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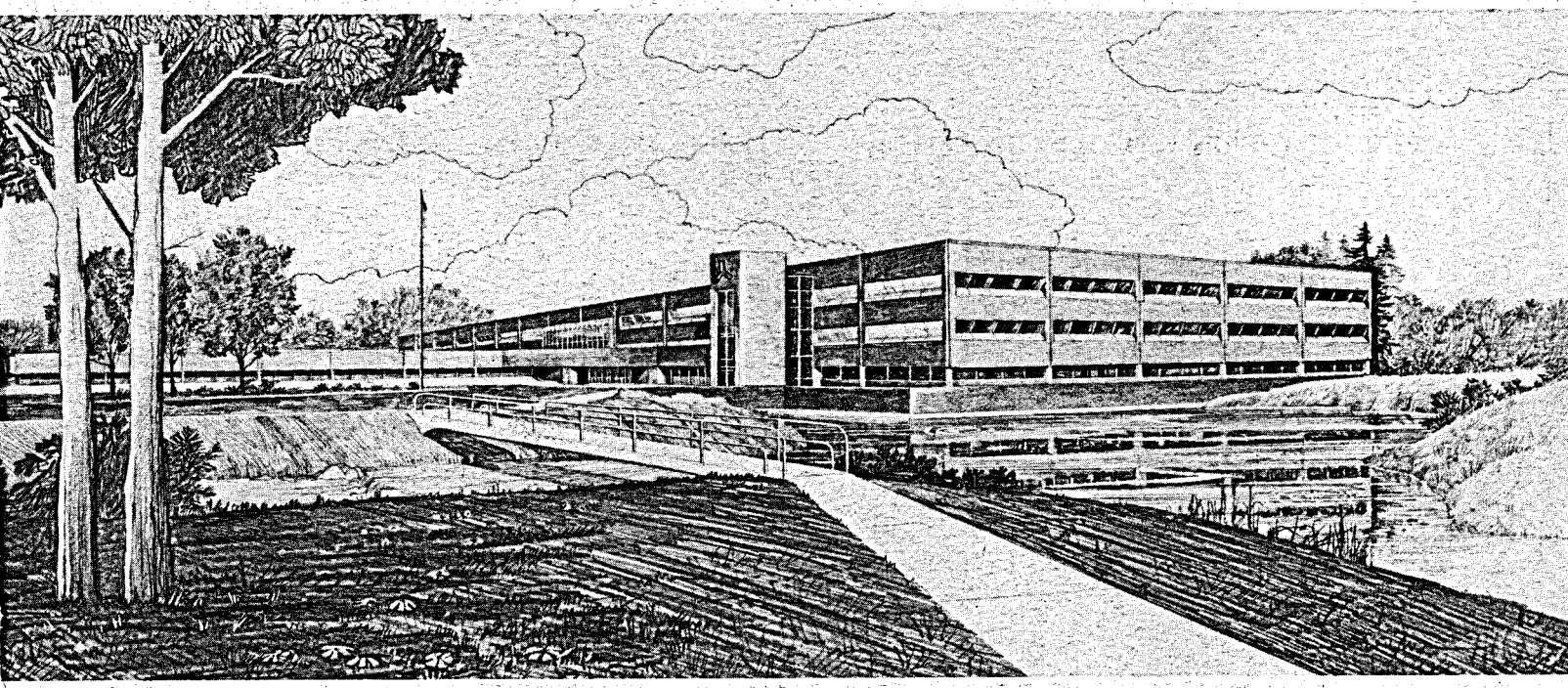
BRUNEAU KNOWN GEOTHERMAL RESOURCE AREA:

AN ENVIRONMENTAL ANALYSIS

Sue G. Spencer
Brent F. Russell
Editors

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



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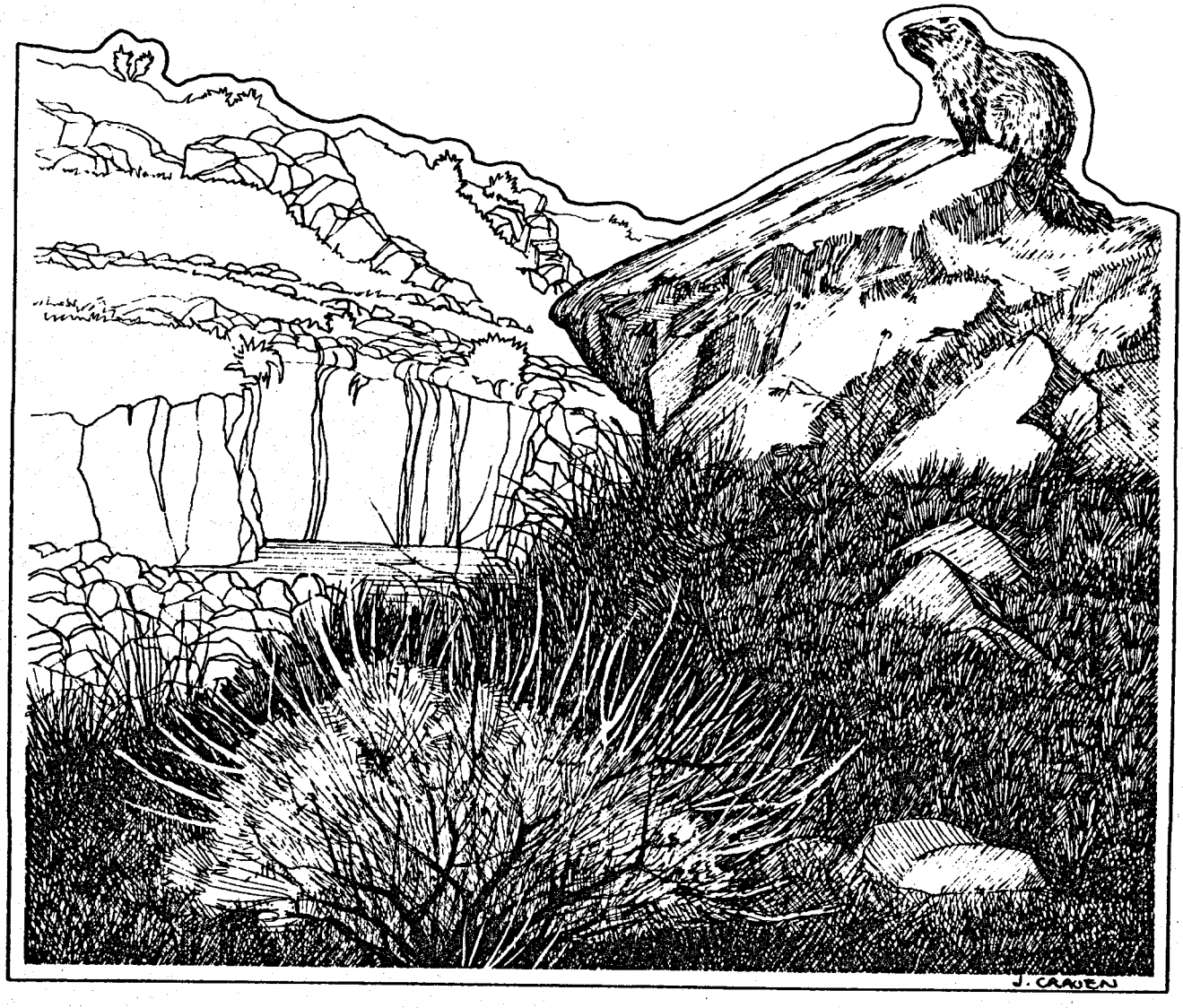


BRUNEAU KNOWN GEOTHERMAL RESOURCE AREA: AN ENVIRONMENTAL ANALYSIS

ABSTRACT

The Bruneau Known Geothermal Resource Area (KGRA) is part of the Bruneau-Grandview thermal anomaly, the largest geothermal area in the western U.S. This part of Owyhee County is the driest part of Idaho. The KGRA is associated with the southern boundary fault zone of the Snake River Plain. Thermal water, produced from numerous artesian wells in the region, is supplied from two major aquifers. Ecological concerns include the threatened Astragalus mulfordiae and the numerous birds of prey nesting in the Snake River canyon northwest of the KGRA. Extensive geothermal development may strain the limited health care facilities in the county. Ethnographic information suggests that there is a high probability of prehistoric cultural materials being remnant in the Hot Spring locality.

INTRODUCTION

EG&G Idaho, Inc., has completed an environmental analysis for the Bruneau KGRA as part of a comprehensive preplanning environmental program related to the KGRAs in the Snake River Basin. EG&G Idaho, Inc., is performing this preplanning environmental program under the auspices of the Office of Health and Environmental Research of the U.S. Department of Energy (DOE). KGRAs included under this program (see Figure 1) are Vulcan Hot Springs, Crane Creek, Castle Creek, Bruneau, Mountain Home, Raft River, Island Park, and Yellowstone. The Bruneau KGRA is the subject of this report.

The ultimate goal of the preplanning environmental program is to reduce the delays in geothermal development while minimizing environmental impacts by (a) assessing the existing environmental baseline data for the KGRAs, (b) evaluating those data for adequacy and applicability, and (c) developing a plan for supplementing the existing data to achieve a sound environmental data base prior to geothermal development.

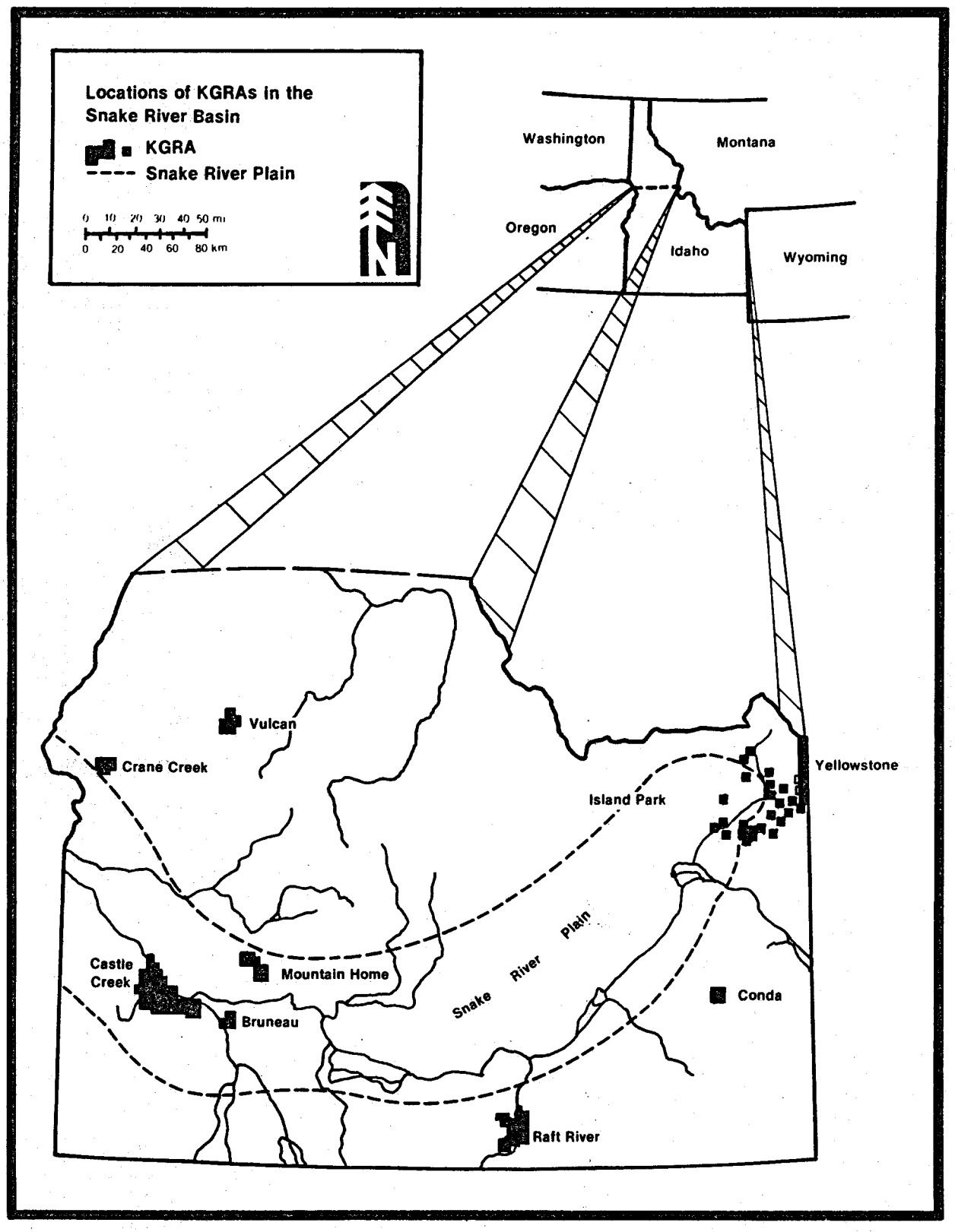


Figure 1. Locations of KGRAs in the Snake River Basin.

Results from the environmental program thus far include a summary of the environmental concerns related to geothermal development in each of the KGRAs,[1] an annotated bibliography of reference materials, detailed reports on the various program elements for each of the KGRAs, a program plan identifying future research needs, and a comprehensive data file. These will serve (a) as planning tools for state and federal energy, environmental, and land management agencies; (b) as reference documents for developers to shorten and simplify project environmental evaluations; and (c) as a means of identifying the significant environmental concerns for each KGRA so that mitigation measures can be incorporated early in the development process.

This report includes available environmental information for the Bruneau KGRA. The information presented is a compilation of the most recent data available for analyzing the physical, biological, and human environment for this area. The sources providing the data are identified alongside the subject titles throughout the report. Current commitments and environmental concerns that might affect geothermal development in the region are discussed. Other reports in this series, as well as the technical reports that form the basis of this overview, are listed in Appendix A and are available from Information Processing in the Information Division at EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, Idaho 83401.

EVALUATION OF THE ENVIRONMENT

The Bruneau KGRA is located in eastern Owyhee county on the Bruneau River (Figures 2 - 5). The Bruneau River canyon is considered the steepest canyon in the United States. Of the 2072 ha in the KGRA, 1052 are controlled by the Bureau of Land Management. All of the BLM land has been leased for geothermal exploration and development. Early use of hot springs in the area included Pence Ranch, the oldest settlement in the valley, which boasted a swimming pool supplied from hot springs. At Indian Bathtub, hot springs form a falls into the tub area, the walls of which are covered with pictographs.

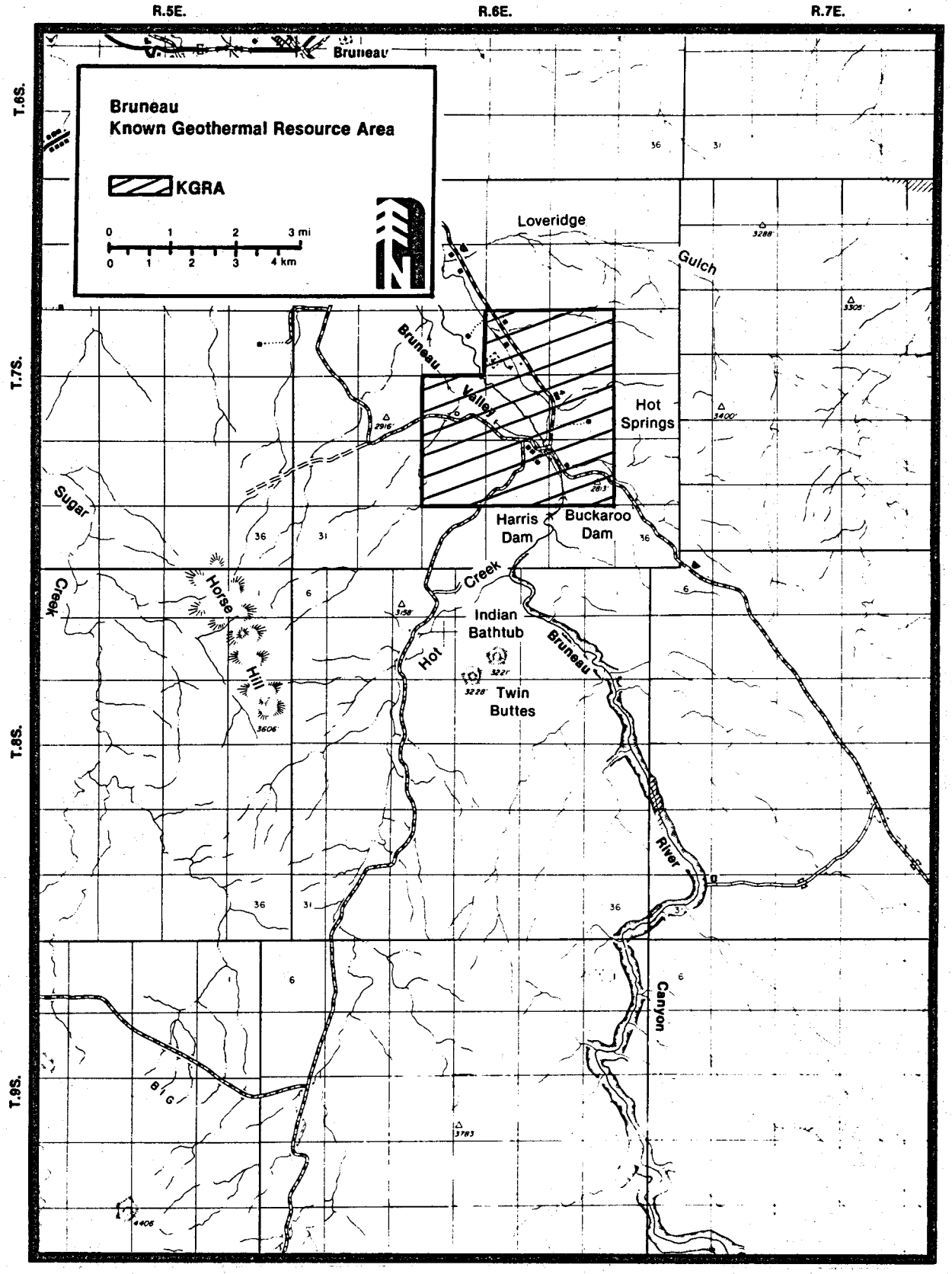


Figure 2. Bruneau KGRA.

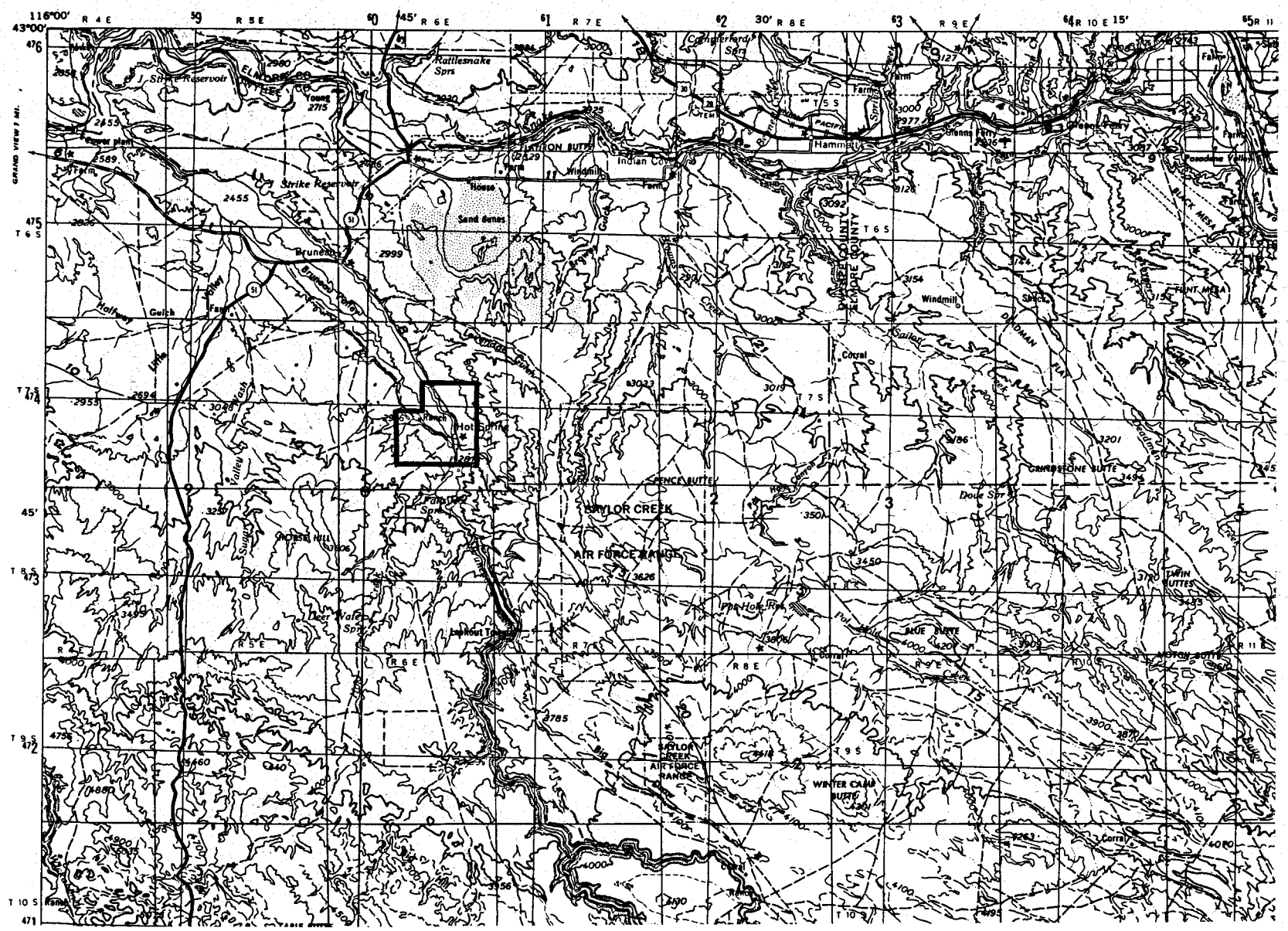


Figure 3. Topography of Bruneau KGRA.

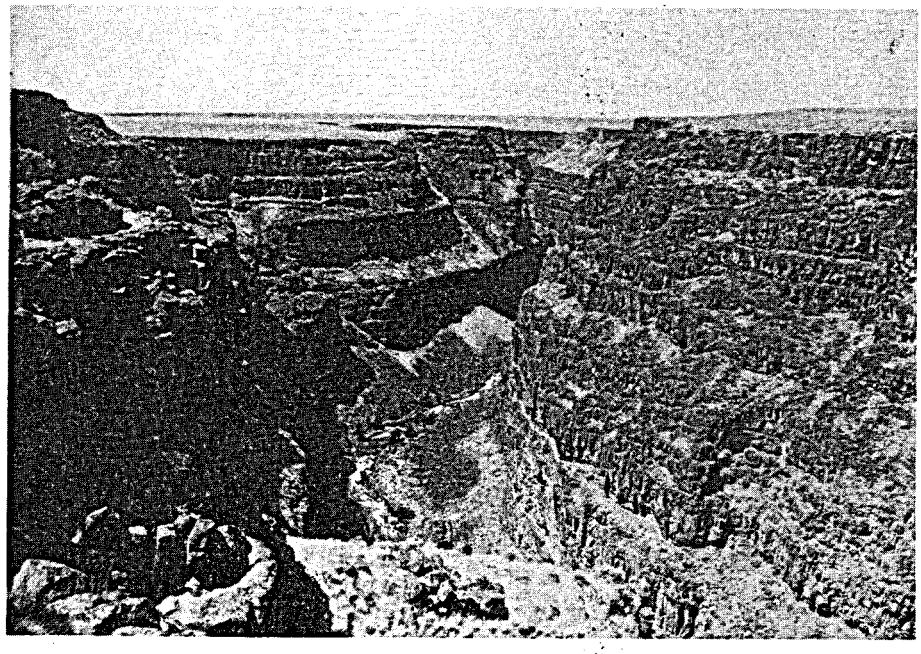


Figure 4a. Bruneau River Canyon.

