARNIVORA

Family Canidae
Canis latrans coyote
Vulpes macrotis kit fox
Family Mustelidae
Mustela sp. weasel
Taxidea taxus badger
Family Felidae
Lynx rufus bobcat

Order ARTIODACTYLA

Family Antilocapridae
Antilocapra americana pronghorn

* Species observed on both Hill and Wendover Bombing Ranges

All other species observed only on Hill Range

Appendix C. Common and scientific names of avian species observed on Hill and Wendover Bombing Ranges, 1976-1977. Nomenclature follows *Behle and Perry* [1975].

Order PODICIPEDIFORMES

Family Podicipedidae
Podiceps nigricollis eared grebe

Order CICONIIFORMES

Family Ardeidae
Egretta thula snowy egret

Order ANSERIFORMES

Family Anatidae
Anas crecca green-winged teal
Anas discors blue-winged teal
* *Anas cynoptera* cinnamon teal
Anas americana American wigeon
Oxyura jamaicensis ruddy duck

Order FALCONIFORMES

Family Accipitridae
Buteo jamaicensis red-tailed hawk
Buteo lagopus rough-legged hawk
Buteo regalis ferruginous hawk
* *Aquila chrysaetos* golden eagle
* *Circus cyaneus* marsh hawk
Family Falconidae
* *Falco mexicanus* prairie falcon
* *Falco sparvarius* American kestrel

Order GALLIFORMES

Family Phasianidae
Alectoris chukar chukar

Order GRUIFORMES

Family Rallidae
* *Fulica americana* American coot

Order CHARADRIIFORMES

Family Charadriidae
Charadrius vociferus killdeer
Family Recurvirostridae
Himentopus mexicanus black-necked stilt

Appendix C. (Continued)

Family Phalaropodidae
Stegonopus tricolor Wilson's phalarope
Family Laridae
* *Larus californicus* California gull

Order COLUMBIFORMES

Family Columbidae
Columba livia rock dove
Zenaida macroura mourning dove

Order STRIGIFORMES

Family Strigidae
Bubo virginianus great horned owl
Speotyto cunicularia burrowing owl

Order CAPRIMULGIFORMES

Family Caprimulgidae
Chordeiles minor common nighthawk

Order PASSERIFORMES

Family Tyrannidae
Tyrannus verticalis western kingbird
Family Alaudidae
* *Eremophila alpestris* horned lark
Family Hirundinidae
Tachycineta thalassina violet-green swallow
Family Corvidae
* *Corvus corax* common raven
Family Paridae
Parus gambeli mountain chickadee
Family Sittidae
Sitta canadensis red-breasted nuthatch
Family Troglodytidae
Salpinctes obsoletus rock wren
Family Turdidae
Turdus migratorius American robin
Sialia currucoides mountain bluebird
Family Laniidae
Lanius ludovicianus loggerhead shrike
Family Sturnidae
Sturnus vulgaris starling
Family Parulidae
Dendroica petechia yellow warbler
Dendroica coronata yellow-rumped warbler
Family Pleceidae
Passer domesticus house sparrow

Appendix C. (Continued)

Family Icteridae
Sturnella neglecta western meadowlark
Xanthocephalus xanthocephalus yellow-headed blackbird
* *Agelarius phoeniceus* red-winged blackbird
Euphagus cyanocephalus Brewer's blackbird
Molothrus ater brown-headed cowbird
Family Fringillidae
Pheucticus melanocephalus black-headed grosbeak
Pooecetes gramineus vesper sparrow
Chondestes grammacus lark sparrow
Amphispiza bilineata black-throated sparrow
Junco caniceps gray-headed junco
Spizella passerina chipping sparrow
Zonotrichia leucophrys white-crowned sparrow
Melospiza melodia song sparrow

* Species observed on Wendover Range, as well as Hill Range. All other species were observed only on Hill Range.

Appendix D. Common and scientific names of plant species encountered on Hill Air Force Range, western Utah, 1976-1977.

Class GYMNOSPERMAE

Family Cupressaceae
Juniperus osteosperma (Torr.) Little. Utah juniper
Family Ephedraceae
Ephedra nevadensis S. Wats. Nevada ephedra

Class ANGIOSPERMAE

Subclass Monocotyledonae

Family Poaceae
Bromus tectorum L. cheatgrass
Elymus cinereus Scribn. and Merr. gray ryegrass
Agropyron spicatum (Pursh) Scribn. and Smith. bluebunch
Elymus ambiguous Vasey and Scribn. bull grass /wheatgrass
Hilaria jamesii (Torr.) Benth. galleta
Oryzopsis hymenoides (R. and S.) Riker. Indian ricegrass
Poa sandbergii Vasey. Sandberg bluegrass
Sitanion hystrix (Nutt.) J. G. Smith. squirreltail
Sporobolus airoides Torr. alkali sacaton
Family Cyperaceae
Scirpus sp. bulrush

Subclass Dicotyledonae

Family Salicaceae
Salix exigua Nutt. sandbar willow
Family Santalaceae
Comandra umbellata (L.) Nutt. var. *pallida* (DC.) Jones. toad-
Family Polygonaceae /flax
Eriogonum spp. buckwheat
Family Chenopodiaceae
Allenrolfea occidentalis (S. Wats.) Kuntz. pickleweed
Atriplex canescens (Pursh) Nutt. fourwing saltbush
Atriplex confertifolia (Torr. and Frem.) S. Wats. shadscale
Atriplex falcata (M. E. Jones) Standl. Nuttall's saltbush
Ceratoides lanata (Pursh) Howell. winterfat
Grayia spinosa (Hook.) Moq. hopsage
Halogeton glomeratus(Bieb.) C. A. Meyer. halogeton
Kochia americana S. Wats. gray molly
Salsola kali L. Russian thistle
Sarcobatus vermiculatus (Hook.) Torr. greasewood
Suaeda occidentalis S. Wats. seepweed
Suaeda nigra (Raf.) J. F. Macbr. seepweed
Bassia hyssopifolia (Pall.) Kuntz. bassia
Family Amaranthaceae
Amaranthus albus L. amaranth

Appendix D. (Continued).