Figure 4b. Bruneau KGRA.

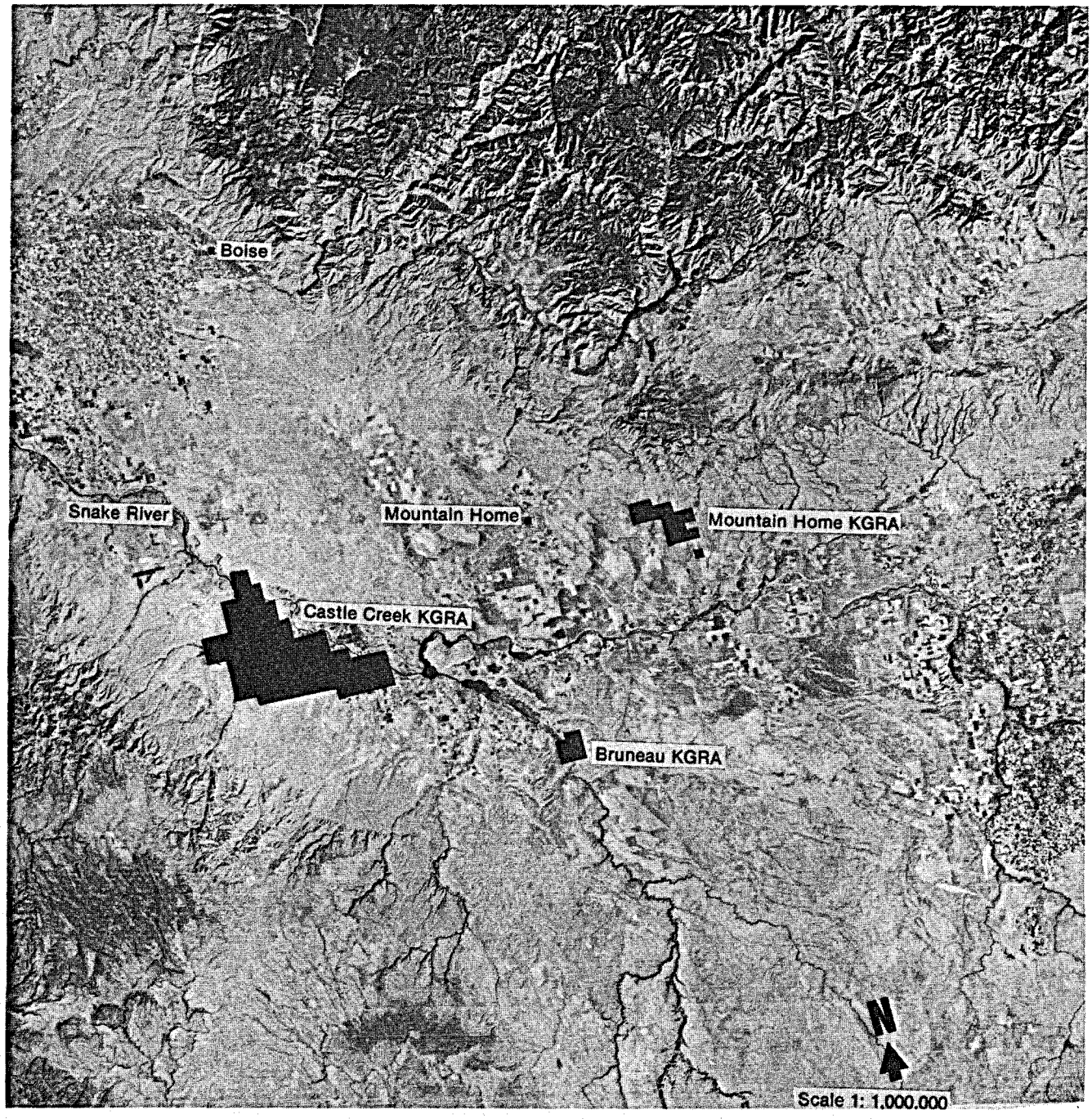


Figure 5. LANDSAT photo of Southwest Idaho.

The KGRA is part of the Bruneau-Grandview thermal anomaly, the largest geothermal area in the western United States (excluding Yellowstone Park). The U.S. Geological Survey estimates[2] that 450×10^{18} J of heat are contained in a reservoir underlying 14,800 ha of land. The area represents a complex geothermal system consisting of several volcanic and sedimentary aquifers. More than 100 wells, many of which are artesian, produce thermal fluids from these aquifers. The most accurate temperature at depth is from a Phillips Petroleum exploratory well which reported a bottomhole temperature of 108°C at 2670 m.[3] The area may have a potential for greenhouse operations and other low-temperature direct-heat applications using warm water from shallow depths. Table 1 shows chemical analyses from wells and springs in the KGRA. Fluoride levels are high in thermal waters, even in waters of low total dissolved solids.

Physical Environment

Climate and Meteorology (M. Delisio, GeoTechniques)

Few data exist on the climate and meteorology of the Bruneau KGRA. The information presented here is taken from several sources, including Climatological Summary, Normals, Means and Extremes, Boise, Idaho,[4] The Atlas of the Pacific Northwest,[5] The Mean Annual Precipitation Map, 1937 - 57, State of Idaho,[6] and Climatological Data, Idaho.[7]

The KGRA is located in the driest area of the state because of its situation immediately in the lee of the Owyhee mountains in the southwestern corner of Idaho. The region is marked by generally clear skies, little inclement weather, and wide fluctuation in diurnal and annual temperatures. Table 2 shows summary data on climate. Temperatures average 11°C annually, with extremes of -23°C and 40°C. The mean annual precipitation is 230 mm, most of which falls as snow or as rain in the early spring.

TABLE 1. CHEMICAL ANALYSES - BRUNEAU KGRA WELLS AND SPRINGS[3]
(in mg/l unless otherwise noted)

	Well 7S-6E-23BBB1	Well 7S-6E-23CAD1	Well 7S-6E-26ADA1	Indian Bathtub Hot Springs	Hot Springs Well 7S-6E-21DBC1
Temperature (°C)	47	44	38	39	43
Depth (m)		396	305	0	232
Discharge (l/s)	--	--	65	28	--
B	--	--	--	--	--
Ca	9	12	16	6.5	5.9
K	6.1	7.2	6.9	6.7	4.6
Mg	1.2	1.1	2.8	0.6	0.3
Na	51	53	36	53	54
NH_3	--	0.12	0.10	0.08	0.07
SiO_2	75	100	82	87	82
Cl^-	9	8.7	8.6	9.1	9.0
$CO_3^=$	--	--	5.0		7.0
F^-	10.0	8.2	3.1	6.0	12.0
HCO_3^-	110	126	134	113	91

TABLE 1. (continued)

	Well 7S-6E-23BBB1	Well 7S-6E-23CAD1	Well 7S-6E-26ADA1	Indian Bathtub Hot Springs	Hot Springs Well 7S-6E-21DBC1
NO_3^-	1.3	0.54	0.66	0.66	0.28
$PO_4^{\equiv}$	--	0.01	0.02	0.06	--
$SO_4^{=}$	17	17	15	15	18
Conductivity (µmhos)	287	327	288	300	287
pH	7.2	8.3	8.0	8.3	8.5
TDS	233	269	236	245	237

Table 2. SUMMARY OF CLIMATE CONDITIONS

Temperature (^{o}C)

Annual average	11^{o}
Extremes:	-23^{o} and 40^{o}

Precipitation (mm)

Total annual	229

Wind

(No surface data available)

850 mb flow:

Spring	- SE
Summer	- SE
Fall	- W
Winter	- S

Stagnation Frequency (%)

Summer:	Night-time windspeed ≥ 11 km/hr - < 60%
	Inversion based 150 m above ground - 40%
Fall:	Night-time windspeed ≤ 11 km/hr - 60%
	Inversion based ≤ 150 m above ground - 53%

The area is in the zone of the Prevailing Westerlies and Polar Easterlies wind systems. The contact of the two fronts generates the few clouds and associated weather activity that occurs. Most of the cool or cold air consequent with frontal activity is maritime polar air from the Pacific, while some is the result of continental polar air from interior Canada. Surface airflow is greatly affected by landforms, primarily by the Owyhee mountains directly to the west and to a lesser extent by the Snake River Plain, the Northern Rocky Mountains, and diurnal conditions. No adverse weather conditions have been documented; however, occassional duststorms and thunderstorms can be expected.

Air Quality (E. Bentley, GeoTechniques)

At the present time, there are no monitoring stations in Owyhee County. Ambient air quality for the KGRA can only be extrapolated from observation and from regional data available from the Environmental Protection Agency. The regional data indicate that the air quality is at an acceptable level for all pollutants except particulates. Both primary and secondary standards for particulate materials are exceeded; most of the particulates are fugitive dust from agriculture, unpaved roads, and construction activities. Solid wastes account for over 74% of total particulate emissions in the region, while stationary fuel combustion accounts for nearly 20%.

Although no noncondensable gas analyses have been conducted on warm wells and springs in the area, slight sulfur odors can be detected at several locations. Air stagnation and fog conditions occur in the Bruneau Valley during the winter, and venting geothermal fluids to the atmosphere could result in periods of deteriorating air quality.

Geology (R. Hardyman, GeoTechniques)

The Bruneau KGRA lies within the Snake River Valley physiographic subdivision of the Western Snake River Plain. The mouth of Bruneau Canyon, located about 2 km south of the KGRA, marks the approximate

southern physiographic boundary of the Snake River Valley in this area. South of this boundary, the region passes into an extensive plateau area (Owyhee Plateau) that extends northwest-southeast and separates the Owyhee Mountains to the south-southwest from the Snake River Plain proper.

The oldest rocks in the region are exposed in the Owyhee Plateau approximately 13 km south-southeast of the KGRA. These rocks consist primarily of extremely densely-welded, flow-layered rhyolite tuffs that are interpreted[8] as ash-flow tuff deposits that reverted back to a viscous liquid subsequent to deposition but prior to final emplacement and cooling. They have been dated as Miocene.[9] These silicic volcanic rocks are probably correlative with rocks mapped as undivided silicic volcanic rocks by Littleton and Crosthwaite[10] and later designated Idavada Volcanics by Malde, Powers, and Marshall[11] (Figures 6 and 7).

The silicic volcanic rocks are bound on the north-northeast by a series of northwest-trending, high-angle faults that generally separate the older silicic volcanic rocks from younger volcanic and basin fill deposits to the northeast. The northwest-trending zone of faults marks the southern margin of the western Snake River graben in the Bruneau region of the Western Snake River Plain. The KGRA lies approximately 11 kilometers north of this graben boundary fault zone.

Stratigraphy. Miocene silicic volcanic rocks of the Owyhee Plateau, exposed southeast of the Bruneau KGRA and on the upthrown side of the graben boundary fault zone, are not exposed at the surface in the KGRA. Suspected silicic volcanic rocks were penetrated at depth, however, in at least three wells drilled in the KGRA.

The silicic volcanic rocks probably consist of densely-welded ash-flow tuffs, lavas, and flow-banded lava-appearing rocks of rhyolitic composition. Some of the rhyolite lavas are apparently ash-flow tuffs that have reverted to lavas before they were completely cooled.[8] By inference from adjacent maps,[8] the silicic volcanics

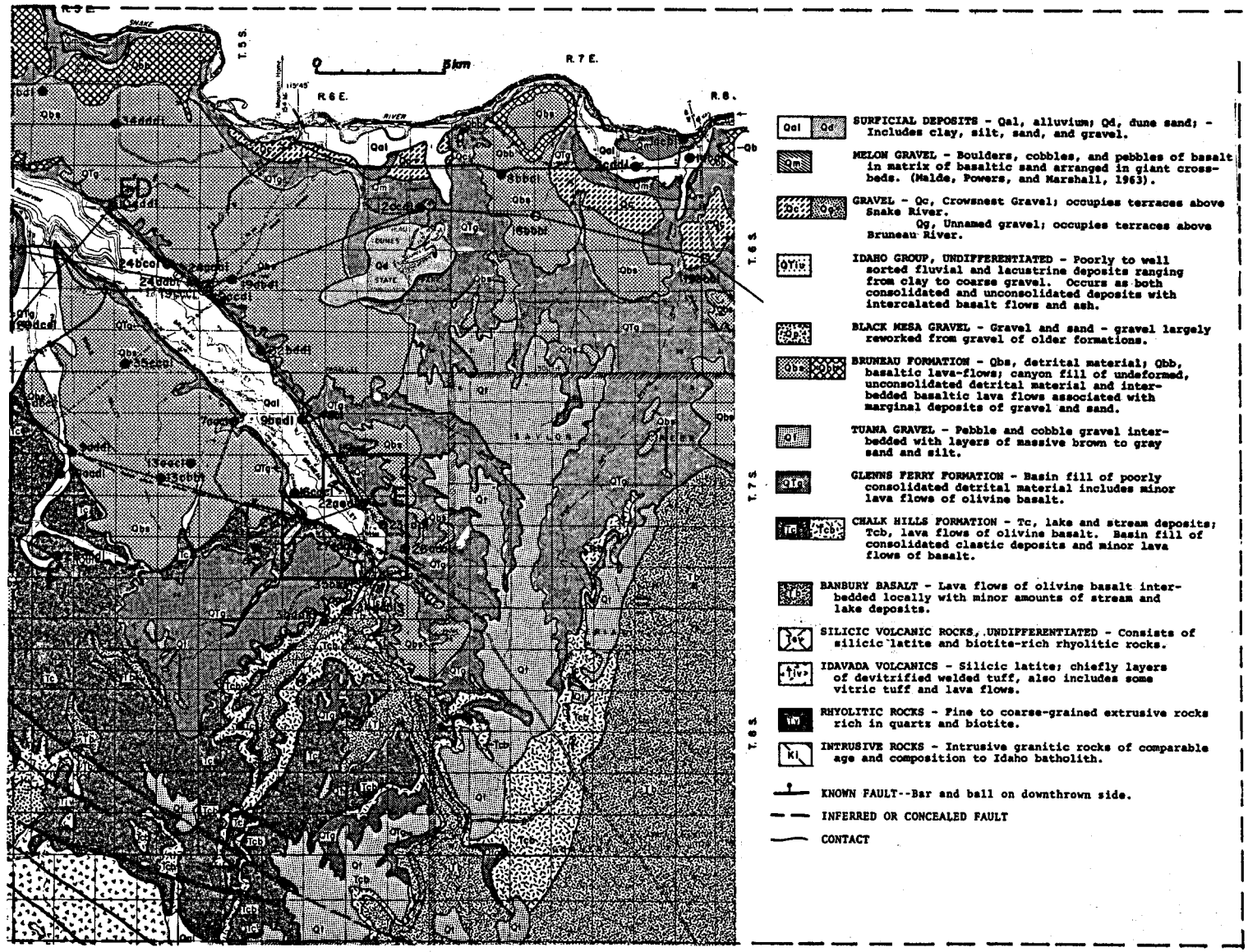


Figure 6. Generalized geologic map of the Bruneau-Grand View areas (after Ralston and Chapman[12])

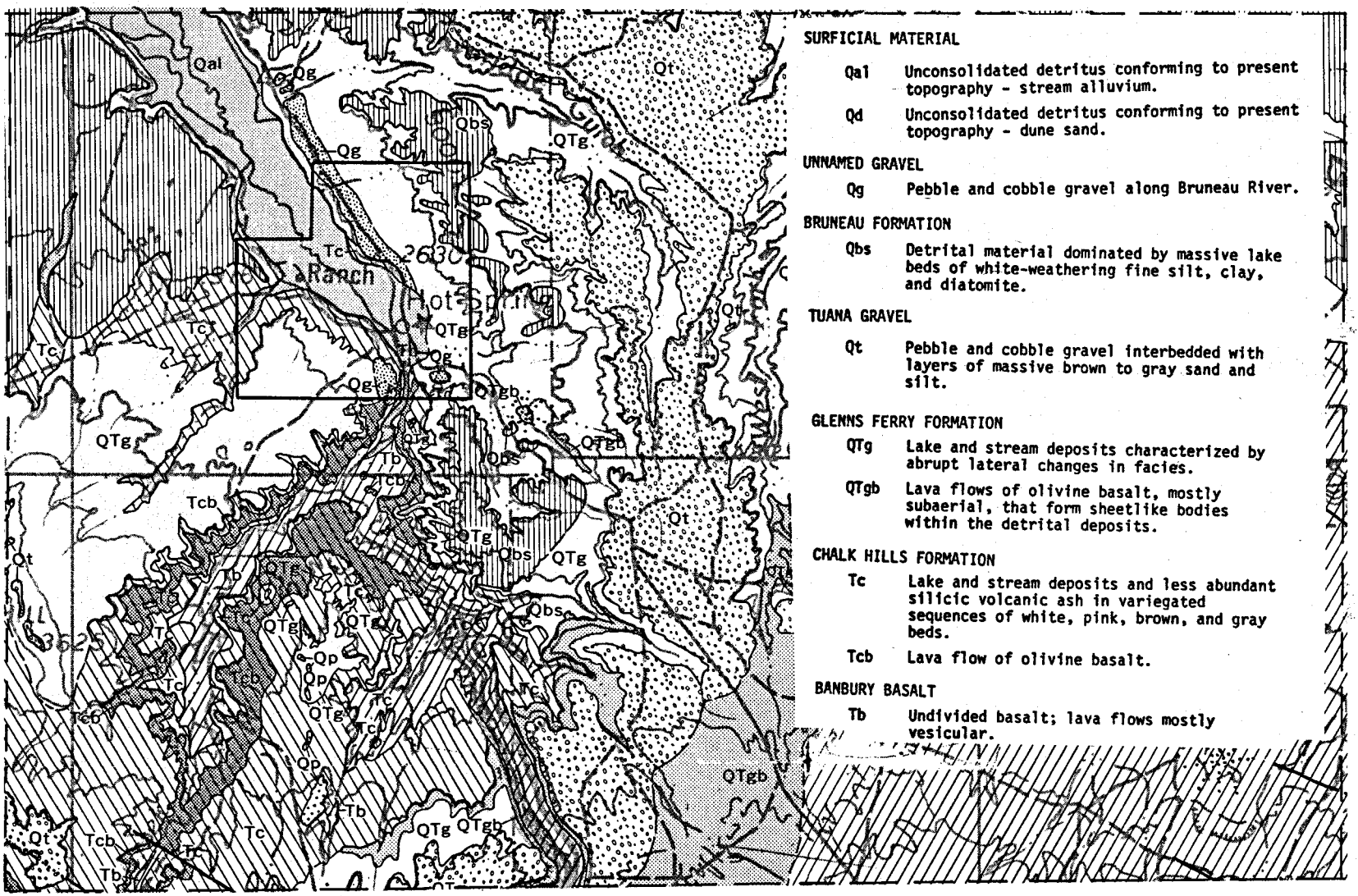


Figure 7. Generalized geologic map of the Bruneau KGRA (after Malde, Powers, and Marshall[11]). Outlined area is approximate boundary of Bruneau KGRA.

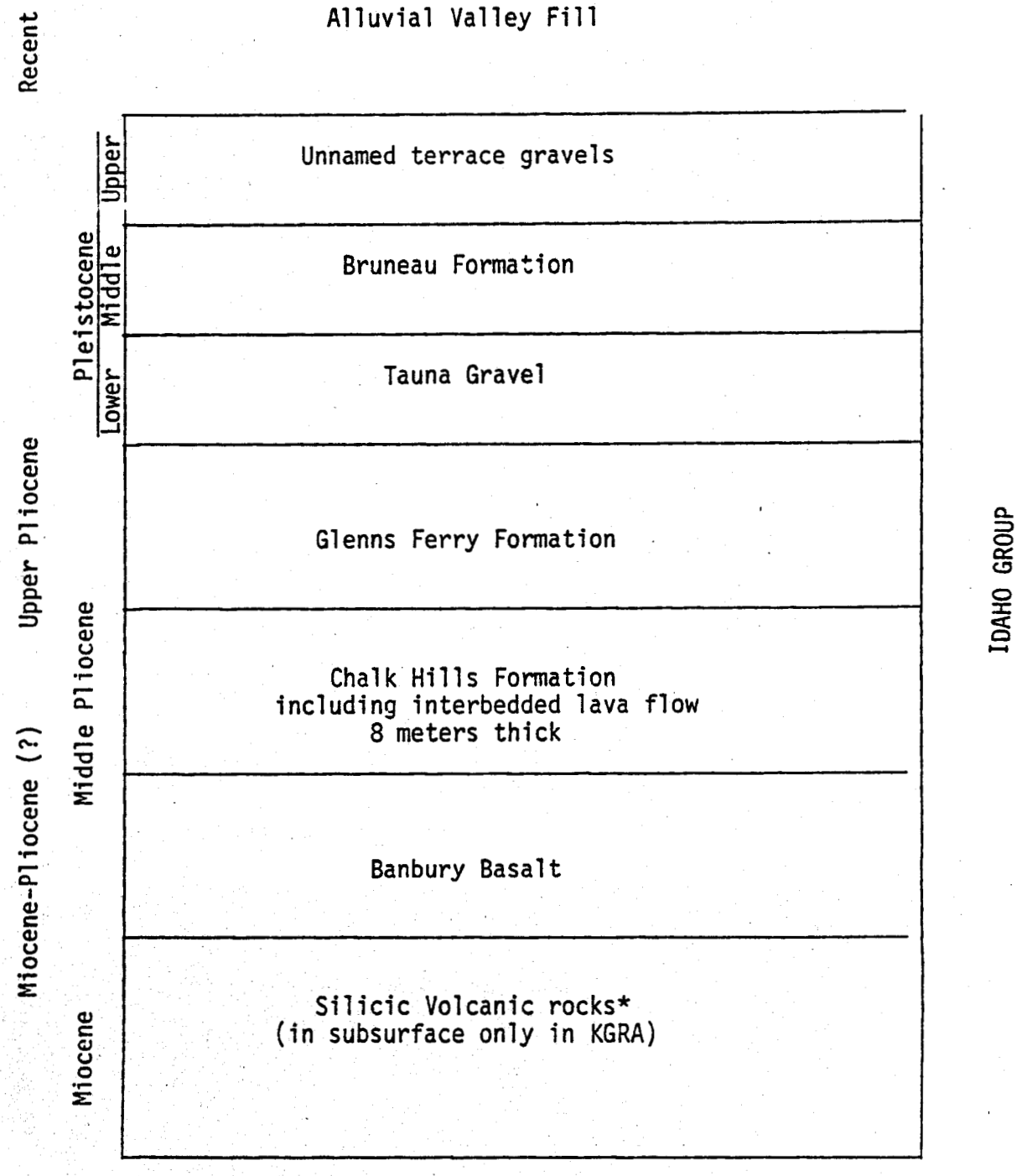
in the subsurface of the KGRA are probably ash-flow tuff or lava-like ash-flow tuff cooling units, each 20 - 100 m thick, that are separated by thin basal flow breccias. The tuffs are crystal-poor rhyolites and are densely-welded. The silicic volcanic rocks probably total at least 900 m in aggregate thickness.

Rock units exposed at the surface in the Bruneau KGRA consist of rocks comprising the Middle Pliocene Banbury Basalt and Chalk Hills formations, the Upper Pliocene Glenns Ferry Formation, the Lower Pleistocene Tuana Gravel, the Middle Pleistocene Bruneau Formation, and unnamed Upper Pleistocene gravels (Figure 8).

The oldest rock unit exposed in the Bruneau KGRA is a sequence of basalt flows and minor interbedded tuffaceous sediments and pyroclastic material (cinders) of Middle Pliocene age. This unit, mapped as Banbury Basalt,[11] forms an extensive plateau surface southeast of the KGRA and is exposed in the Bruneau River Canyon south of the KGRA. The basalt unit is at least 200 m thick in the canyon of the Bruneau River south of the KGRA and rests on older silicic volcanic rocks. Many small vents, presumably source areas for the basalt flows, occur on the upper plateau surface of mapped Banbury Basalt southeast of the Bruneau KGRA.

Basalts of the Banbury Basalt unit in the KGRA occur as thin lava flows (generally less than 15 m thick) of fine-grained, intergranular to ophitic-textured coarse-grained olivine basalt that is locally vesicular and amydgaloidal. Amydgules are filled with either zeolites or calcite. Lenticular beds of fluvial sand, fine gravel, tuffaceous material, and basaltic pyroclastic debris are locally interbedded with the thin basalt flows. The Banbury Basalt is the oldest of rock units in the Western Snake River Plain that are included in the Idaho Group of formations.

Lacustrine and fluvial basin fill deposits of the Chalk Hills Formation (Middle Pliocene) rest unconformably on the older Banbury Basalt in the KGRA. These basin fill sediments along with a thin



*(In part correlative with, if not all enclusive of, Idavada Volcanics as mapped by Malde, Powers, Marshall, 1963).

Figure 8. Stratigraphic nomenclature of rocks exposed in the Bruneau KGRA.[11]

interbedded basalt flow form limited outcrops within the KGRA but form extensive outcrops within the area south and west of the KGRA. The Chalk Hills Formation consists of a variegated sequence of well sorted, cross-bedded sand; massive silt; clay; and diatomite. Less abundant thin (a few cm thick) silicic volcanic ash beds are also present in this unit. A thick (8 m thick) olivine basalt lava flow forms the base of the Chalk Hills Formation in the KGRA but becomes interbedded with the lacustrine sediments just south of the KGRA.

Overlying the Chalk Hills Formation are Upper Pliocene rocks of the Glenns Ferry Formation. These rocks form moderately extensive outcrops within the Bruneau KGRA and are more extensively exposed in regions north and east of the KGRA. The Glenns Ferry Formation apparently thickens to the north and east of the KGRA. As elsewhere in the Western Snake River Plain, the Glenns Ferry Formation in the vicinity of the KGRA consists of lacustrine and fluvial sediments that are poorly to well stratified and characterized by abrupt lateral changes in facies. These sediments consist predominantly of thin bedded tuffaceous sand, silt (commonly micaceous), and clay. Discontinuous, lenticular channel deposits of pebble gravels containing clasts of rhyolite, basalt, and granite are common. Thin beds of vitric ash (apparently not extensively reworked) are also locally common in this unit.

In the KGRA and areas to the west, the base of the Glenns Ferry Formation includes a thick-bedded fossiliferous oolitic limestone as much as 10 m thick. This bed locally thickens to the west[8] and gives way laterally to a massive unconsolidated coarse arkosic sand or pebble conglomerate. Minor olivine basalt lava, apparently forming a linear feed dike in Glenns Ferry Formation sediments, occurs in the southeast corner of the KGRA. A thin basalt lava flow interbedded with Glenns Ferry Formation sediments crops out southeast of the KGRA, but its genetic relationship to the possible feeder dike in the KGRA is unknown.

Upland pediment surfaces cut on Glenns Ferry Formation rocks in the Bruneau KGRA are veneered by pebble and cobble gravels of the Tauna Gravel Formation (Lower Pleistocene). Gravels of this unit are interbedded with layers of sand and silt. Cobbles in this unit consist primarily of silicic volcanics and locally abundant quartzite in the vicinity of the Bruneau KGRA. In the northern two-thirds of the KGRA and in limited outcrops in the southeast corner, Tuana Gravels are absent and the Glenns Ferry Formation is overlain by sediments of the Bruneau Formation (Middle Pleistocene).

The Bruneau Formation exposed in the KGRA consists of detrital material dominated by massive lake beds of silt, clay, and diatomite. Distinctive iron-stained beach gravels occur interbedded in the lake bed sequence. Sediments of the Bruneau Formation thicken northward and become interbedded with Bruneau Formation basalts near the present course of the Snake River. The younger rocks present in the KGRA are unnamed Upper Pleistocene terrace gravels, exposed along the margins of the Bruneau River valley, and the alluvial deposits of the present flood plain of the Bruneau River.

Structure. The Bruneau KGRA lies approximately 10 kilometers north-northeast of the zone of northwest trending high-angle normal faults that marks the surface expression of the southern margin of the Western Snake River Plain graben. The boundary fault zone is approximately 4 - 9 km wide in this area and contains several parallel faults that generally dip 50 - 80 degrees to the northeast. Individual mapped faults have surface traces up to 45 km. Relative sense of displacement on the majority of these faults is down to the northeast. Some faults, however, display relative down-thrown displacements to the southwest that produce some horst blocks within the fault zone. Displacements on some of the faults in this zone are on the order of several hundred m.[10] The aggregate amount of displacement of the silicic volcanic rocks across the graben boundary fault zone is uncertain but may be comparable to the displacement across the boundary fault zone on the north side of the Western Snake River Plain graben.

Northwest-trending high-angle faults parallel to the graben boundary fault zone, but northeast of the zone and in the graben proper, are present but are generally concealed by younger Idaho Group rock units in the vicinity of the KGRA. A zone of these northwest trending faults that displace older Idaho Group formations (Banbury Basalt lavas and Glenns Ferry Formation rocks) have mappable surface traces a few kilometers southeast of the Bruneau KGRA. Either these faults do not extend along strike to the KGRA or are concealed below Bruneau Formation units in the vicinity of the KGRA (Figure 7). One fault on strike with this trend has been mapped at the surface in the Bruneau KGRA.[10] The linear basalt dike (possible fissure vent) in Glenns Ferry Formation rocks in the southeast corner of the KGRA occurs along this northwest-trending mapped fault. Locally, sedimentary beds of the Idaho Group (undifferentiated) are displaced a few tens of m across this fault.[10] Subsurface well data in the Bruneau KGRA indicate that the silicic volcanic rocks below the Banbury Basalt are displaced as much as 120 m across this fault. Most of the fault displacement along the southern margin of the Western Snake River Plain graben appears to have taken place prior to deposition of Bruneau Formation rock units.

Subsurface information (water wells) in the Bruneau KGRA and adjacent area to the west indicates that the base of the Idaho Group rocks (undifferentiated) above the Banbury Basalt is displaced perhaps as much as 200 m (down to the northeast) and that the top of the silicic volcanics may be displaced (down to the northeast) as much as 300 m across northwest trending faults that may not have surface expressions. Apparently, no drill holes in the Bruneau KGRA or immediate vicinity have penetrated through silicic volcanic rocks to early Tertiary or pre-Tertiary basement rocks. Gravity and magnetic data for the KGRA[13] are reconnaissance in scale, but even so they also support the existence of northwest-trending subsurface faults in the area. Some northeast-trending faults apparently deduced from subsurface well or geophysical data have also been postulated in the vicinity of the KGRA.[13] The general north-northeast dips of Idaho Group

rocks, apparently including the Banbury Basalt, along with the general increase in thickness of these units to the north, suggest that deposition of these units was contemporaneous with graben development.

Geologic History. The earliest recorded geologic event in southwestern Idaho was emplacement of Late Cretaceous igneous plutonic rocks into older metamorphic rocks of probable Paleozoic (?) age. This intrusive event, contemporaneous with emplacement of the Idaho Batholith north of the present Snake River Plain, resulted in a mountainous region in the core of the present Owyhee Mountains. The Late Cretaceous emplacement of plutonic igneous rocks was followed by an initial period of silicic volcanism of Eocene age that was in part intrusive and extrusive. A period of extensive erosion apparently ensued and lasted through Oligocene time.

Beginning in Miocene time, extensive volcanism began with emplacement of rhyolite dikes and deposition of some basalt flows. Eruption of voluminous silicic magma as lava and ash-flows continued throughout the Miocene. Most of these eruptions apparently issued from vent areas along the northeast margin of the Cretaceous Owyhee Mountains. Many of these vent areas are undoubtedly buried beneath younger volcanic and sedimentary rocks of the present Snake River Plain. Silicic volcanism, primarily, with intermittent erosion and sedimentation continued through Miocene time and deposited the silicic volcanic rocks exposed in the Owyhee Plateau south of the Bruneau KGRA. The silicic volcanic rocks in this area are Miocene in age[8] but apparently correlate, at least in part, with silicic volcanic rocks designated as Idavada Volcanics in this area on earlier reconnaissance maps.[11]

The early (Miocene) silicic volcanism, which presumably resulted from crustal weakening in the area of the present Snake River Plain, was followed by basaltic volcanism that deposited the Banbury Basalt (Miocene-Pliocene). The deposition of at least some of the basalt flows of the Banbury sequence predated the initial subsidence of the

Western Snake River Plain graben, but eruption of some of these flows may have been localized along developing graben boundary faults. Graben subsidence and associated block faulting continued through the Middle and Upper Pliocene. In the Bruneau area, a moderate hiatus followed deposition and initial faulting of the Banbury Basalt lava flows. This hiatus was closely accompanied by erosion of the silicic volcanic uplands and deposition of the Chalk Hills Formation, perhaps, in part, as deltaic sediments accumulated in a shallow lake. Continued graben subsidence and faulting generally tilted these sediments to the north.

Following the minor deformation of the Chalk Hills Formation, the area of the Bruneau KGRA was inundated by a lake which allowed deposition of the oolitic fossiliferous limestone at the base of the Glenns Ferry Formation. Deposition of Glenns Ferry Formation lake and stream deposits was followed by a period of general erosion, minor faulting, and canyon cutting. Deposition of the Tuana Gravel followed by more canyon cutting preceeded deposition of Bruneau Formation sediments of Middle Pleistocene time. Bruneau Formation sediments deposited in the Bruneau KGRA were in response to lava dams elsewhere (to the north-northwest) in the Western Snake River Plain. General valley erosion followed deposition of the Bruneau Formation rocks in the area of the KGRA. Apparently only very minor faulting has occurred since deposition of Bruneau Formation rocks.

Subsidence (J. Applegate, GeoTechniques)

Subsidence of the ground surface associated with the production of fluids (petroleum and water), has been documented in many areas of the world. A significant number of these areas are in the American West and include Houston, Texas; portions of southern Arizona; Las Vegas, Nevada; the Wilmington and Inglewood oil fields of southern California; the San Joaquin Valley of California; the South Bay area near San Jose, California; and the Raft River Valley of Idaho.

Generalized criteria can be established from assessing these areas where subsidence has occurred. Subsidence generally occurs where there are youthful, relatively unconsolidated sedimentary rocks of Cenozoic age.[14] These rocks are generally of lacustrine or alluvial origin, and include interbedded coarse-grained and fine-grained rocks. Permeable sands or gravel aquifers with low compressibility are interbedded with clayey aquitards of low permeability, high compressibility, and variable thickness. The withdrawal of fluids causes a decrease in the hydrostatic head of the aquifers and in turn causes a transfer of additional load to the matrix (grain-to-grain load). The effect results in small amounts of generally elastic compaction in the coarse-grained aquifer and much larger amounts of inelastic compaction in the fine-grained aquitard. In the aquitard, the increase in effective stress results in a dewatering of the clays.[15] Montmorillonite, the common clay mineral in many of the aforementioned cases of subsidence,[14] has the ability to lose large volumes of water.

Withdrawal of fluids appears to be the most likely subsidence mechanism in the KGRA under study. However, two other potential mechanisms should be assessed. These are hydrocompaction and tectonic subsidence.

Hydrocompaction is subsidence due to the collapse of the soil structure of certain moisture-deficient deposits when these deposits lose their dry strength due to wetting.[16] Hydrocompaction is a one-time process where excess moisture penetrates below the root-zone into moisture-deficient material. The process may continue to intensify as the water percolates downward and deeper deposits become wetted. No documented data on the occurrence of hydrocompactable soils in the KGRA is noted in the literature, but the limited data do not preclude their presence in arid portions of the geothermal areas.

Tectonic subsidence is subsidence, or uplift, that is related to active tectonic processes within the earth such as movement along faults, aseismic movement, emplacement of igneous bodies, etc. As with subsidence related to fluid withdrawal, tectonic subsidence is best observed with repeated leveling. Again, these data are extremely limited. There is some documentation of tectonic movements of 6.7 cm in the Raft River Valley, Idaho.[17]

More detailed studies indicating the potential for subsidence have been undertaken in the area of the Bruneau KGRA than in other areas. Some of these studies are summarized in Young and Whitehead.[13] The Bruneau KGRA has undifferentiated Idaho Group rocks of Pleistocene age at or near the surface. These rocks include poorly to well sorted fluvial and lacustrine deposits with intercalated basalt flows and ash. In both areas, the underlying rocks are lava flows of olivine basalt (Banbury Basalt) interbedded locally with minor amounts of stream and lake deposits. At depth, these deposits probably overlie the Idavada volcanics, which include silicic latite.

Some sections of the Idaho Group have good well yields, while others are very poor. Some sands of this group produce as much as 230 l/s. The Banbury Basalt is an excellent aquifer depending on the degree of alteration. Highly altered portions produce limited amounts of water, whereas unaltered sections produce large volumes.[13] The underlying Idavada Volcanics are highly fractured and jointed and consequently have large well yields where the wells penetrate this deep. It is believed that these rocks serve to transmit recharge water to the area from the Owyhee uplift to the south, and that the water then moves upward into the overlying units.

The rocks in the Bruneau area are typical of the unconsolidated to semiconsolidated rocks that have proved to be susceptible to subsidence in other areas. In addition, heavy irrigation could have already caused, or in the future could cause, a decline of the water level. This decline could be initiated or accelerated by the production of deeper thermal water if, as speculated earlier, these deeper

aquifers are recharging the shallow system. Hence, the Bruneau KGRA is a potential area of subsidence.

Seismicity (J. Applegate, GeoTechniques)

Seismicity studies to determine levels of microearthquake activity have been one of the principal exploration tools to define areas of geothermal activity. It has been observed that many geothermal areas have large numbers of small earthquakes. It is postulated that the microseismic events are a function of the youthful geologic activities (volcanism, faulting, etc.) that are associated with geothermal areas. Thus, it is more common than not to find significant seismic activity in close proximity to geothermal systems.

The Bruneau KGRA is in Seismic Risk Zone II. However, the data base on which this recommendation was made was somewhat limited. The problem is that the instrumental seismic data set represents only a limited time period. This is a major problem in the evaluation of seismic risk. In the last few years, several additional seismic networks have been installed in the state. However, the only two that provide much usable data for this study are the networks surrounding the Idaho National Engineering Laboratory (INEL) and a three-station array in the vicinity of Boise which is operated by Boise State University (BSU).

Regional structural maps show the Bruneau KGRA to be associated with the southern boundary fault zone of the Snake River Plain.[18,19]. The Bruneau KGRA is transected by faults that are suspected to have been recurrently active since Middle Miocene.

A look at the historical record of seismicity for the period 1880 through 1975 (Figure 9) shows no epicenters or felt reports within 80 kilometers of the KGRA. The seismicity data for 1976-1977 (Figure 10) from the Boise State University (BSU) network shows only a small number of events (less than 10) within 50 km of the area. Short-term microseismic studies[20] in the area during 1972 detected no events, but

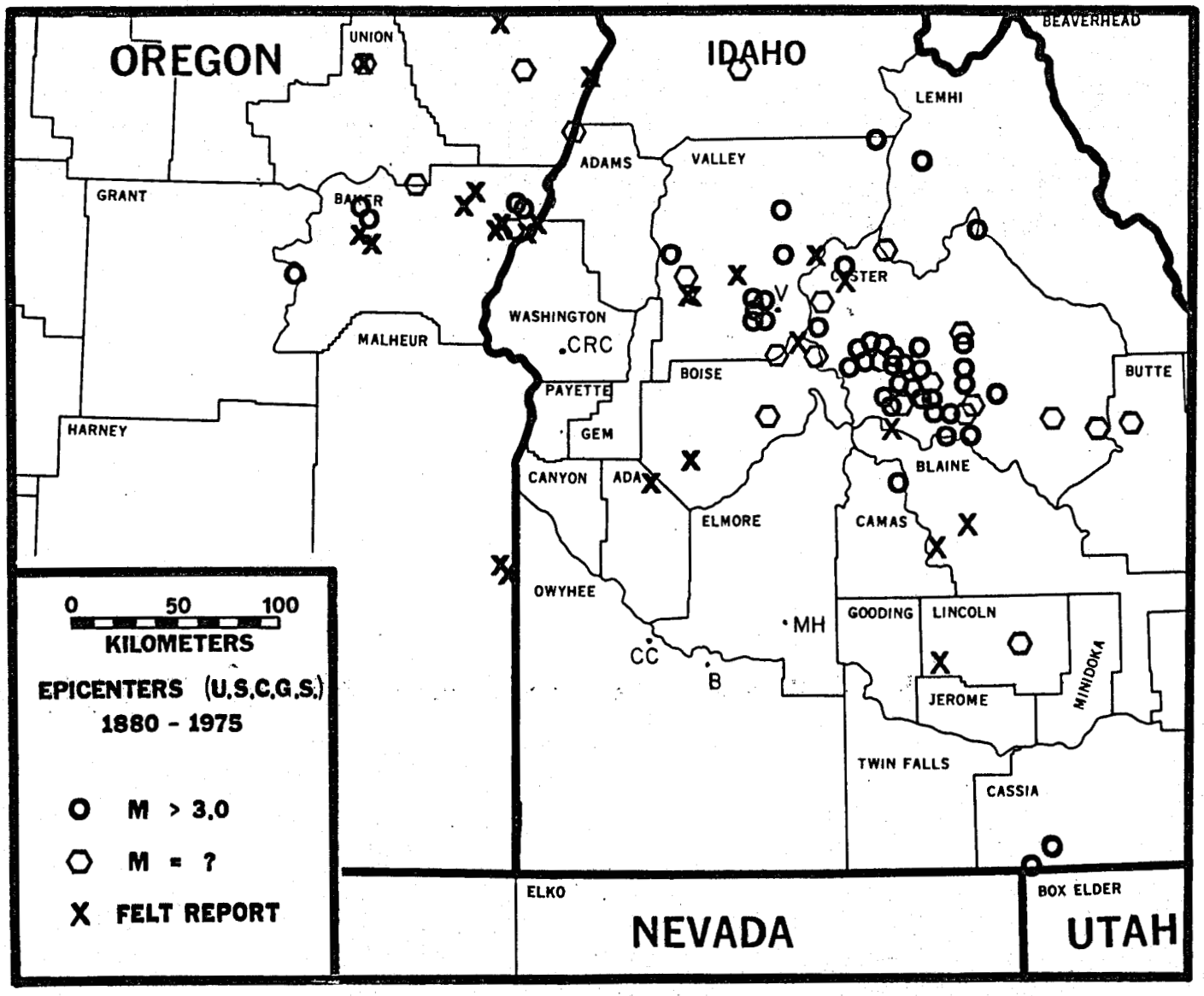


Figure 9. Historical seismicity from U.S. Coast and Geodetic Survey (NOAA) - 1880-1975. KGRAs are noted on map: MH-Mountain Home, B-Bruneau, CC-Castle Creek, CRC-Crane Creek, and V-Vulcan. (Vincent and Applegate, 1978)

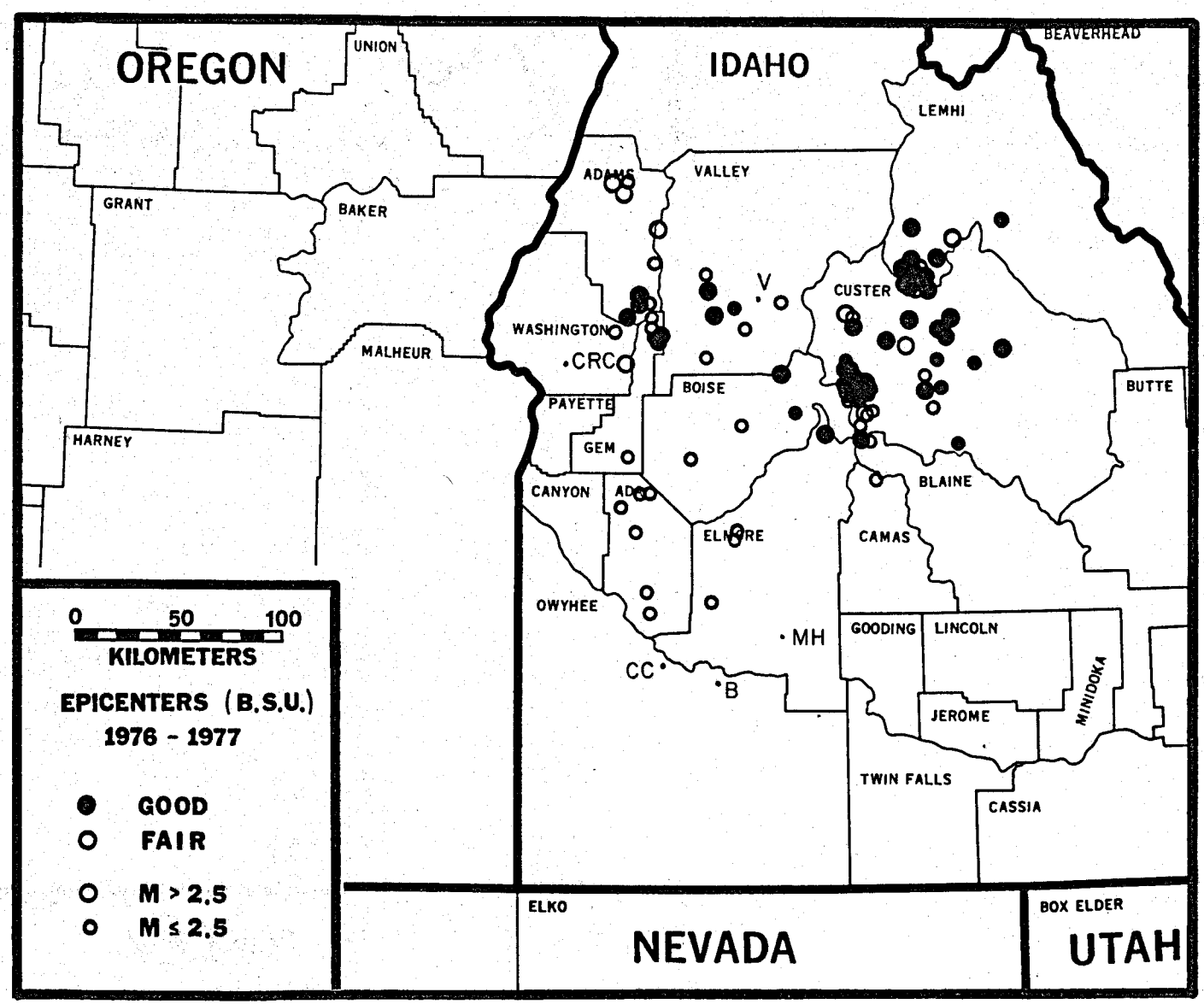


Figure 10. Seismicity for 1976-1977 from B.S.U. network. KGRAs are noted on the map: MH-Mountain Home, B-Bruneau, CC-Castle Creek, CRC-Crane Creek, and V-Vulcan. (Vincent and Applegate, 1978).

the periods of monitoring may have been too short to be conclusive. Individuals active in microseismic consulting have stated that if the detectors are installed in deep boreholes, significant background microseismic activity can be recorded. However, there are no published data to support these statements. Considering the relatively high seismic activity in nearby areas (southeast Idaho, the Stanley and Challis areas, and the western boundary of the Idaho Batholith, etc.) this lack of activity in the KGRA is quite interesting. Smith[21] postulates that the lack of seismic activity within the Snake River Plain is due to high heat flow. The abnormally high heat flow causes the relief of stress to be limited to aseismic creep.

Detailed geologic mapping[24] of areas within the Snake River Plain and observations of proprietary seismic reflection data from the Plain suggest that there are a number of faults that offset youthful horizons and have relatively large throws at shallow depths. Unfortunately, this type of data is not available immediately within or near the Bruneau KGRA.