Family Brassicaceae
Arabis divaricarpa A. Nels. rockcress
Descurainia pinnata (Watt.) Britt. tansy mustard
Erysimum asperum DC. wallflower
Lepidium perfoliatum L. peppergrass
Sisymbrium altissimum L. tumbling mustard
Thelypodium sagittatus (Nutt.) Endl. thelypodium
Family Saxifragaceae
Ribes cereum Dougl. squaw currant
Family Fabaceae
Astragalus purshia Dougl. milkvetch
Family Geraniaceae
Geranium sp. geranium
Family Malvaceae
Sphaeralcea munroana (Dougl.) Spach. orange globemallow
Family Tamaricaceae
Tamarix pentandra Pall. five-stamen tamarisk
Family Loasaceae
Mentzelia laevicaulis (Dougl.) T. and G. blazing star
Family Cactaceae
Opuntia sp. prickly pear
Family Onagraceae
Oenothera caespitosa Nutt. evening primrose
Family Apiaceae
Lomatium grayi C. and R. desert parsley
Family Polemoniaceae
Phlox hoodii Richards. phlox
Family Boraginaceae
Cryptantha nana (Eastw.) Payson. cryptantha
Family Scrophulariaceae
Castilleja chromosa A. Nels. Indian paintbrush
Verbascum thapsus L. flannel mullein
Family Asteraceae
Artemisia spinescens D. C. Eaton. budsage
Artemisia tridentata Nutt. big sagebrush
Artemisia nova A. Nels. black sagebrush
Brickellia microphylla (Nutt.) Gray. bricklbrush
Chrysothamnus viscidiflorus (Hook.) Nutt. rabbitbrush
Chrysothamnus nauseosus (Pall.) Britt. rabbitbrush
Grindelia aphanactis Rydb. gumweed
Gutierrezia sarothrae (Pursh) Britt. and Rusby snakeweed
Helianthus annuus L. sunflower
Lygodesmia juncea (Pursh) D. Don. slender rush pink
Lygodesmia spinosa Nutt. spiny rush pink
Tetradymia spinosa T. and G. spiny horsebrush
Tetradymia glabrata Gray. horsebrush
Erigeron pumilus Nutt. fleabane
Haplopappus acaulis (Nutt.) Gray. goldenweed
Haplopappus nanus (Nutt.) Eat. goldenweed
Aster canescens Pursh aster

Appendix E.

Cover map of Hill Air Force Range, western Utah

Appendix F.

Cover map of Wendover Air Force Range, western Utah

Appendix G. Common and scientific names of additional mammals that may occur on Hill and Wendover Bombing Ranges, according to studies in the Great Basin area of Utah [*Fautin*, 1946; *Durrant*, 1952; *Egoscue*, 1952; *Egoscue*, 1961; *Flinders*, 1968]. Nomenclature follows *Hall and Kelson* [1959] except as noted.

Order INSECTIVORA

Family Soricidae
Sorex vagrans vagrant shrew

Order CHIROPTERA

Family Vespertilionidae
Myotis lucifugus little brown myotis
Myotis evotis long-eared myotis
Myotis volans long-legged myotis
Myotis subulatus small-footed myotis
Pipistrellus hesperus western pipistrel
Eptesicus fuscus big brown bat
Lasiurus cinereus hoary bat
Plecotus townsendii western big-eared bat
Antrozous pallidus pallid bat
Family Molossidae
Tadarida brasiliensis Mexican freetail bat

Order LAGOMORPHA

Family Leporidae
Sylvilagus nuttallii Nuttall's cottontail
Sylvilagus audubonii desert cottontail

Order RODENTIA

Family Sciuridae
Eutamias minimus least chipmunk
Eutamias dorsalis cliff chipmunk
Family Geomyidae
Thomomys bottae Hall Botta pocket gopher
Family Heteromyidae
Perognathus longimembris little pocket mouse
Perognathus formosus long-tailed pocket mouse
Microdipodops megacephalus dark kangaroo mouse
Family Cricetidae
Reithrodontomys megalotis western harvest mouse
Peromyscus crinitus canyon mouse
Onychomys leucogaster northern grasshopper mouse
Neotoma cinerea bushy-tailed woodrat
Microtis montanus mountain vole
Microtis longicaudus long-tailed vole
Lagurus curtatus sagebrush vole

Appendix G. (Continued).

Order CARNIVORA

Family Mustelidae
Mustela frenata long-tailed weasel
Spilogale putorius Eastern spotted skunk
Family Felidae
Felis concolor mountain lion

Order ARTIODACTYLA

Family Cervidae
Odocoileus hemionus mule deer