The phenomenon of induced seismicity is being extensively investigated to establish its cause and to determine under what conditions it is a problem. Several areas have provided extensive case histories on the relationship of seismicity to injection or withdrawal of fluids. These include Derby, Colorado;[23,24] Rangeley, Colorado; and more recently the area near Snyder, Texas. Studies are underway to verify or negate the hypothesis that there is induced seismic activity associated with the geothermal system at the Geysers geothermal field, California.

Special problems may arise in an area where large quantities of hot water or steam are produced and then cooler water is reinjected. This could cause thermal stresses in the subsurface -- an interesting hypothesis, especially in areas (such as the Snake River Plain) where plastic creep may be occurring. Perhaps this cooling effect could, over a significant period of time, create areas where the stresses

might be relieved by brittle deformation instead of plastic deformation, resulting in seismic activity.

The problem of induced seismicity is a real one and must be addressed with the acquisition of the necessary data. Fortunately, however, the Bruneau KGRA is not in a populous area where even relatively low levels of induced seismicity could be disruptive and destructive to urban structures and facilities. Induced seismicity in this area could on the other hand, be highly disruptive to development of facilities necessary to produce and utilize the geothermal energy. With proper control of the injection program, including pressure, volume, and location of injection, induced seismicity may be minimized or eliminated.

Water Resources (C. L. Miller and C. C. Warnick, Idaho Water Resources Research Institute)

The Bruneau River flows to the north through the Bruneau KGRA and joins the Snake River at C. J. Strike Reservoir. The drainage area at the gaging station, about 0.8 km south of the KGRA, is 6840 km^2. The major tributaries to the Bruneau River are the Jarbridge River, East Fork of the Bruneau River, West Fork of the Bruneau River, and Sheep Creek (Figure 11). The topography of the drainage basin is broken into narrow valleys through which these tributaries flow.

Hydrology. The hydrologic data base for the Bruneau River basin in the area surrounding the Bruneau KGRA consists of three rain-gage records and one river-gage record. The rain gages that are currently active are: Bruneau gage at Bruneau and Three Creek gage on the East Fork of the Bruneau River near the Idaho-Nevada border. The third gage, which is no longer active, was located inside the KGRA at Hot Springs. The river gaging station is located about 0.8 km south of the southern KGRA boundary. Table 3 gives information concerning the location of the gages, type of gage, length of record, and average annual values of the gages. Figure 12 gives a plot of the monthly distribution of runoff at the river gaging station near Hot Springs.

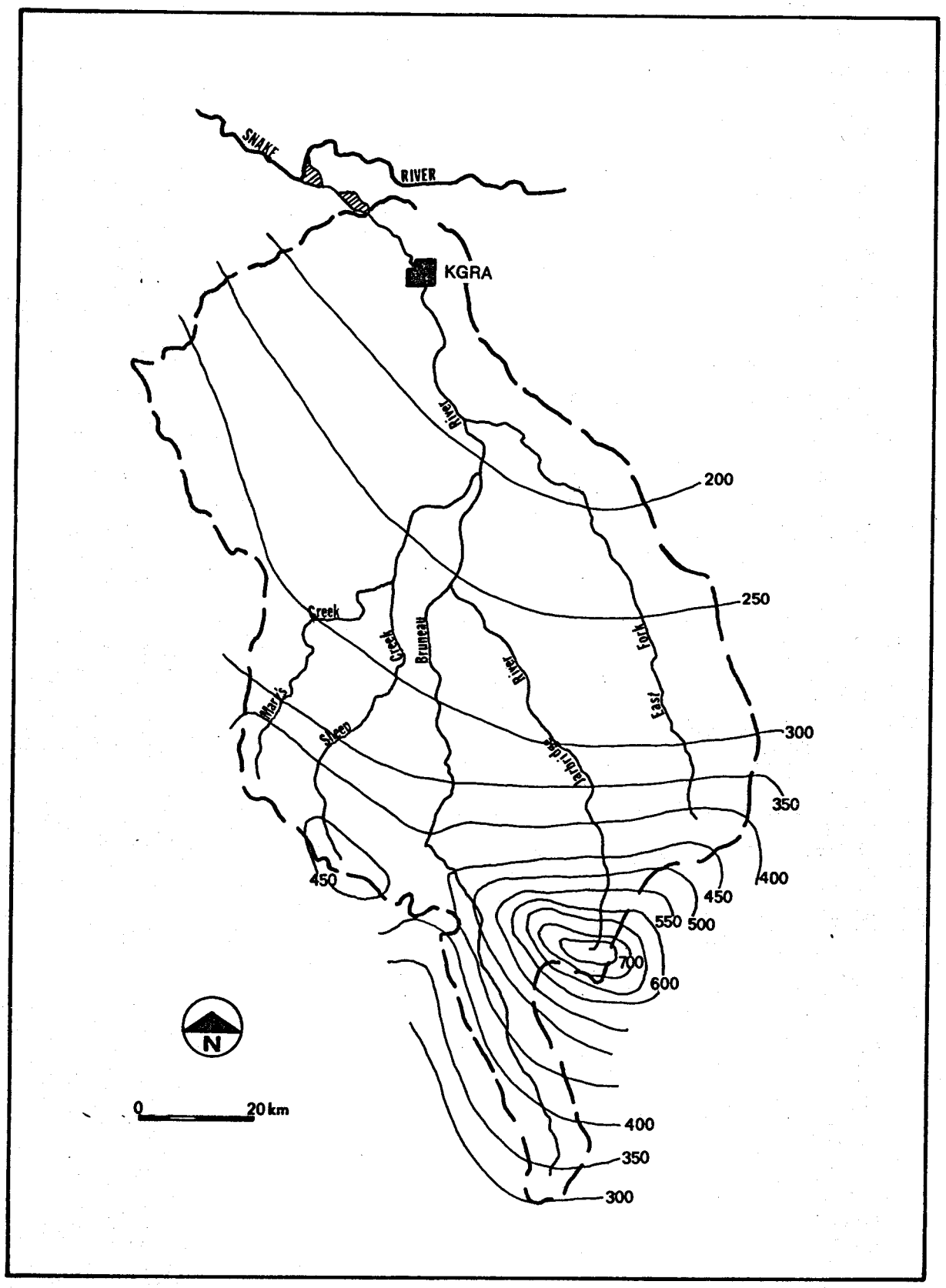


Figure 11. Map of Bruneau River basin and Bruneau KGRA, showing normal annual precipitation variation (mm).

TABLE 3. INFORMATION ON HYDROLOGIC RECORDS IN THE AREA NEAR THE BRUNEAU KGRA

Station	Type of Record	Latitide	Longitude	Period of Records	Length (months)	Annual Average
Bruneau	Rainfall	42° 53'	115° 48'	06/1962 - 05/1964	24	187 mm
				08/1964 - 12/1976	149	
	Snowfall			11/1962 - 12/1976	45	152 mm
Three Creek	Rainfall	42° 05'	115° 15'	07/1940 - 12/1943	42	
				02/1944 - 12/1950	83	
				02/1951 - 07/1952	18	
				11/1952 - 07/1959	81	
				04/1961 - 06/1963	27	
				08/1963 - 12/1976	161	
	Snowfall			08/1940 - 12/1976	283	1720 mm
Hot Springs	Rainfall	42° 48'	115° 42'	01/1906 - 05/1918	146	
Bruneau River	Streamflow	42° 46' 16"	115° 43' 10"	07/1909 - 02/1915	68	$3.6 \times 10^8 m^3$
Near Hot Springs Springs				10/1943 - 09/1976	396	

Source: HISARS, Univ of Idaho

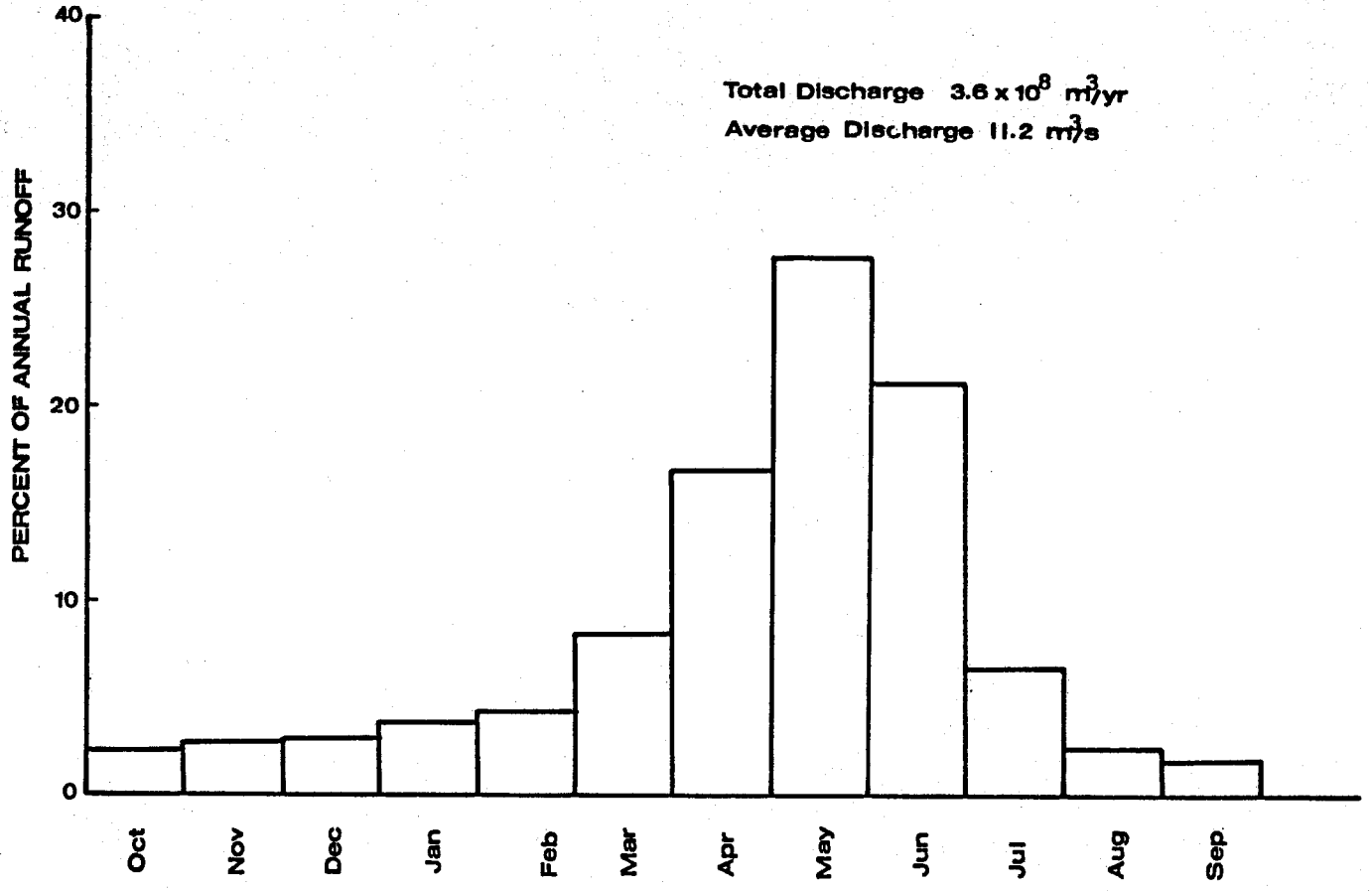


Figure 12. Characteristic monthly runoff of the Bruneau River near Hot Springs.

Figure 13 is a duration curve of the Bruneau River runoff near Hot Springs, based on the record to date. This is a regulated stream due to irrigation development. Discharge extremes for the period of record at the river gage are 184 m^3/s and 0.7 m^3/s.

The Bruneau River is under study for inclusion in the National Wild and Scenic River System as specified in Section 5(a) of PL 90-542 (82 Stat 906). The final decision for status of the river has not been made, awaiting the action of Congress and the President. The early drafts of the Idaho Water Plan expressed interest in having the Bruneau River as part of a State Natural and Recreational River System.

The ground water hydrology of the area surrounding the Bruneau KGRA has been studied and summarized in study by Ralston and Chapman[25]. In addition, ground water level records are available for observation wells in the Bruneau area. Figure 14 shows well hydrographs for some of these wells. No water table contour maps of the area were found.

Thermal water is produced from wells penetrating both (a) volcanic-rock aquifers, which include the Idavada Volcanics, the Banbury Basalt, and rhyolitic and intrusive rocks, and (b) the sedimentary-rock aquifers, which include the Idaho and Snake River groups. A survey of wells in the Bruneau area[13] indicates that wells producing from sedimentary aquifers have lower temperatures than those producing from volcanic aquifers (30°C average vs 38°C average). Young and Whitehead[13] concluded that the source of the hot water in the area is the Idavada Volcanics or an underlying rock unit.

Recharge to the volcanic aquifers is believed to be precipitation on outcrops at higher altitudes to the south and southwest (Figure 15). Upward movement of water from the volcanic aquifers is probably the primary recharge to the sedimentary aquifers. Percolation losses from streams in the area may also supply some recharge to the shallow aquifers.

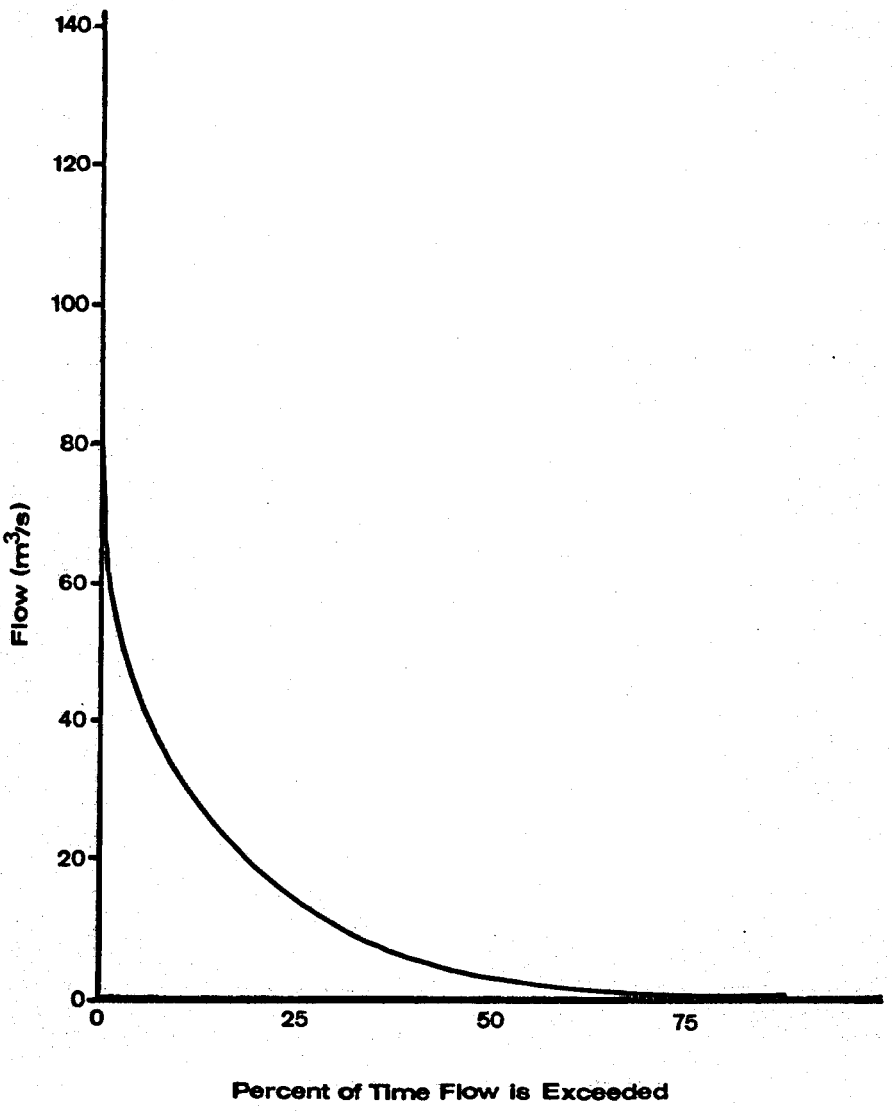


Figure 13. Duration curve of Bruneau River runoff near Hot Springs.

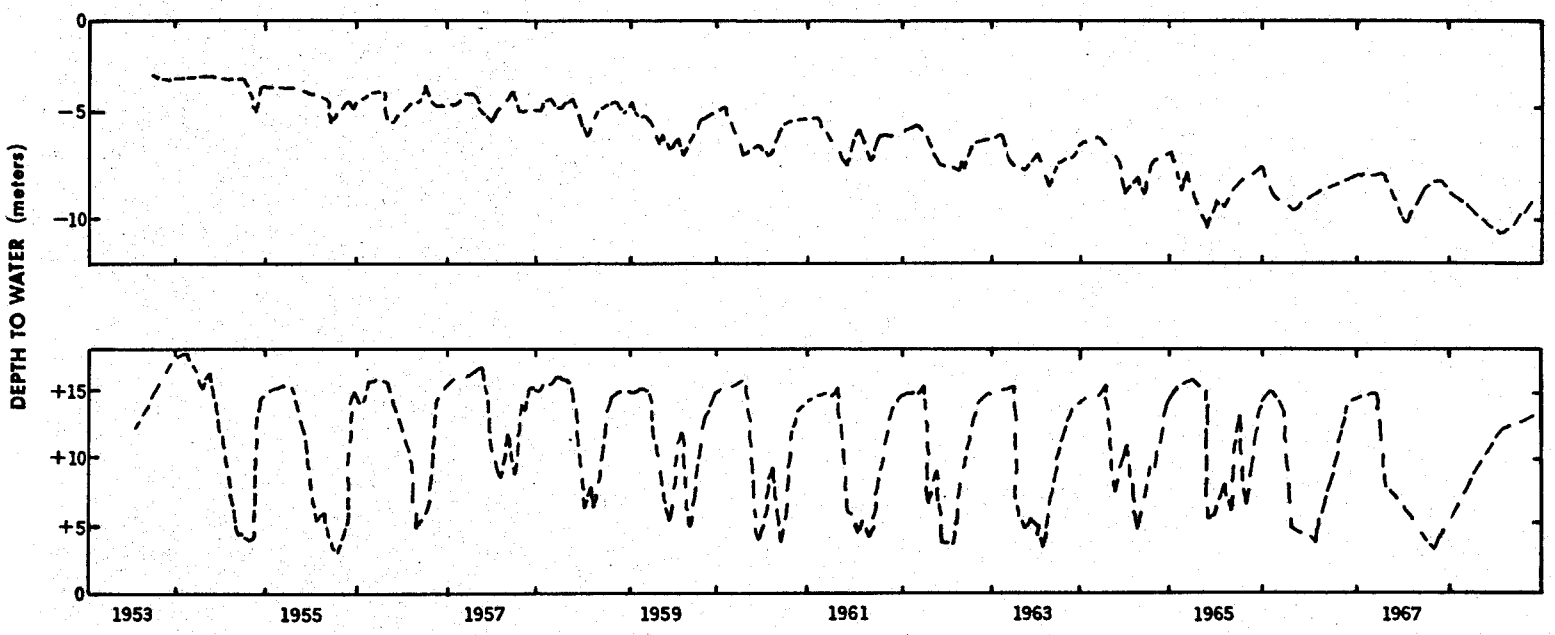


Figure 14. Hydrograph of groundwater wells in the Bruneau area.

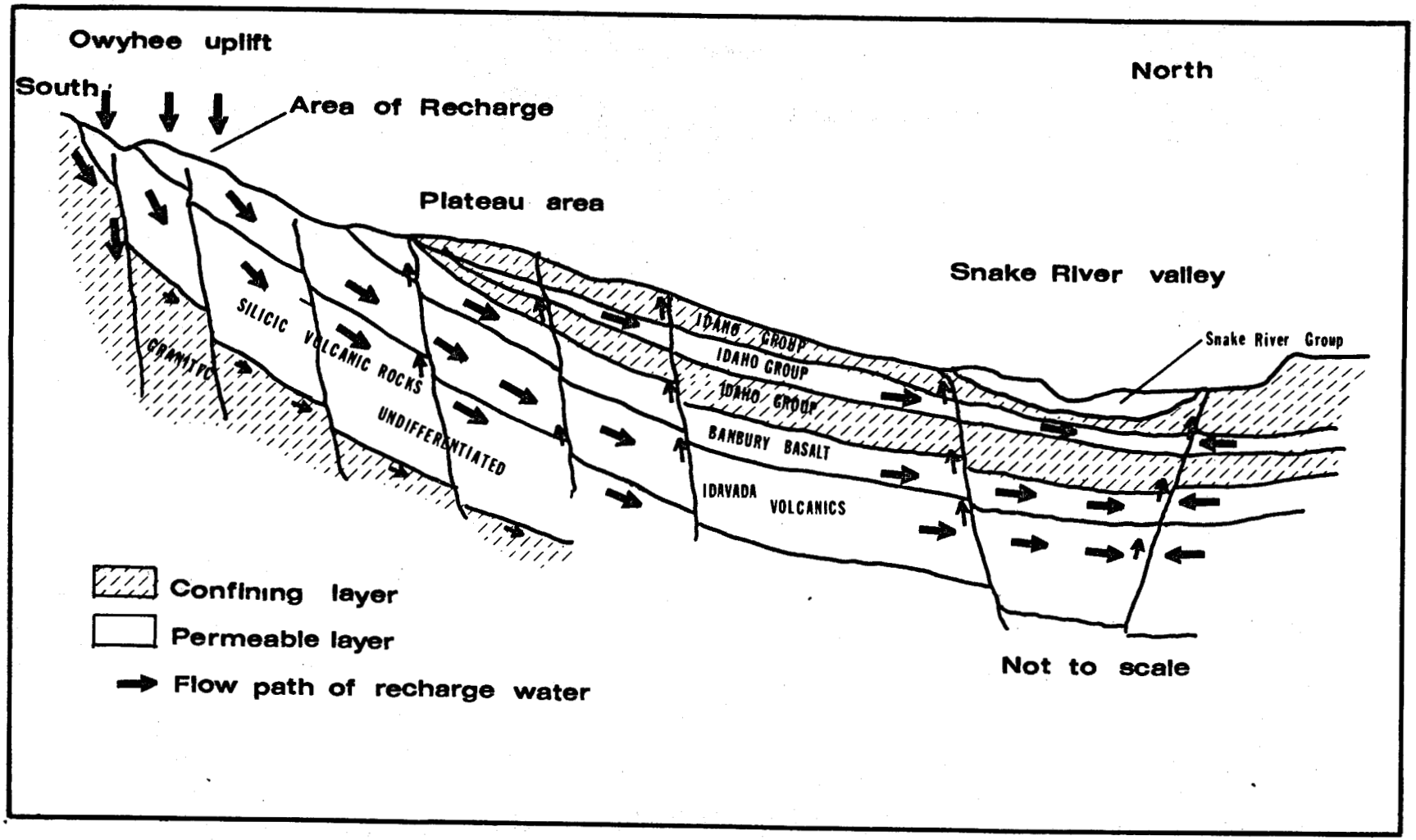


Figure 15. Idealized recharge for Bruneau-Grandview area.

Water Quality. The surface water quality data base for the Bruneau River basin consists of five partial years of data at several sites scattered throughout the river basin, with on site having 2-1/2 years of continual records for 1976, 1977, and 1978. There are some partial records available for a site at Hot Springs, and continuous records are available for a site at Bruneau. Figure 16 gives plots of the temperature and dissolved oxygen data for the years 1976 and 1977 at the Bruneau site. Table 4 shows the water quality of the Bruneau River for the water year 1976-1977.

An Idaho Department of Water Resources report by Ralston and Chapman[12] contains some data in the form of contour maps for sodium, fluoride, and dissolved solid concentrations for the ground water in the Bruneau area. This information appears in Figure 17. The water quality of thermal wells and springs in the KGRA is shown in Table 1. Fluoride levels in these wates are high and may restrict their use.

Water Rights. The water rights currently held in the Bruneau KGRA consist of three licensed wells and five wells under permits. Two canals running through the KGRA use water taken from the Bruneau River, but no information was found in the Idaho Department of Water Resources files concerning quantities or water right status. Table 5 shows information concerning the water rights in and around the Bruneau KGRA.

Soils (N. Savage, Idaho Water Resources Research Institute)

The Bruneau KGRA contains private ranch lands, mainly in the Bruneau Valley, and BLM lands on the surrounding plateau, each constituting about 50% of the KGRA. Three soil surveys have been conducted on all or parts of the KGRA at three levels of detail:

1. The SCS has completed detailed soil surveys on two parcels of private land within the KGRA. These surveys are on open file in the SCS office in Grand View, Idaho.

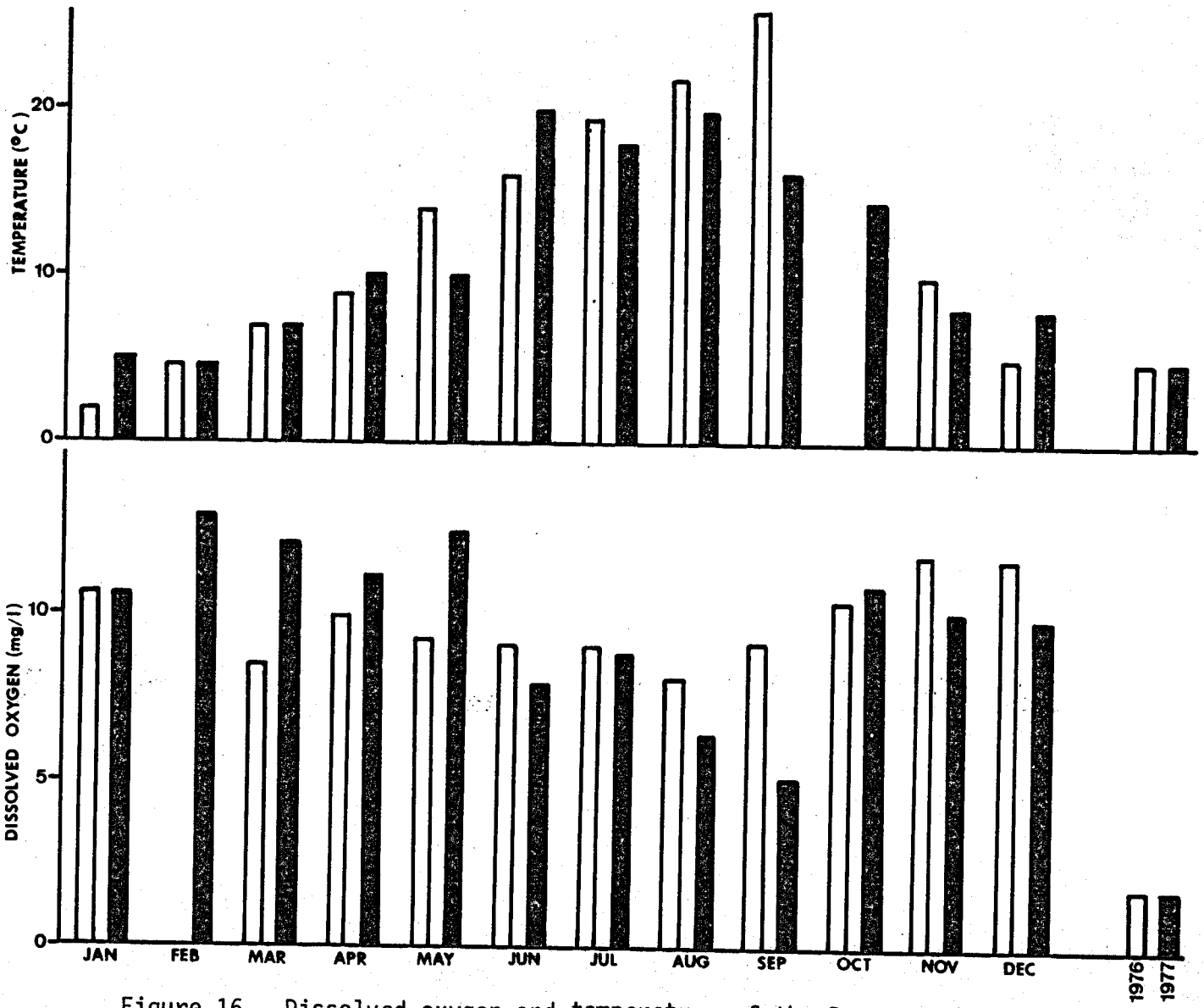


Figure 16. Dissolved oxygen and temperature of the Bruneau River, 1976 and 1977.

TABLE 4. WATER QUALITY OF THE BRUNEAU RIVER (1977)[26]
(in mg/l unless otherwise noted)

Ca	16
K	3.3
Mg	2.3
Na	21
SiO_2	34
Cl^-	5.4
$CO_3^=$	0
F^-	2.2
HCO_3^-	81
$NO_2 + NO_3^=$ (as N)	0.29
$SO_4^=$	13
Specific Conductance (µmhos)	218
Total Dissolved Solids	139
pH	8.4
Suspended Sediment	222
Sodium Adsorption Ratio	1.3

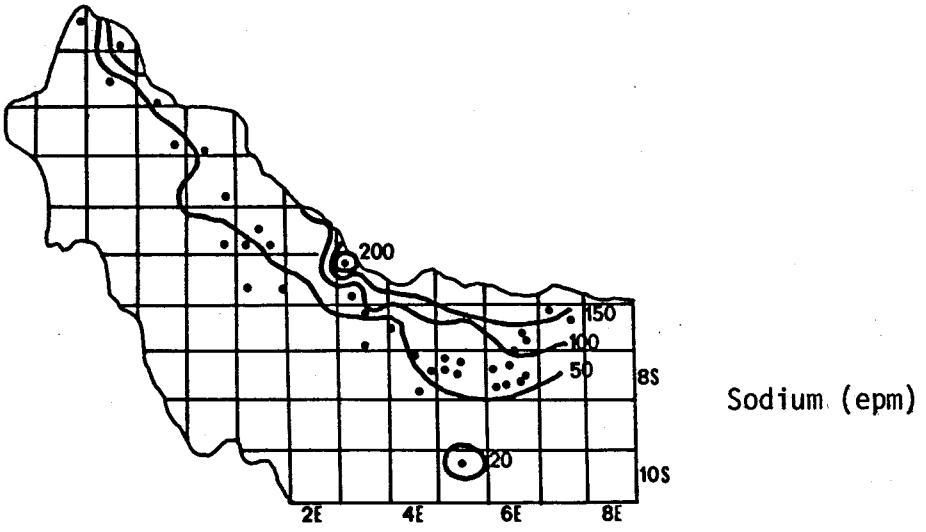


Figure 17a. Contours of concentrations of sodium in epm in northern Owyhee County.

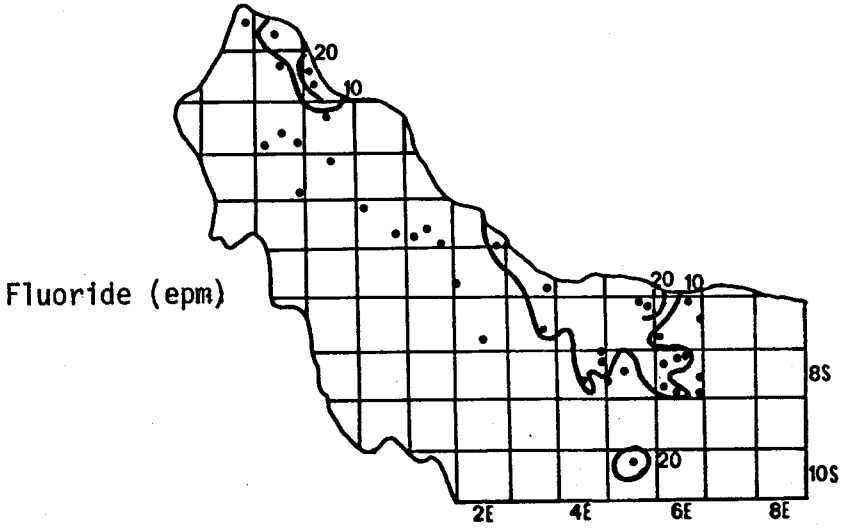


Figure 17b. Contours of concentrations of fluoride in epm in northern Owyhee County.

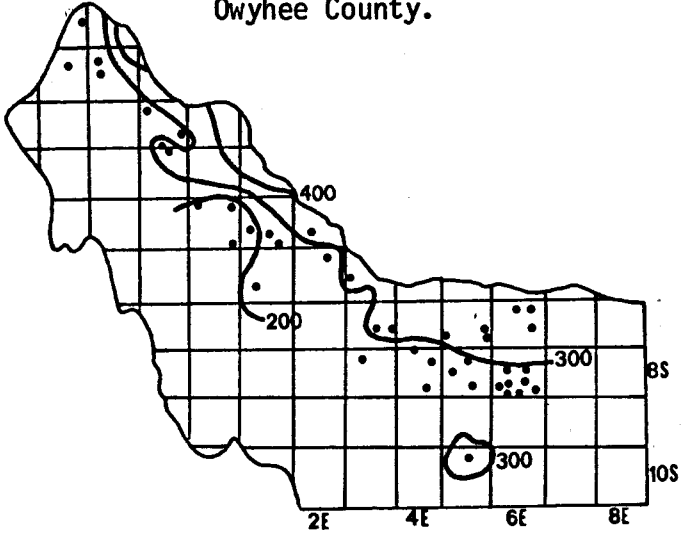


Figure 17c. Contours of total dissolved solids from samples in northern Owyhee County.

TABLE 5. SUMMARY OF WATER RIGHTS FILINGS IN BRUNEAU AREA

File Number	Quantity	Priority Date	Source	Location
51-7092	0.05 m^3/s		Well	T7S, R6E, SWSW, Sect. 22
51-7047	0.02 m^3/s	9-15-69	Well	T7S, R6E, NENE, Sect. 22 T7W, R6E, NWNW, Sect. 23
51-7082	0.10 m^3/s		Well	T7S, R6E, SWNE, Sect. 26
51-7095	0.18 m^3/s		Well	T7S, R6E, NWSE, Sect. 27
51-7094	0.00 m^3/s		Well	T7S, R6E, NWNW, Sect. 35
51-7093	0.00 m^3/s		Well	T7S, R6E, SWNW, Sect. 35
51-2213	0.06 m^3/s	4-11-66	Well	T7S, R6E, SWSE, Sect. 23

Source: IDWR Files Oct/1978

2. The Boise District of the BLM has completed land capability class surveys on all BLM lands within the KGRA.

3. Chugg et al[27] conducted a special survey in Owyhee County which included all of the Bruneau KGRA. Soil mapping units are shown in Figure 18, and descriptions are included in Appendix B.

Soil erosion is a serious problem on land units on steep slopes on the east and west sides of the valley. Soil wetness would limit activities in the Bruneau River flood-plain. At the present time, most of the privately-owned lands within the Bruneau KGRA are under agricultural development. Additional acres could be "broken out" as irrigation expands. Much of the BLM land is used as rangeland for livestock. These activities represent potential conflicting uses with large-scale geothermal development. There are soil and terrain limitations, at least on the steeper slopes and floodplain.

Biological Environment

Terrestrial Ecology (T. L. Johnson and C. D. Jorgensen, Brigham Young University)

The assessment of the terrestrial ecology of the Bruneau KGRA examined the habitats associated with the region. The potential impact of geothermal development was assessed with regard to habitats found in the KGRA and their relative abundance in the region. The principal vegetation habitat in the KGRA is the Tall Sagebrush Habitat (Figure 19).

Their proximity of threatened and endangered plant species to the KGRA illustrated in Figure 20. Specific species information is included in Appendix C. Records of these plant species were usually made from museum collections only, not from extensive studies.

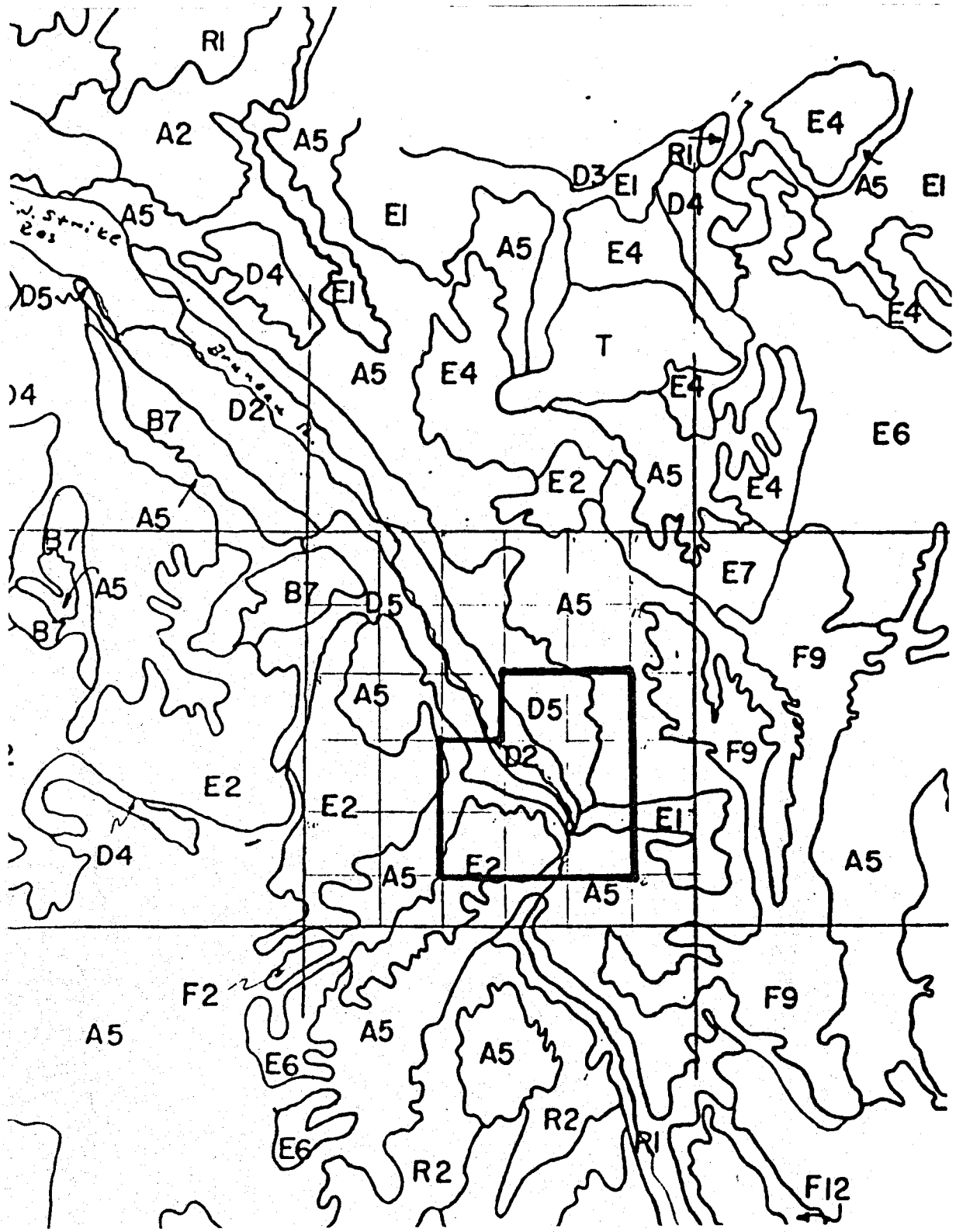


Figure 18. Special soil survey, Bruneau KGRA (Chugg et al, 1968).

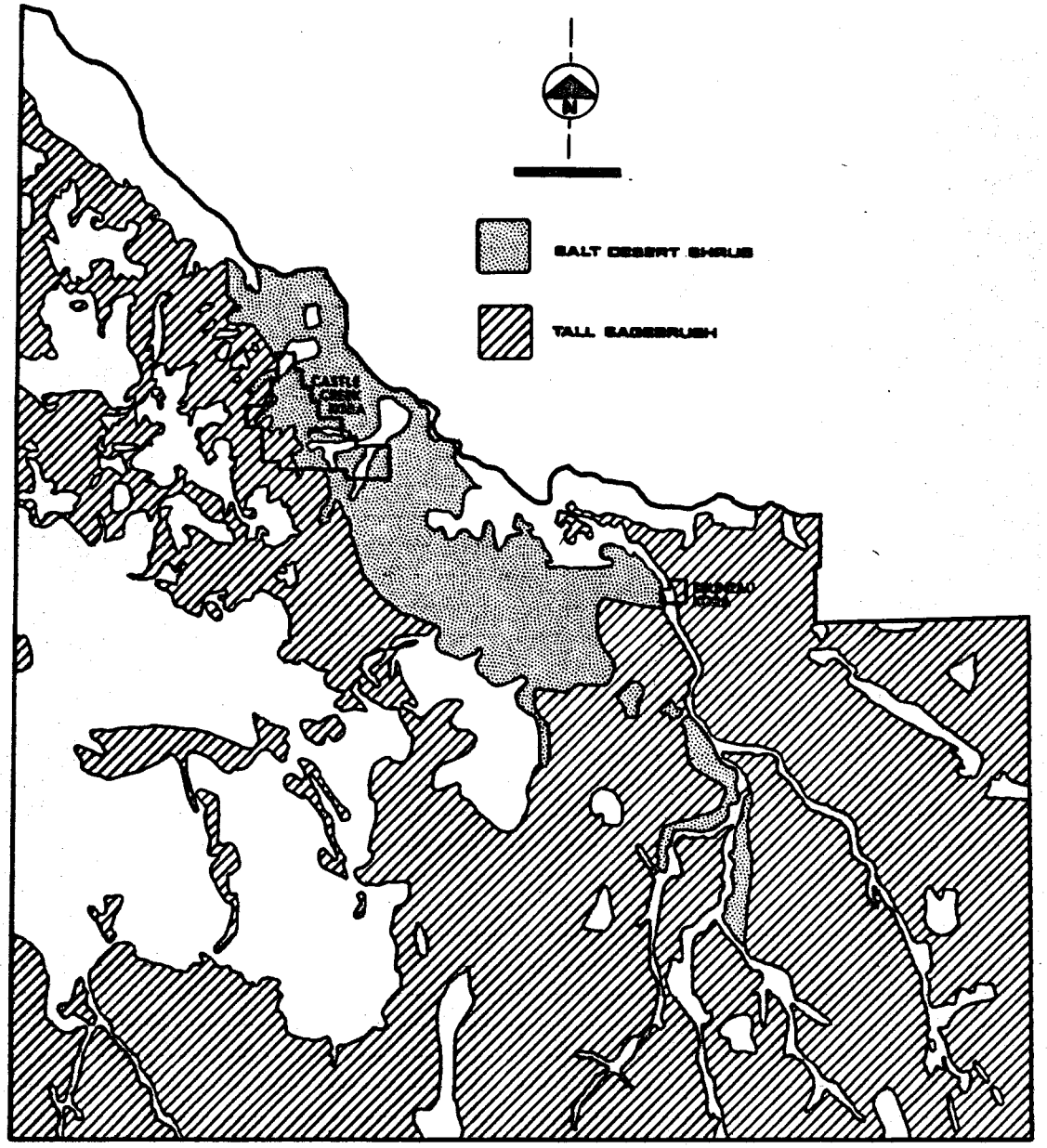


Figure 19. Relative extent of the Tall Sagebrush vegetation habitat (shaded area) within the Bruneau KGRA.

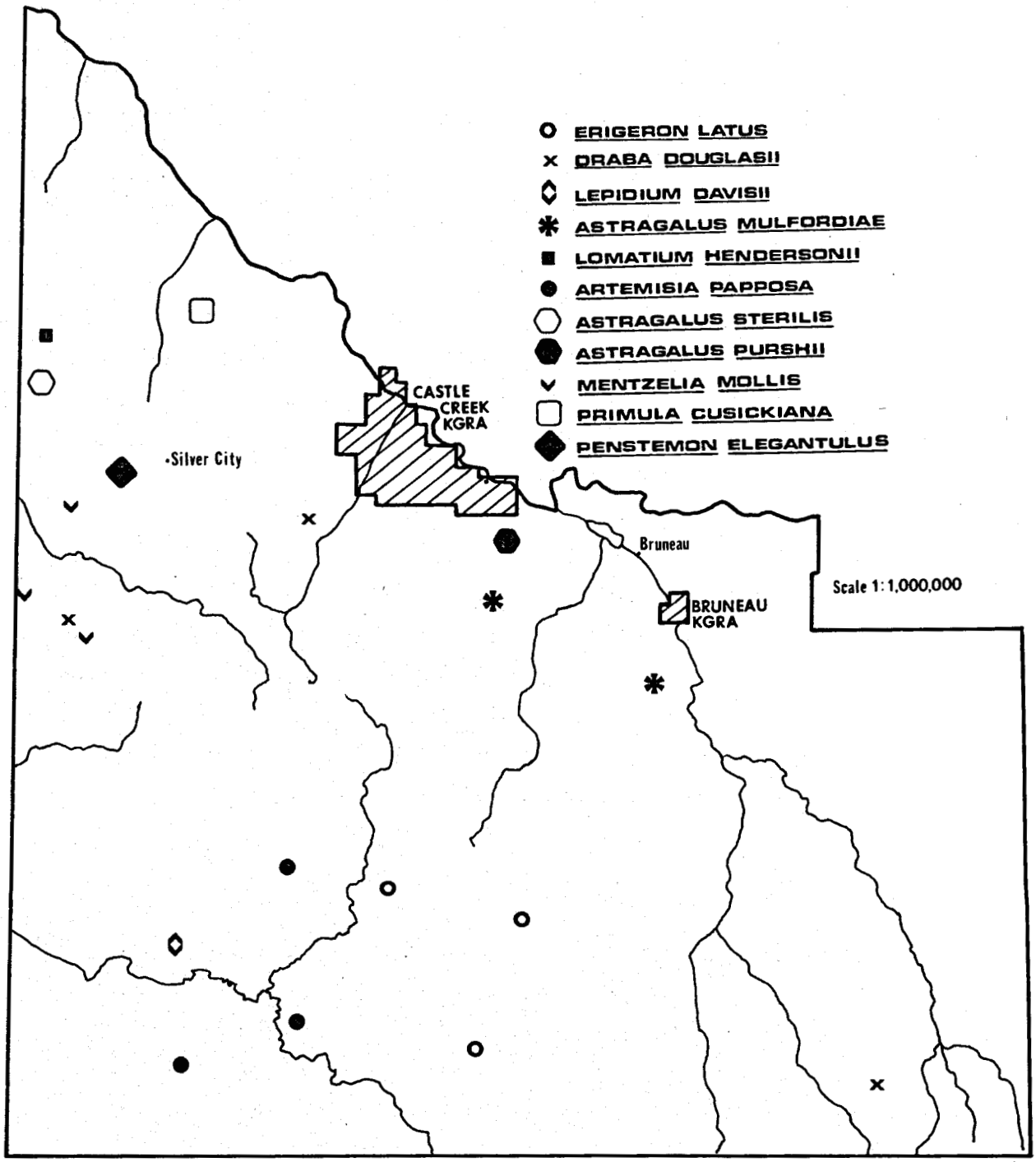


Figure 20. Recorded distributions of threatened and endangered plant species in Owyhee County, Idaho.

Data for the proposed threatened and endangered plant species were taken directly from Henderson et al.[28] Their study not only recommends a status based on the existing state of knowledge, but makes some recommendations for change of status. Only those whose status appears critical because of lack of information or extremely limited distributions are discussed in detail. Because specific efforts have not been made to establish their status, the data are almost incidental and need much more validation to be conclusive.

Astragalus mulfordiae, being known from only six sites that are limited in size, is considered "threatened" and should probably be reclassified as "endangered." Field work is recommended to provide sufficient data on distribution, population size, and edaphic characteristics for this species.

Species of vertebrates were compiled for the Bruneau KGRA on the basis of their reported association with habitats included in the area. These data were collected from numerous sources and represent the best estimate of what might be expected. Specific on-site research would be required to validate species present and relative numbers, but in the absence of such data, these listings represent the best summary of what is included in the resources available. The listings in Tables 6 - 9 are as comprehensive as possible, with reported species being deleted only if there is reason for doing so.

Most of the information included in Tables 6 - 9 was obtained from a limited number of sources, although specific data were collected from many scattered references, some correspondence with Idaho researchers, personal knowledge, and some conversations with strategic researchers. These data sources are summarized in the following listings:

TABLE 6. AMPHIPIANS IN THE BRUNEAU KGRA, WITH RELATIVE ABUNDANCE AND HABITAT LISTINGS

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Long-toed Salamander	Ambystoma macrodactylum	L	L	L	L				X	X	
Great Basin Spadefoot	Scaphiopus intermontanus	L	L	L	L		X		X	X	
Western Toad	Bufo boreas	L	L	L	L		X	X	X	X	
Woodhouse's Toad	Bufo woodhousei	L	L	L	L				X	X	
Chorus Frog	Pseudacris triseriata	L	L	L	L				X	X	
Pacific Treefrog	Hyla regilla	L	L	L	L				X	X	
Spotted Frog	Rana pretiosa	M	M	M	M					X	
Leopard Frog	Rana pipiens	M	M	M	M				X	X	

[a]Key To Relative Abundance: H=High, M=Medium, L=Low, A=Absent, P=Population level unknown, U=Presence unknown.

[b]Key to Habitat Types: 1=Salt Desert Shrub, 2=Sagebrush, 3=Perennial Grass, 4=Irrigated Farm, 5=Stream Side, 6=Lakes.

TABLE 7. REPTILES IN THE BRUNEAU KGRA, WITH RELATIVE ABUNDANCE AND HABITAT LISTINGS

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Collared Lizard	Crotaphytus collaris	M	M	M	M		X	X	X	X	
Leopard Lizard	Crotaphytus wislizenii	M	M	M	M	X	X	X	X	X	
Western Fence Lizard	Sceloporus occidentalis	M	M	M	M	X	X	X	X	X	
Sagebrush Lizard	Sceloporus graciosus	H	H	H	H	X	X	X	X	X	
Side-blotched Lizard	Uta stansburiana	L	L	L	L	X	X	X			
Desert Horned Lizard	Phrynosoma platyrhinos	L	M	M	M	X	X	X		X	
Short Horned Lizard	Phrynosoma douglassi	L	L	L	L	X	X	X			
Western Whiptail	Cnemidophorus tigris	M	M	M	M	X	X	X			
Ringneck Snake	Diadophis punctatus	P	M	M	M					X	
Racer	Coluber constrictor	M	M	M	M	X	X	X	X	X	
Striped Whipsnake	Masticophis taeniatus	M	M	M	M	X	X	X			
Gopher Snake	Pituophis melanoleucus	H	H	H	H	X	X	X	X	X	
Common Garter Snake	Thamnophis sirtalis	M	M	M	M		X	X	X	X	
Western Garter Snake	Thamnophis elegans	M	M	M	M	X	X	X	X	X	
Western Ground Snake	Sonora semiannulata	L	L	L	L	X	X			X	
Night Snake	Hypsiglena torquata	H	H	H	H		X				
Western Rattlesnake	Crotalus viridis	L	L	L	L	X	X	X	X	X	

[a]Key To Relative Abundance: H=High, M=Medium, L=Low, A=Absent, P=Population level unknown, U=Presence unknown.

[b]Key to Habitat Types: 1=Salt Desert Shrub, 2=Sagebrush, 3=Perennial Grass, 4=Irrigated Farm, 5=Stream Side, 6=Lakes.

TABLE 8. BIRDS IN THE BRUNEAU KGRA, WITH RELATIVE ABUNDANCE AND HABITAT LISTINGS

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Common Loon	Gavia immer	U	U	U	U						
Western Grebe	Aechmophorus occidentalis	L	L	L	L						X
Horned Grebe	Podiceps auritus	U	U	U	U						
Eared Grebe	Podiceps caspicus	L	L	L	P						X
Pied-billed Grebe	Podilymbus podiceps	L	L	L	L						X
White Pelican	Pelecanus erythrorhynchos	L	L	L	P						X
Double-crested Cormorant	Phalacrocorax auritus	L	L	L	P						X
Whistling Swan	Olor columbianus	L	L	L	L					X	X
Canada Goose	Branta canadensis	M	M	M	M				X	X	X
Snow Goose	Chen hyperborea	U	U	U	U						
Mallard	Anas platyrhynchos	M	M	M	H				X	X	X
Pintail	Anas acuta	L	L	L	L				X	X	X
Gadwall	Anas strepera	L	L	L	L				X	X	X
Wigeon	Anas americana	M	M	M	H					X	X
Northern Shoveler	Anas clypeata	L	M	L	L					X	X
Blue-winged Teal	Anas discors	L	M	M	P					X	X
Cinnamon Teal	Anas cyanoptera	L	M	L	P					X	X
Green-winged Teal	Anas crecca	M	M	M	M					X	X
Wood Duck	Aix sponsa	L	L	L	L					X	X
Redhead	Aythya americana	L	L	L	P					X	X
Canvasback	Aythya valisineria	L	L	L	P					X	X
Ring-necked Duck	Aythya collaris	L	P	L	P					X	X
Greater Scaup	Aythya marila	L	P	L	P						X
Lesser Scaup	Aythya affinis	L	L	L	P					X	X
Common Goldeneye	Bucephala clangula	P	P	P	L					X	X

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Bufflehead	Bucephala albeola	L	L	L	L					X	X
Ruddy Duck	Oxyura jamaicensis	L	M	L	P					X	X
Common Merganser	Mergus merganser	L	L	L	L					X	X
Hooded Merganser	Lophodytes cucullatus	U	U	U	U						
Turkey vulture	Cathartes aura	L	M	L	L	X	X	X	X	X	
Goshawk	Accipiter gentilis	P	P	P	L	X	X	X	X	X	
Cooper's Hawk	Accipiter cooperii	L	L	L	L	X	X	X	X	X	
Sharp-shinned Hawk	Accipiter striatus	L	L	L	L	X	X	X	X	X	
Marsh Hawk	Circus cyaneus	M	M	M	M	X	X	X	X	X	
Rough-legged Hawk	Buteo lagopus	P	P	P	M	X	X	X	X	X	
Red-tailed Hawk	Buteo jamaicensis	H	H	M	M	X	X	X	X	X	
Ferruginous Hawk	Buteo regalis	L	L	L	M	X	X	X	X	X	
Swainson's Hawk	Buteo swainsoni	M	M	M	M	X	X	X	X	X	
Golden Eagle	Aquila chrysaetos	H	H	H	H	X	X	X	X	X	
Bald Eagle	Haliaeetus leucocephalus	L	L	L	L		X			X	X
Osprey	Pandion haliaetus	L	L	L	L					X	X
Prairie Falcon	Falco mexicanus	H	H	H	H	X	X	X	X	X	
Peregrine Falcon	Falco peregrinus	L	L	L	L	X	X				
American Kestrel	Falco sparverius	H	H	H	H	X	X	X	X	X	
Blue Grouse	Dendragapus obscurus	L	L	L	L		X				
Spruce Grouse	Canachites canadensis	U	U	U	U						
Sage Grouse	Centrocercus urophasianus	H	H	H	H		X	X	X	X	
Bobwhite	Colinus virginianus	L	L	L	L	X	X			X	
California Quail	Lophortyx californicus	M	M	M	M	X	X		X	X	
Ring-necked Pheasant	Phasianus colchicus	M	M	M	M	X	X	X	X	X	

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Chukar	Alectoris chukar	M	M	M	M	X	X	X	X	X	
Gray Partridge	Perdix perdix	L	M	M	M	X	X	X	X	X	
Sandhill Crane	Grus canadensis	L	L	L	P				X		X
Great Blue Heron	Ardea herodias	L	L	L	L	X	X		X	X	X
Snowy Egret	Leucophoyx thula	L	L	L	L					X	X
Black-crowned Night Heron	Nycticorax nycticorax	L	L	L	L					X	X
American Bittern	Botaurus lentiginosus	L	L	L	P			X		X	X
Virginia Rail	Rallus limicola	U	U	U	U						
Sora	Porzana carolina	L	L	P	P					X	
American Coot	Fulica americana	U	U	U	U						
American Avocet	Recurvirostra americana	L	L	L	L					X	X
Black-necked Stilt	Himantopus mexicanus	U	U	U	U						
Killdeer	Charadrius vociferus	M	M	M	L	X	X	X	X	X	
Long-billed Curlew	Numenius americanus	U	U	U	U						
Marbled Godwit	Limosa fedoa	U	U	U	U						
Solitary Sandpiper	Tringa solitaria	U	U	U	U						
Spotted Sandpiper	Actitis macularia	L	L	L	L	X	X		X	X	X
Willet	Catoptrophorus semipalmatus	U	U	U	U						
Greater Yellowlegs	Totanus melanoleucus	U	U	U	U						
Lesser Yellowlegs	Totanus flavipes	U	U	U	U						
Long-billed Dowitcher	Limnodromus scolopaceus	U	U	U	U						
Pectoral Sandpiper	Erolia melanotos	U	U	U	U						
Baird's Sandpiper	Erolia bairdii	U	U	U	U						
Least Sandpiper	Erolia minutilla	U	U	U	U						
Western Sandpiper	Ereunetes mauri	U	U	U	U						

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Wilson's Phalarope	Steganopus tricolor	U	U	U	U						
Northern Phalarope	Lobipes lobatus	U	U	U	U						
Common Snipe	Capella gallinago	U	U	U	U						
California Gull	Larus californicus	H	M	M	M	X	X		X		X
Ring-billed Gull	Larus delawarensis	L	L	L	P	X	X		X		X
Franklin's Gull	Larus pipixcan	L	L	L	P				X		X
Bonaparte's Gull	Larus philadelphia	U	U	U	U						
Forster's Tern	Sterna forsteri	L	L	L	P						X
Black Tern	Chlidonias niger	L	L	L	P						X
Rock Dove	Columba livia	U	U	U	U						
Mourning Dove	Zenaidura macroura	M	H	M	L	X	X	X	X	X	
Yellow-billed Cuckoo	Coccyzus americanus	U	U	U	U						
Black-billed Cuckoo	Coccyzus erythropthalmus	U	U	U	U						
Barn Owl	Tyto alba	L	L	L	L	X	X	X	X	X	
Screech Owl	Otus asio	L	L	L	L	X	X		X	X	
Great Horned Owl	Bubo virginianus	L	L	L	L	X	X	X	X	X	
Short-eared Owl	Asio flammeus	L	L	L	L	X	X		X	X	
Long-eared Owl	Asio otus	L	L	L	L				X		
Burrowing Owl	Speotyto cunicularia	L	L	L	L	X	X	X	X		
Saw-whet Owl	Aegolius acadicus	L	L	L	L				X		
Poor Will	Phalaenoptilus nuttallii	L	M	L	L	X	X	X			
Common Nighthawk	Chordeiles minor	L	M	L	P	X	X	X	X	X	
Broad-tailed Hummingbird	Selasphorus platycercus	L	L	L	P	X	X	X	X	X	
Rufous Hummingbird	Selasphorus rufus	L	L	L	P				X	X	
Belted Kingfisher	Megaceryle alcyon	L	L	L	L					X	X

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Common Flicker	Colaptes auratus	M	M	M	M	X	X	X	X	X	
Lewis' Woodpecker	Asyndesmus lewis	U	U	U	U						
Hairy Woodpecker	Dendrocopos villosus	L	L	L	L				X		
Downy Woodpecker	Dendrocopos pubescens	L	L	L	L				X		
Eastern Kingbird	Tyrannus tyrannus	L	L	L	P	X	X	X	X	X	
Western Kingbird	Tyrannus verticalis	L	M	L	P	X	X	X	X	X	
Say's Phoebe	Sayornis saya	M	M	L	L	X	X	X	X	X	
Traill's Flycatcher	Empidonax traillii	L	M	L	P	X	X	X	X	X	
Hammond's Flycatcher	Empidonax hammondii	U	U	U	U						
Dusky Flycatcher	Empidonax oberholseri	U	U	U	U						
Western Wood Pewee	Contopus sordidulus	L	L	L	P					X	
Olive-sided Flycatcher	Nuttallornis borealis	L	L	L	P			X			
Horned Lark	Eremophila alpestris	M	M	M	M	X	X	X	X		
Barn Swallow	Hirundo rustica	M	M	M	P	X	X		X	X	X
Cliff Swallow	Petrochelidon pyrrhonota	L	L	L	P				X	X	X
Violet-green Swallow	Tachycineta thalassina	L	L	L	P	X	X	X	X	X	X
Tree Swallow	Iridoprocne bicolor	L	L	L	L	X	X	X	X	X	
Bank Swallow	Riparia riparia	M	M	M	P	X	X		X	X	
Rough-winged Swallow	Stelgidopteryx ruficollis	L	L	L	P					X	X
Steller's Jay	Cyanocitta stelleri	L	L	L	L						
Pinon Jay	Gymnorhinus cyanocephala	P	P	P	L	X					
Black-billed Magpie	Pica pica	H	H	H	H	X	X	X	X	X	
Common Raven	Corvus corax	M	M	M	M	X	X	X	X	X	
Common Crow	Corvus brachyrhynchos	H	H	H	H	X	X		X	X	
Black-capped Chickadee	Parus atricapillus	L	P	L	L		X		X	X	

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Mountain Chickadee	Parus gambeli	P	P	P	L				X	X	
White-breasted Nuthatch	Sitta carolinensis	L	P	L	L					X	
Brown Creeper	Certhia familiaris	L	L	L	P	X	X		X		
House Wren	Troglodytes aedon	L	M	L	L			X	X	X	
Winter Wren	Troglodytes troglodytes	L	P	P	L					X	
Long-billed Marsh Wren	Telmatodytes palutris	U	U	U	U						
Canyon Wren	Catherpes mexicanus	M	H	M	P	X	X				
Rock Wren	Salpinctes obsoletus	L	L	L	P	X	X	X	X		
Gray Catbird	Dumetella carolinensis	L	L	L	L					X	
Sage Thrasher	Oreoscoptes montanus	M	H	M	P	X	X	X	X		
Robin	Turdus migratorius	M	M	M	L	X	X	X	X	X	
Hermit Thrush	Hylocichla guttata	L	P	L	P				X		
Swainson's Thrush	Hylocichla ustulata	L	P	L	P				X		
Veery	Hylocichla fuscescens	U	U	U	U						
Mountain Bluebird	Sialia currucoides	L	M	L	L			X	X	X	
Townsend's Solitare	Myadestes townsendi	P	P	P	L					X	
Golden-crowned Kinglet	Regulus satrapa	P	P	P	L					X	
Ruby-crowned Kinglet	Regulus calendula	P	P	P	L					X	
Bohemian Waxwing	Bombycilla garrula	P	P	P	L	X	X		X	X	
Cedar Waxwing	Bombycilla cedrorum	L	M	L	L	X	X		X	X	
Northern Shrike	Lanius excubitor	P	P	P	L	X	X	X	X	X	
Loggerhead Shrike	Lanius ludovicianus	L	M	M	L	X	X	X	X	X	
Starling	Sturnus vulgaris	M	M	M	M	X	X	X	X	X	
Red-eyed Vireo	Vireo olivaceus	U	U	U	U						
Warbling Vireo	Vireo gilvus	M	M	M	P					X	

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Orange-crowned Warbler	Vermivora celata	U	U	U	U						
Yellow Warbler	Dendroica petechia	L	L	L	P				X	X	
Yellow-rumped Warbler	Dendroica coronata	L	P	L	P					X	
MacGillivray's Warbler	Oporornis tolmiei	L	L	P	P					X	
Common Yellowthroat	Geothlypis trichas	L	L	L	P	X	X		X	X	
Wilson's Warbler	Wilsonia pusilla	M	M	M	P					X	
Yellow-breasted Chat	Icteria virens	L	L	L	P	X	X		X	X	
House Sparrow	Passer domesticus	M	M	M	M	X	X	X	X		
Western Meadowlark	Sturnella neglecta	M	M	M	M	X	X	X	X	X	
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	U	U	U	U						
Red-winged Blackbird	Agelaius phoeniceus	M	L	M	L			X	X	X	
Northern Oriole	Icterus galbula	L	M	L	P					X	
Brewer's Blackbird	Euphagus cyanocephalus	M	M	M	L	X	X	X	X	X	
Brown-headed Cowbird	Molothrus ater	L	L	L	L	X	X	X	X	X	
Western Tanager	Piranga ludoviciana	L	M	L	P					X	
Black-headed Grosbeak	Pheucticus melanocephalus	L	L	L	L					X	
Lazuli Bunting	Passerina amoena	L	L	L	L			X		X	
Evening Grosbeak	Hesperiphona vespertina	U	U	U	U						
Cassin's Finch	Carpodacus cassinii	L	L	L	L	X	X	X	X	X	
House Finch	Carpodacus mexicanus	L	L	L	L	X	X	X	X	X	
Pine Siskin	Spinus pinus	P	P	P	L				X		
American Goldfinch	Spinus tristis	L	M	L	L	X			X	X	
Green-tailed Towhee	Chlorura chlorura	L	L	L	P	X	X	X	X	X	
Rufous-sided Towhee	Pipilo erythrophthalmus	M	M	M	L			X		X	
Lark Bunting	Calamospiza melanocorys	U	U	U	U						

TABLE 8. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Savannah Sparrow	Passerculus sandwichensis	H	H	H	H	X	X	X	X		
Grasshopper Sparrow	Ammodramus savannarum	L	M	M	L	X	X	X	X		
Vesper Sparrow	Pooecetes gramineus	L	L	L	L	X	X	X	X		
Lark Sparrow	Chondestes grammacus	M	M	M	M	X	X	X	X		
Black-throated Sparrow	Amphispiza bilineata	U	U	U	U						
Sage Sparrow	Amphispiza belli	P	P	P	P		X				
Dark-eyed Junco	Junco hyemalis	L	P	L	L	X	X		X	X	
Tree Sparrow	Spizella arborea	U	U	U	U						
Chipping Sparrow	Spizella passerina	L	M	M	L	X	X	X	X	X	
Brewer's Sparrow	Spizella breweri	M	M	M	M	X	X	X	X		
White-crowned Sparrow	Zonotrichia leucophrys	L	L	L	M	X	X	X	X	X	
Fox Sparrow	Passerella iliaca	L	L	L	P	X	X	X	X	X	
Song Sparrow	Melospiza melodia	L	M	L	L	X	X	X	X	X	

[a]Key To Relative Abundance: H=High, M=Medium, L=Low, A=Absent, P=Population level unknown, U=Presence unknown.

[b]Key to Habitat Types: 1=Salt Desert Shrub, 2=Sagebrush, 3=Perennial Grass, 4=Irrigated Farm, 5=Stream Side, 6=Lakes.

TABLE 9. MAMMALS IN THE CASTLE CREEK-BRUNEAU KGRA, WITH RELATIVE ABUNDANCE AND HABITAT LISTINGS

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Shrews		M	M	M	M	X	X	X	X	X	
Vagrant Shrew	Sorex vagrans										
Merriam Shrew	Sorex merriami										
Bats		M	M	M	L	X	X	X	X	X	X
Yuma Myotix	Myotis yumanensis										
Long-eared Myotis	Myotis evotis										
Fringed Myotis	Myotis thysanodes										
Long-legged Myotis	Myotis volans										
California Myotis	Myotis californicus										
Small-footed Myotis	Myotis subulatus										
Western Pipistrel	Pipistrellus hesperus										
Big Brown Bat	Eptesicus fuscus										
Spotted Bat	Euderma maculata										
Western Big Eared	Plecotus townsendi										
Raccoon	Procyon lotor	L	L	L	L	X	X	X	X	X	
Weasel		L	L	L	L	X	X	X	X	X	
Shorttail Weasel	Mustela erminea										
Longtail Weasel	Mustela frenata										
Mink	Mustela vison	L	L	L	L					X	
River Otter	Lutra canadensis	P	P	P	P					X	X
Badger	Taxidea taxus	H	H	H	H	X	X	X	X		
Spotted Skunk	Spilogale putorius	L	L	L	L	X	X	X	X	X	
Striped Skunk	Mephitis mephitis	M	M	M	M	X	X	X	X	X	
Coyote	Canis latrans	H	H	H	H	X	X	X	X	X	
Red Fox	Vulpes fulva	L	L	L	L		X		X		
Kit Fox	Vulpes macrotis	U	U	U	U						
Bobcat	Lynx rufus	M	M	M	M	X	X	X	X	X	
Yellowbelly Marmot	Marmota flaviventris	M	M	M	M	X	X	X	X		
Townsend Ground Squirrel	Spermophilus townsendi	M	M	M	M	X	X	X	X	X	

TABLE 9. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Richardson Ground Squirrel	Spermophilus richardsoni	P	P	P	P		X	X	X	X	
Belding Ground Squirrel	Spermophilus beldingi	P	P	P	P			X	X	X	
Columbia Ground Squirrel	Spermophilus columbianus	L	L	L	L			X	X	X	
Whitetail Antelope Ground Spuirrel	Ammospermophilus leucurus	H	H	H	H	X	X			X	
Least Chipmunk	Eutamias minimus	M	M	M	M	X	X	X	X	X	
Fox Squirrel	Sciurus niger	L	L	L	L					X	
Northern Pocket Gopher	Thomomys talpoides	H	H	H	H	X	X	X	X	X	
Townsend Pocket Gopher	Thomomys townsendi	P	P	P	P				X	X	
Great Basin Pocket Mouse	Perognathus parvus	P	P	P	P		X				
Kangaroo Rat		H	H	H	H	X	X	X	X		
Ord Kangaroo Rat	Dipodomys ordi										
Great Basin Kangaroo Rat	Dipodomys microps										
Beaver	Castor canadensis	M	M	M	M					X	X
Western Harvest Mouse	Reithrodontomys megalotis	M	M	M	M		X	X	X	X	
Deer Mouse	Peromyscus maniculatus	M	M	M	M	X	X	X	X	X	
Canyon Mouse	Peromyscus crinitus	P	P	P	P	X	X			X	
Northern Grasshopper Mouse	Onychomys leucogaster	M	M	M	M	X	X	X	X		
Wood Rats		L	L	L	L	X	X			X	
Bushytail Woodrat	Neotoma cinerea										
Desert Woodrat	Neotoma lepida										
Mountain Vole	Microtus montanus	L	L	L	L				X	X	

TABLE 9. (continued)

Species		Relative Abundance[a]				Habitat Types[b]					
Common Name	Scientific Name	Sp	Su	Fa	Wi	1	2	3	4	5	6
Sagebrush Vole	Lagurus curtatus	P	P	P	P		X				
Muskrat	Ondatra zibethica	L	L	L	L					X	X
House Mouse	Mus musculus	P	P	P	P				X	X	
Western Jumping Mouse	Zapus princeps	M	M	M	M		X			X	
Porcupine	Erethizon dorsatum	P	P	P	P					X	
Whitetail Jackrabbit	Lepus townsendi	L	L	L	L		X			X	
Blacktail Jackrabbit	Lepus californicus	M	M	M	M	X	X	X	X		
Mountain Cottontail	Sylvilagus nuttalli	M	M	M	M	X	X	X	X	X	
Pygmy Rabbit	Sylvilagus idahoensis	L	L	L	L	X	X	X	X	X	
Mule Deer	Odocoileus hemionus	H	H	H	H	X	X	X	X	X	
Pronghorn Antelope	Antilocapra americana	H	H	H	H	X	X	X	X	X	
California Bighorn Sheep	Ovis canadensis	H	H	H	H		X				

[a]Key To Relative Abundance: H=High, M=Medium, L=Low, A=Absent, P=Population level unknown, U=Presence unknown.

[b]Key to Habitat Types: 1=Salt Desert Shrub, 2=Sagebrush, 3=Perennial Grass, 4=Irrigated Farm, 5=Stream Side, 6=Lakes.

Amphibians and Reptiles: References 29, 30, 31, 32, 33, 34, 35

Birds: References 29, 32, 33, 34, 35, 36, 38

Mammals: References 29, 32, 33, 34, 35, 39, 40

Tables 6 - 9 represent a convenient compilation of the information obtained from numerous sources. Since several techniques were used to gather these data, it seemed better to assign their numbers to some "relative abundance" category. This was the best way to avoid encouraging conclusions by the reader that could not be supported with data. Where blanks occur in Tables 6 - 9, data were either unavailable and the species were thought to be present, or data were too questionable to base an opinion on. Habitat types referenced in these tables are those shown in Figures 21 - 29.

Species of special concern listed in Table 10 have been classified (a) according to whether they are considered game species, fur bearers, or of extended concern because of restricted range, specific habitat requirements, or population numbers so low that they may easily be eliminated from Idaho; and (b) according to whether they are threatened or endangered. Because these species have received more consideration in past work, more data are available and Table 10 should be considered rather accurate. Distributions of some species of concern are plotted in Figures 21 - 29, demonstrating their proximities to the KGRA. Species not included in these figures were either ubiquitous or their distributions were unknown, as would be expected for many of the non-game and migratory species. Data included were taken from "Idaho Environmental Overview"[40] and must be accepted cautiously. Local habitat vagaries not included in the diagrams will create many exceptions to what is illustrated.

In 1971, the U.S. Department of the Interior established 10 819 ha of public land along the Snake River canyon as the Snake River Birds of Prey Natural Area (BPNA). This region contains one of the densest populations of nesting raptors ever recorded. More than 600 pairs,

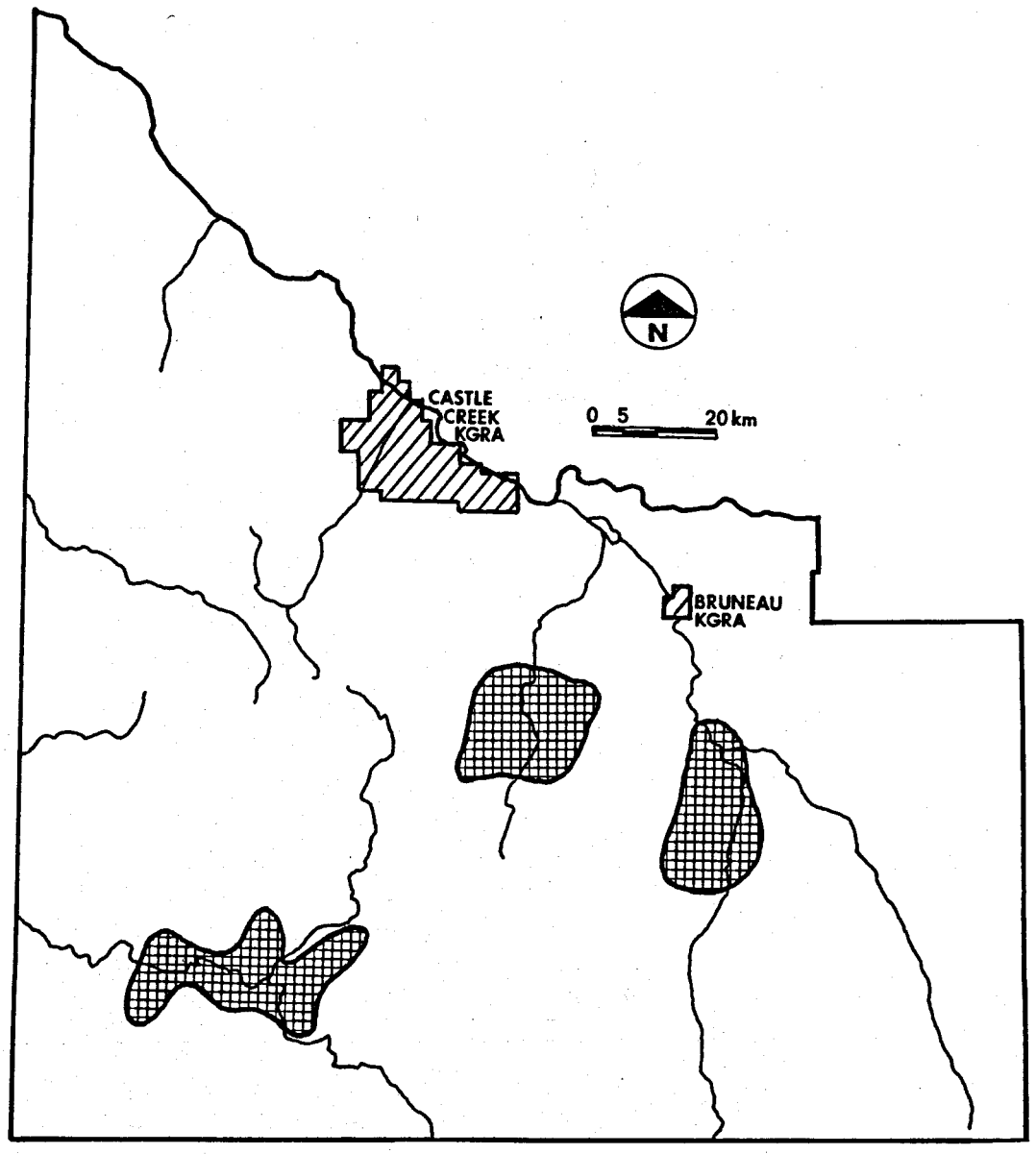


Figure 21. Distribution of California Bighorn Sheep (Ovis canadensis) habitat within Owyhee County, Idaho.

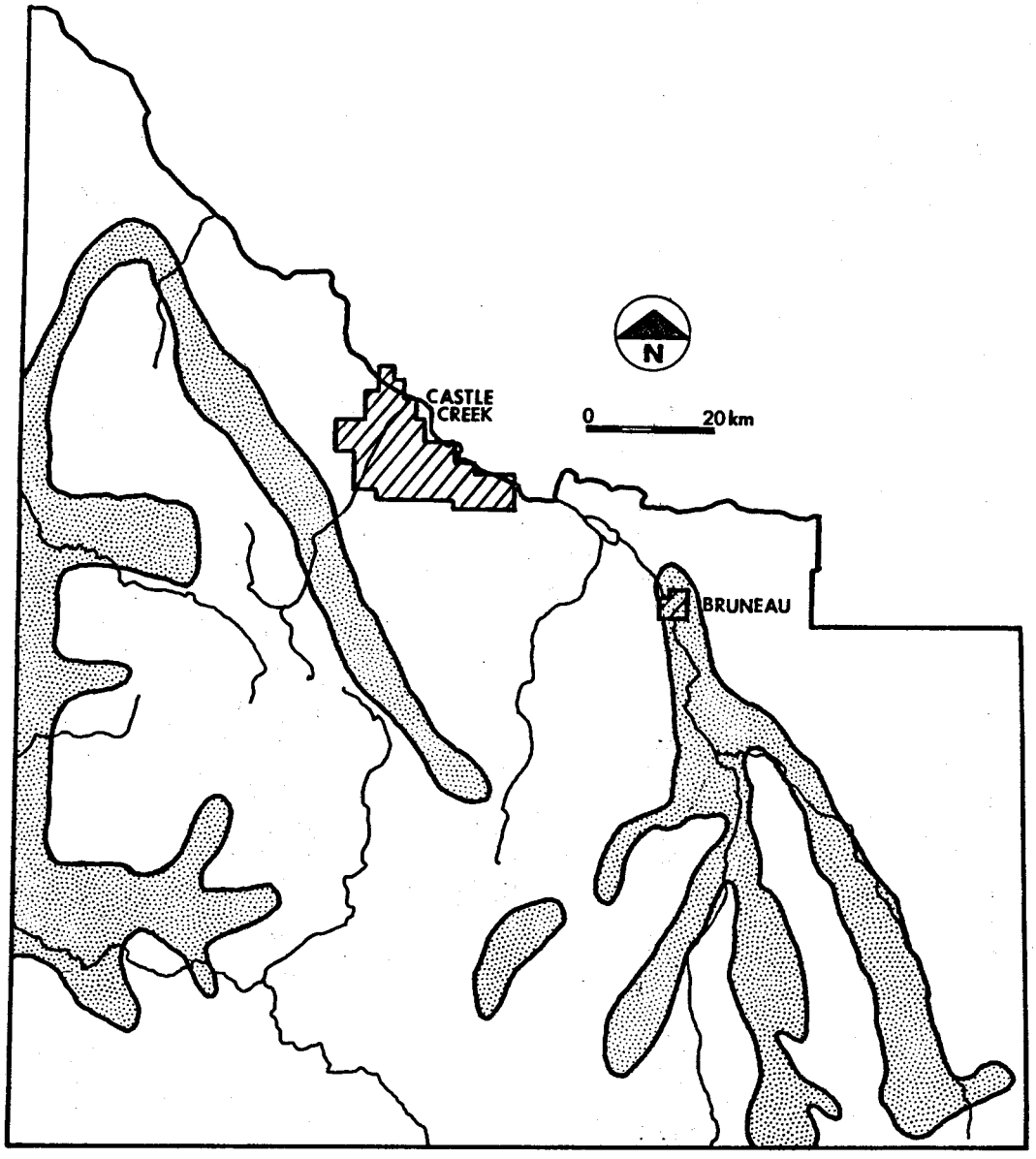


Figure 22. Distribution of Mule Deer (Odocoileus hemionus) overwintering habitat within Owyhee County, Idaho.

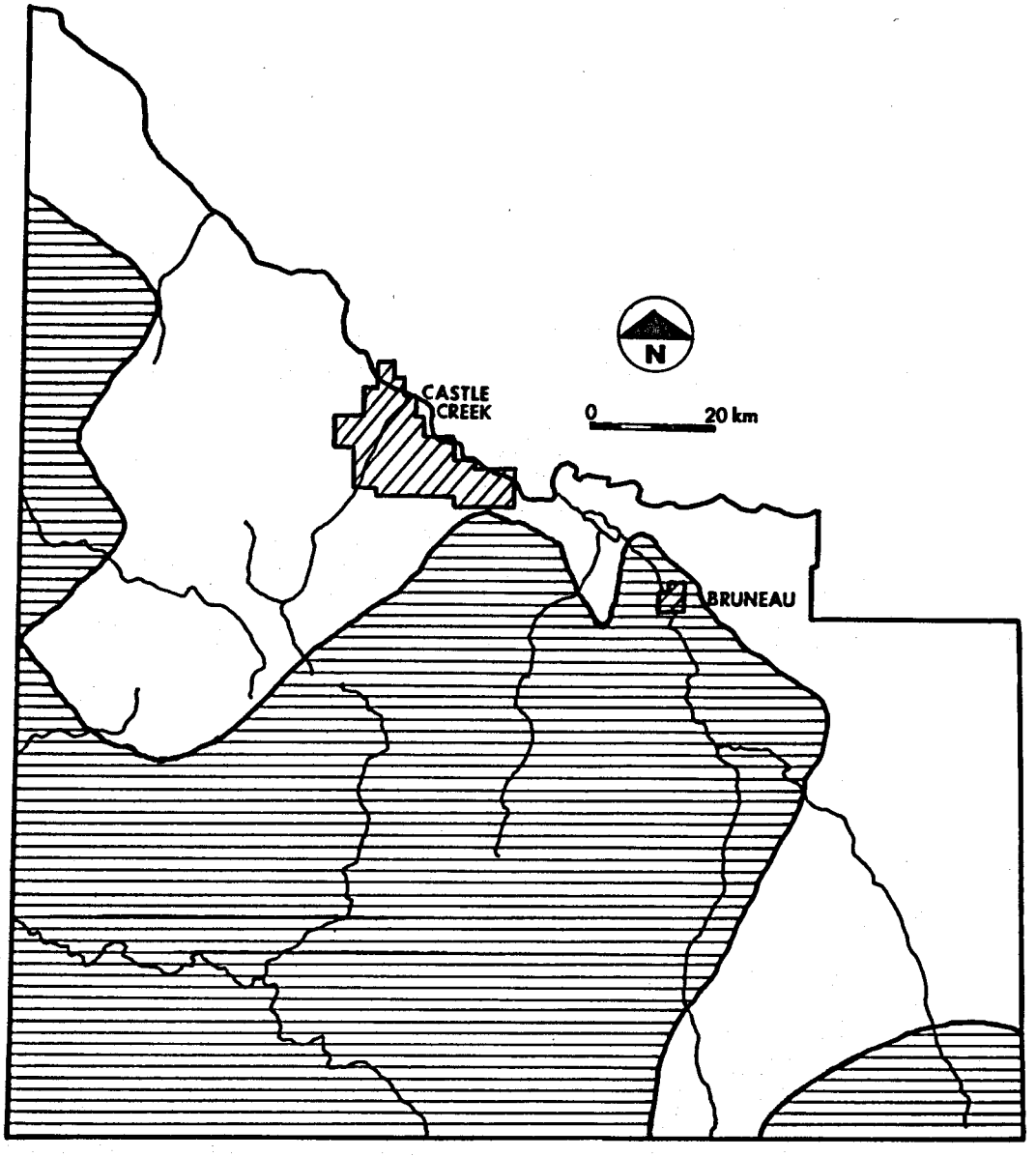


Figure 23. Distribution of Pronghorn (Antilocapra americana) habitat within Owyhee County, Idaho.

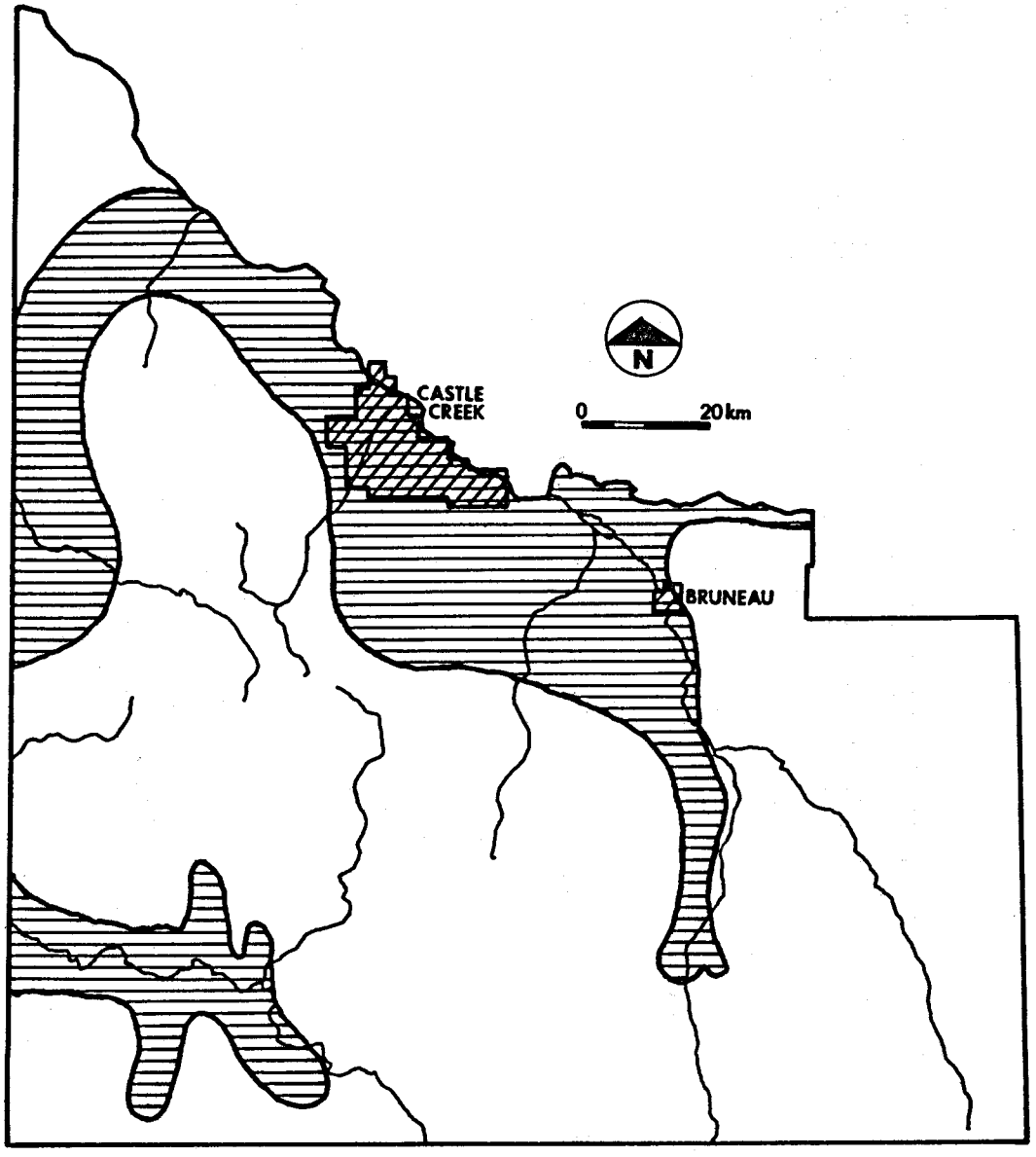


Figure 24. Distribution of Chukar (Alectoris chukar) habitat within Owyhee County, Idaho.

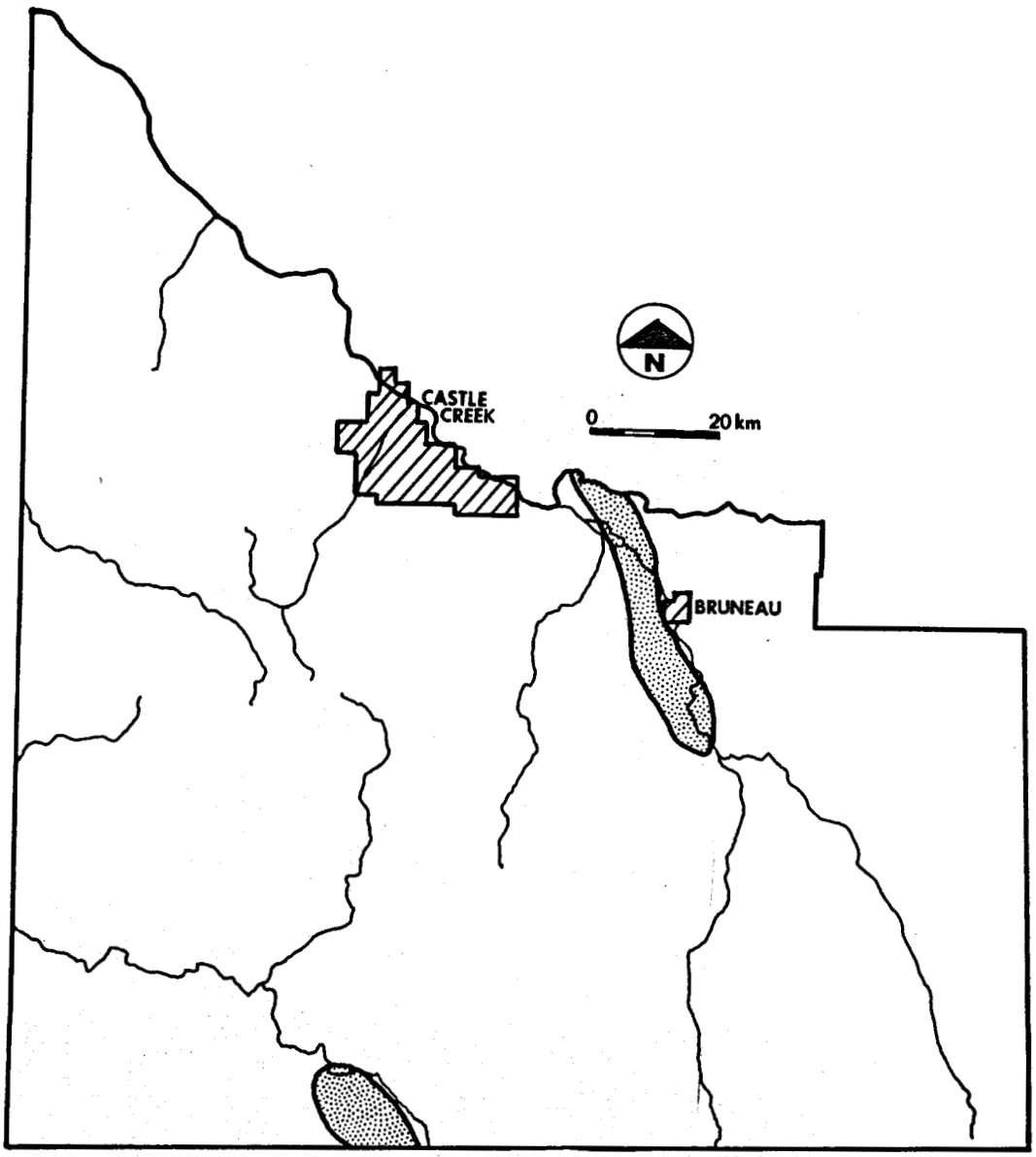


Figure 25. Distribution of overwintering waterfowl habitat within Owyhee County, Idaho.

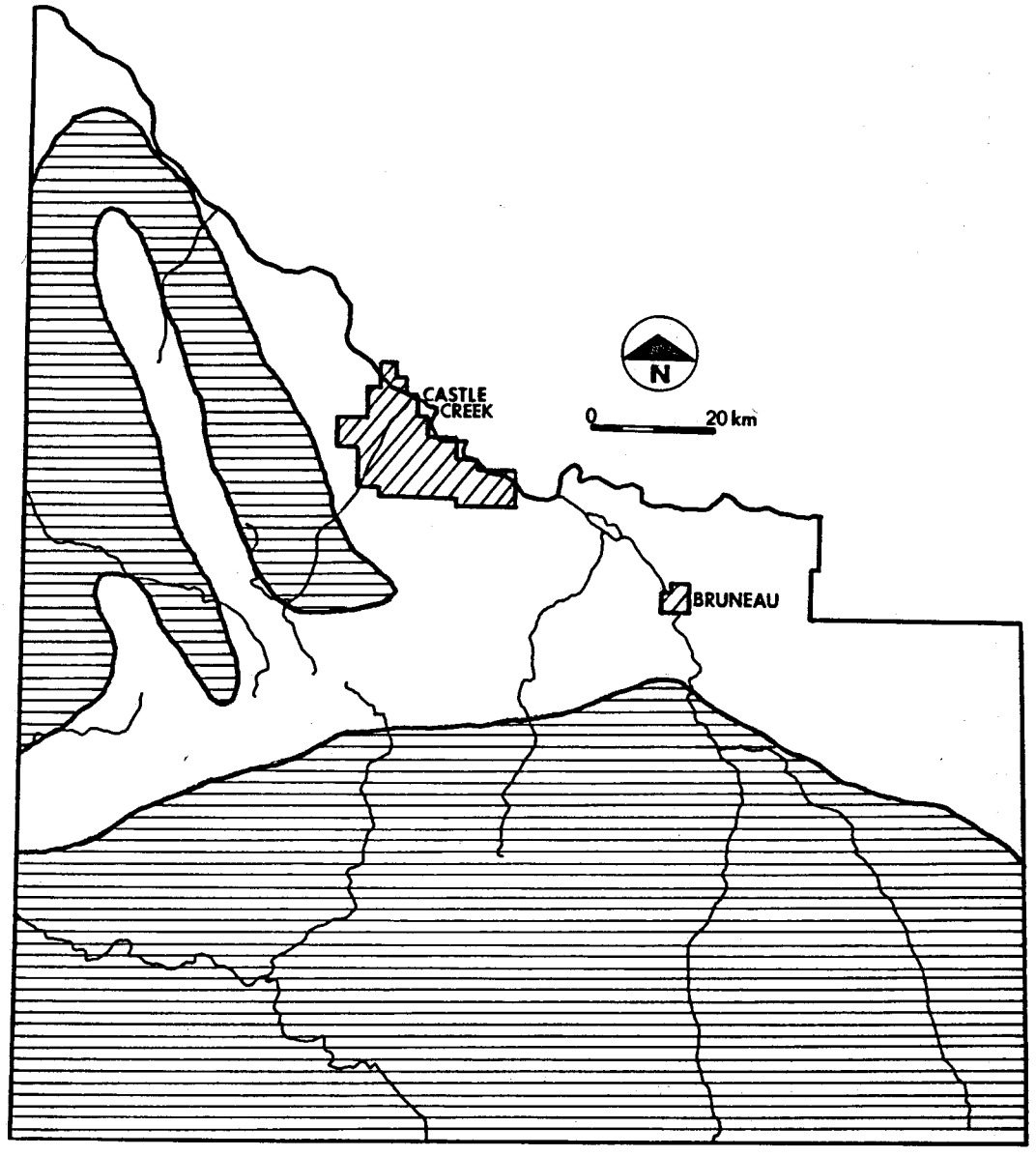


Figure 26. Distribution of sage Grouse (Centrocerus urophasianus) habitat within Owyhee County, Idaho.

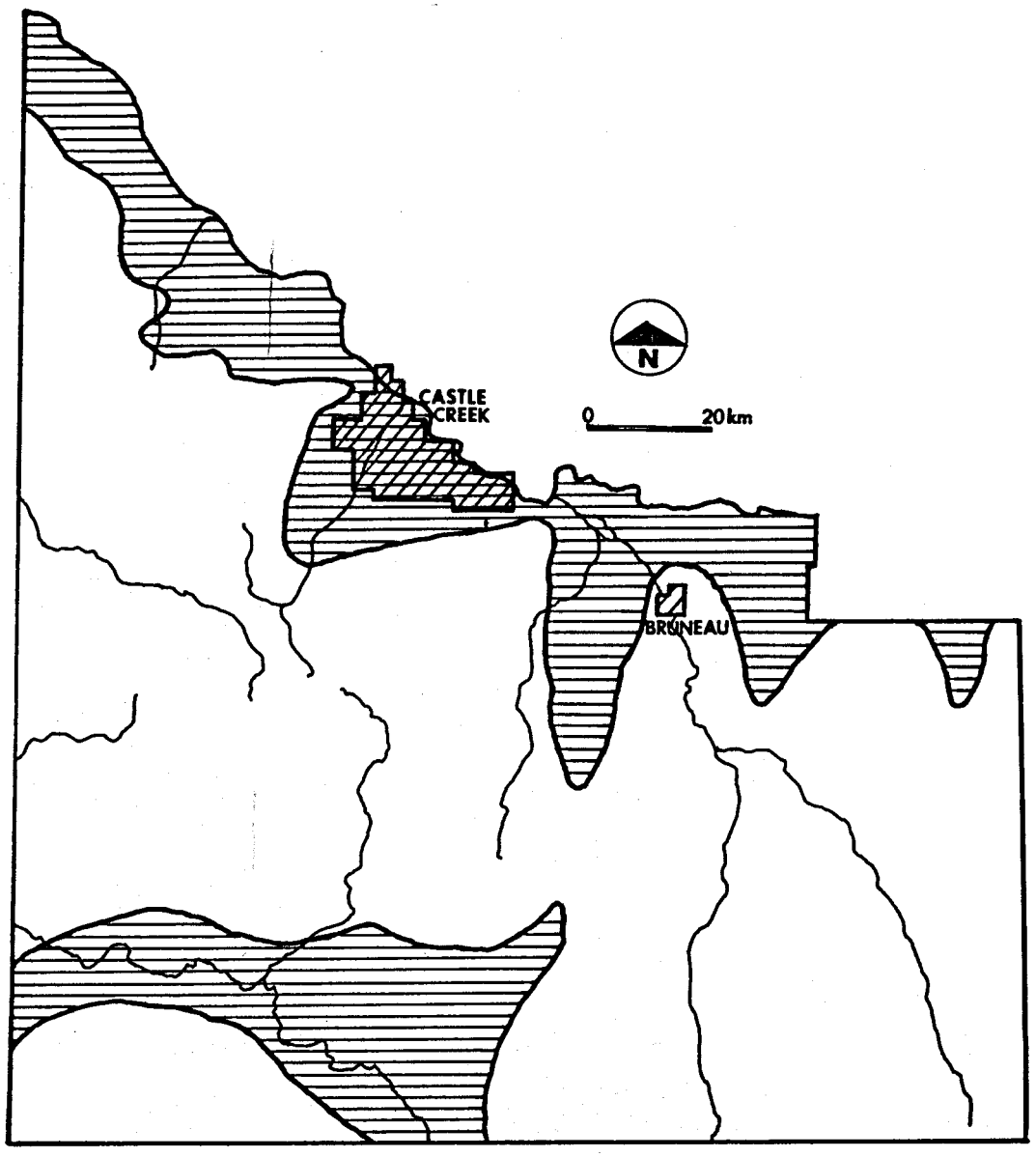


Figure 27. Distribution of Prairie Falcon (Falco mexicanus) habitat within Owyhee County, Idaho.

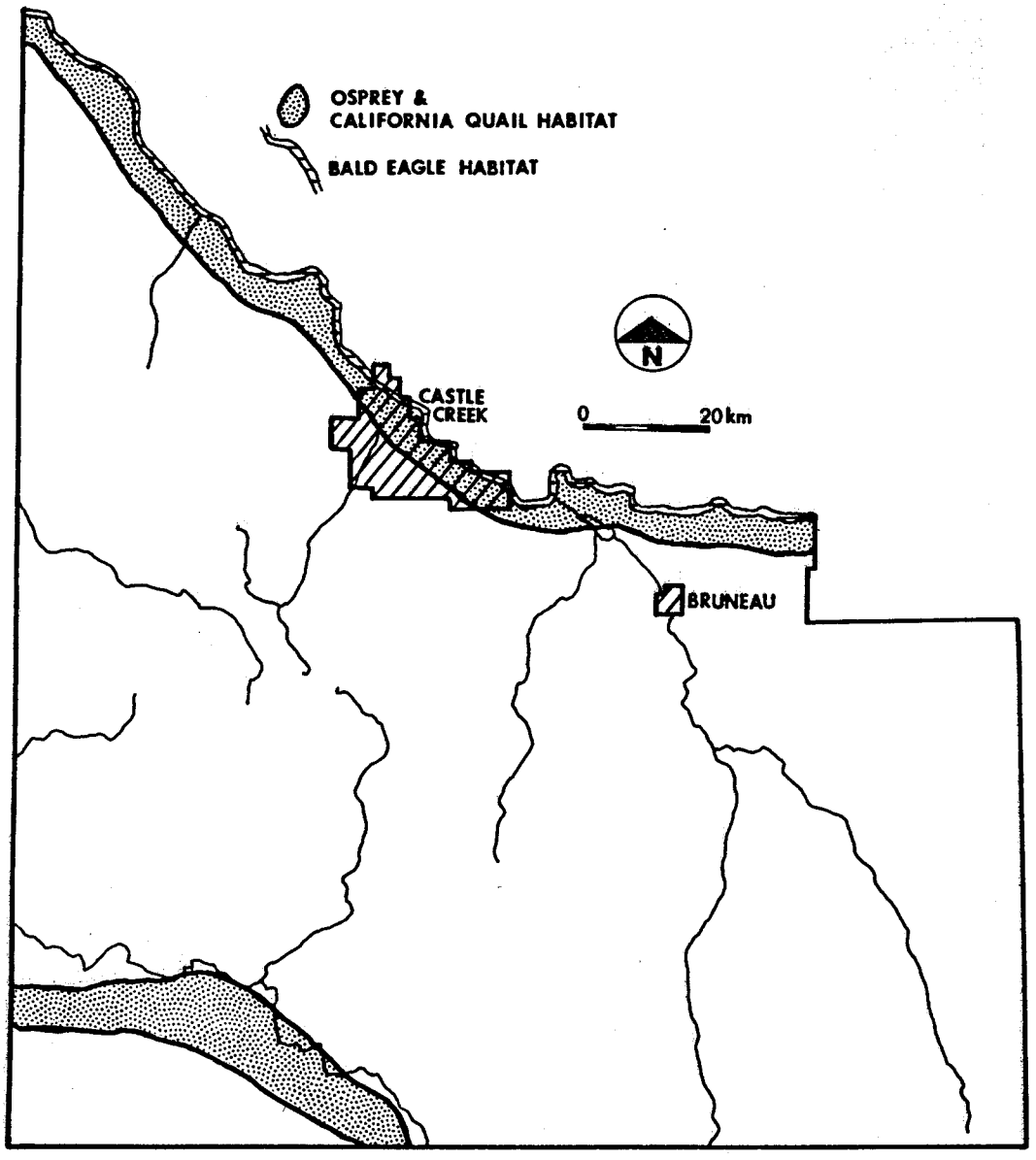


Figure 28. Distributions of Bald Eagle (Haliaectus levocephalus) habitat, and Osprey (Pandion haliaetus) and California Quail (Lophortyx californicus) habitat within Owyhee County, Idaho.

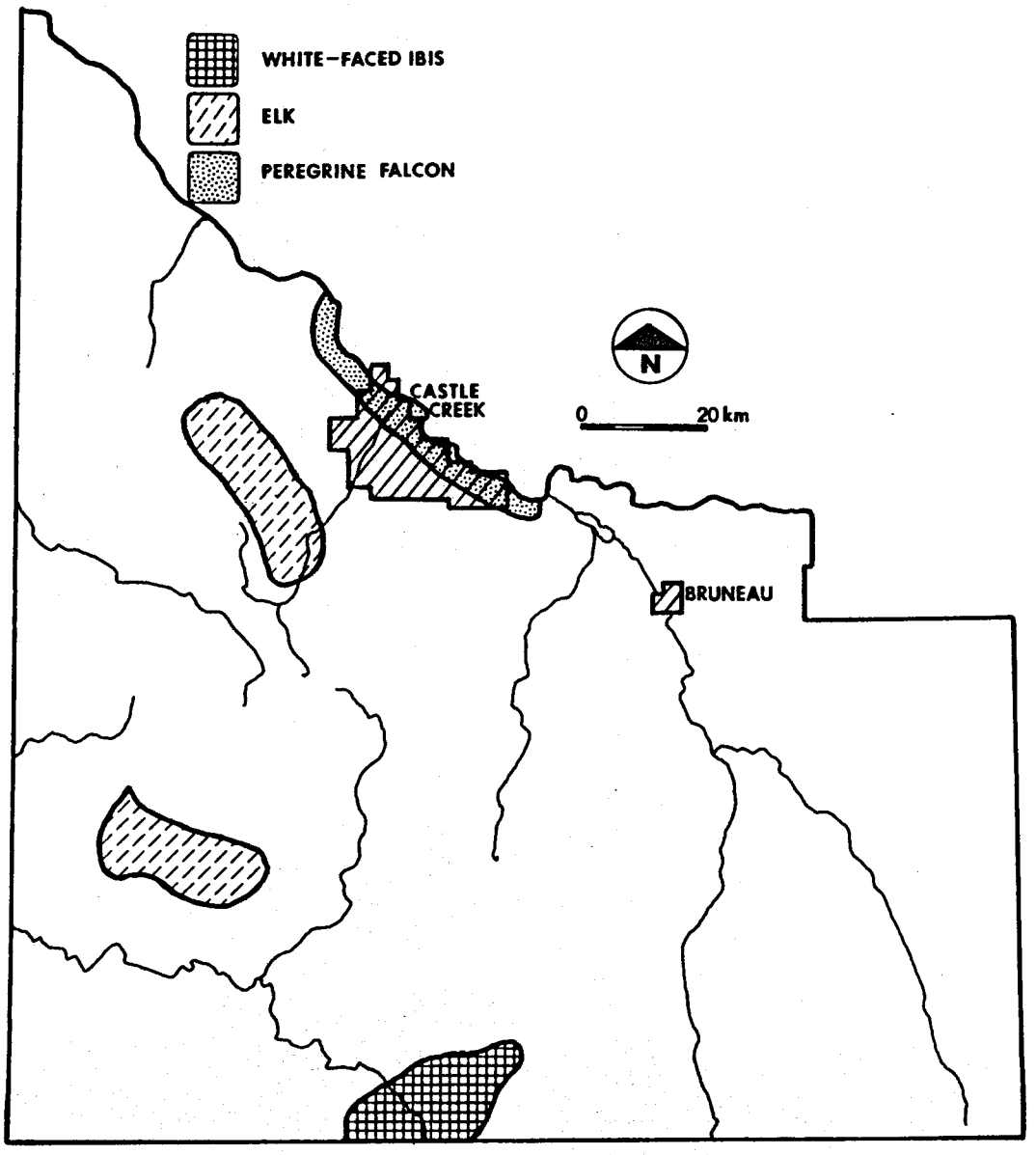


Figure 29. Distributions of Peregrine Falcon (Falco peregrinus) habitat, White-faced Ibis (Plegadis chihi) habitat and Elk (Cervus canadensis) habitat within Owyhee County, Idaho.

TABLE 10. SPECIES OF SPECIAL CONCERN ON OR IN THE PROXIMITY OF THE BRUNEAU KGRA: CLASSIFIED ACCORDING TO THE REASON FOR CONCERN

Species		Special Concern Category		
Common Name	Scientific Name	Game	Furbearer	Extended Concern[a]
Mammals:				
Raccoon	Procyon loter		X	
Mink	Mustela vison		X	
Red Fox	Volpes fulva		X	
Bobcat	Lynx rufus		X	X
Idaho Ground Squirrel	Spermophilus brunneus			X
Beaver	Castor zibethica		X	
Muskrat	Ondatra zibethica		X	
Moutain Cottontail	Sylvilagus nittalli	X		
Pygmy Rabbit	Sylvilagus idahoensis	X		
Mule Deer	Odocoileus hemionus	X		
Pronghorn Antelope	Antilocapra americana	X		
Birds:				
Canada Goose	Branta canadensis	X		
Snow Goose	Chen hyperborea	X		
Mallard	Anas platyrhynchos	X		
Pintail	Anas acuta	X		
Gadwall	Anas strepera	X		
Wigeon	Anas americana	X		

TABLE 10. (continued)

Species		Special Concern Category		
Common Name	Scientific Name	Game	Furbearer	Extended Concern[a]
Birds (continued):				
Northern Shoveler	Anas clypeata	X		
Blue-winged Teal	Anas discors	X		
Cinnamon Teal	Anas cyanoptera	X		
Green-winged Teal	Anas crecca	X		
Wood Duck	Aix sponsa	X		
Redhead	Aythya americana	X		
Canvasback	Aythya valisineria	X		
Ring-necked Duck	Aythya collaris	X		
Greater Scaup	Aythya marila	X		
Lesser Scaup	Aythya affinis	X		
Common Goldeneye	Bucephala clangula	X		
Barrow's Goldeneye	Bucephala islandica	X		
Bufflehead	Bucephala albeola	X		
Ruddy Duck	Oxyura jamaicensis	X		
Common Merganser	Mergus merganser	X		
Red-breasted Merganser	Mergus serrator	X		
Hooded Merganser	Lophosytesa cucullatus	X		
Ferruginous Hawk	Buteo regalis			X
Bald Eagle	Haliaeetus leucocephalus			E

TABLE 10. (continued)

Species		Special Concern Category		
Common Name	Scientific Name	Game	Furbearer	Extended Concern[a]
Birds (continued):				
Prairie Falcon	Falco mexicanus			X
Blue Grouse	Dendragapus obscurus	X		
Ruffed Grouse	Bonasa umbellus	X		
Sharp-tailed Grouse	Pedioecetes phasianellus	X		
Sage Grouse	Centrocercus urophasianus	X		
California Quail	Lophortyx californicus	X		X
Ring-necked Pheasant	Phasianus colchicus	X		
Chukar	Alectoris chukar	X		
Gray Partridge	Perdix perdix	X		
American Coot	Fulica americana	X		
Common Snipe	Capella gallinago	X		
Mourning Dove	Zenaidura macroura	X		
Reptiles:				
Western Ground Snake	Sonora semiannulata			X

a. Special Concern: "X" - Classified by the Idaho State Fish and Game as species whose restricted range, specific habitat requirements, or population numbers make them vulnerable to elimination from the state. "E" - Indicates species that are federally protected as "Endangered Species," according to the Endangered Species Act (Revised List; August 1978).

representing 15 species, breed and rear their young in the canyon each year. In addition, ten species of raptors use the area during the fall and winter. Two species, the ferruginous hawk (Buteo regalis) and the burrowing owl (Athene cunicularia) are classified as "sensitive," while the bald eagle (Haliaeetus leucocephalus) and the peregrine falcon (Falco peregrinus) are classified as "endangered." The population of prairie falcons (Falco mexicanus) nesting in the canyon represents an estimated 5% of the entire population of this species.[41] In 1979, the Bureau of Land Management proposed expanding the BPNA to include 208 500 ha of public land. This proposal includes lands to the northwest of the Bruneau KGRA. The proposed expansion would still allow the Secretary of the Interior to issue leases under the Geothermal Steam Act.

Aquatic Ecology (K. P. McCarthy and J. F. Sullivan, EG&G Idaho)

Data on the aquatic ecology of the Bruneau KGRA were taken from several sources, including a study of the river by the Bureau of Outdoor Recreation,[42] the Geothermal Environmental Analysis Record by the BLM,[43] a report on aquatic macrophytes by Falter et al,[44] and the BLM's Environmental Analysis Record for the Agricultural Development Program.[45]

The swift waters of the upper Bruneau and Jarbridge rivers support healthy populations of trout and whitefish. Below Indian Hot Springs, sucker, squawfish, shiner, and chiselmouth chub are present. Tributary streams in the study area suport caddisflies, dragonflies, scavenger beetles, snails, Pacific tree frogs, mayflies, stone flies, damsel flies, bullfrogs, rainbow trout, bridgelip sucker, redside shiner, speckled dace, leopard dace, alderflies, fishflies, beaver, water boatman, and water striders. Largemouth bass, smallmouth bass, warmouth bass, bluegill, yellow perch, mountain whitefish, pumpkinseed, channel and bullhead catfish, black crappie, and Dolly Varden trout are also apparent.

A survey of aquatic macrophytes in the Bruneau drainage revealed extremely diverse communities of these plants. Heavy occurrences of Potamogeton pectinatus, P. pusillus, P. filiformis, P. robbinsii, P. crispus, Ranunculus aquitalis, R. trichophyllus, Zannichellia palustries, Scirpus acutus, and Ceratophyllum demersum were found above 1500 m. Most sites in the basin had hard water and heavy or nuisance occurrences of aquatic macrophytes. Other taxa identified were: Alismataceae of unknown genus, Callitriche stagnalis, Carex sp., Eleocharis so., Cyperaceae of unknown genus, Myriophylym spictum, L. var. exalbescens, Potamogeton amplifolium Tuckerman, Ranunculus flabellaris Rav., Ranunculus gormanii Greene, Rorippa nosturtium-aqauaticum, Sagittaria sp., Scirpus sp., Sparganium sp., Typha angustifolia, and Typa latifolia L. Lemna minor L. common in lower elevation sloughs and Chara sp. occurs commonly at Bruneau Sand Dunes State Park.

Fluoride levels in the Bruneau River have been determined to be about twice that recommended for human consumption. Tolerance levels for fish are much higher, however, and there are apparently no harmful effects. Increased irrigation in the area is expected to steadily degrade game fish habitat.[45]

HUMAN ENVIRONMENT

Demography (W. C. Lewis, Lewis and Associates)

The demographic data being reported in this section and the socioeconomic data in the next section have been summarized from the larger regional study of the ten-county Southwest Idaho region.[46] It is projected that most of the socioeconomic impacts of geothermal resource development at the Bruneau KGRA will be concentrated in the north-central part of Owyhee County. Because of the proximity of the Castle Creek KGRA, it is to be expected that the impacts of development of both areas will be concentrated along Highway 78, running from 24 km east of Bruneau to Murphy. Unfortunately, very little demographic and socioeconomic data are reported for this area below the county

level. For this reason, virtually all of the data reported here are for Owyhee County.

Population data for 1970 and 1976 for the county and the largest population centers are reported in Table 11. Current estimates are not available for Bruneau, but the 1970 population level was 100. Over the 6-year period, Owyhee County recorded a 23% increase in population, and the larger population centers recorded similar increases. The components of population change indicate positive net immigration of 1000 during the 6-year period. This is indicative of a healthy socioeconomic climate.

Table 12 summarizes population characteristics as reported in 1970. The county has a relatively homogeneous population, with less than 7% being non-Caucasian. While the relative size of minority groups is small, it is larger than in most of the surrounding counties.

Detailed projections of population, employment, and labor force as developed by the Idaho Department of Water Resources[47] are summarized in Table 13. These data are current and provide a more than adequate level of detail for environmental impact assessment. Such projections are essential in environmental impact analysis to meet two objectives: (1) to describe the future socioeconomic environment in the absence of any significant resource development, and (2) to provide a baseline or standard against which the impacts of potential development can be compared.

The projection data indicate a steady but relatively slow (less than 1% per year) increase in population through 2000. Comparable projections are made for employment and labor force. In contrast to the experience since 1970, the projections indicate net outmigration from the county through the end of the projection period.

Especially relevant are the projections of total school enrollment at five grade levels. These data are useful in measuring the socioeconomic impacts of a potential development on the area's school

TABLE 11. POPULATION CHANGE, 1970-1976,[a] OWYHEE COUNTY

County (Cities)	Population 1970	Population 1976 (1975)[a]	% Change 1970-1976 (1975)[a]
Owyhee County	6,422	7,900	23.0
(Grandview)	260	348	33.8
(Marsing)	610	708	16.1

Components of Population Change, 1970-1976

Area	Population Change	Births	Deaths	Net Migration
Owyhee County	1,500	900	400	1,000

[a]City data is for 1975.

Source: U. S. Bureau of the Census, 1977. Idaho Department of Health and Welfare, 1977. Idaho Division of Budget, Policy Planning, and Coordination, 1978.

TABLE 12. SUMMARY CHARACTERISTICS OF THE POPULATION, 1970, OWYHEE COUNTY

Characteristics		Number	Percent
Population:	White	6,004	93.5
	Black	113	1.8
	Other	304	4.7

	Male %	Female %
Median school years completed	10.7	12.0
Percent high school graduates	42.4	51.2
16-17 year-olds in school	94.0	
Percent of population foreign born	1.8	

Source: U. S. Bureau of the Census, 1972a.

TABLE 13. SUMMARY EDUCATION DATA, OWYHEE COUNTY

District	Enrollment				Teachers	Student/ Teacher Ratio
	Elementary[a]	Secondary[b]	Total	Change From 1976-1977		
363 - Marsing	379	259	638	+23	33	19.3
364 - Pleasant View	20	13	33	+2	2	16.5
365 - Bruneau/Grand View	293	287	580	-42	27	21.5
370 - Homedale	473	421	894	-17	46	19.4
Total	1,165	980	2,145	-34	108	19.9

[a]Grades K-6.

[b]Grades 7-12.

Source: Idaho Department of Education, 1977 and 1978.

system. Summary data on the existing school situation in the four districts in the county are reported in Table 14. Enrollment in elementary and secondary schools, number of teachers, and student-teacher ratios are reported. Because of the proximity of the KGRA to the city of Bruneau, District 365 (Bruneau-Grand View) will capture the bulk of any significant enrollment increase. There are elementary schools in Grand View and Bruneau; the Rimrock Junior-Senior High School is in Bruneau. The grades and enrollment in each of these schools are reported in Table 15.

Frequencies and rates of various crimes for the county are reported in Table 16. Because crime rates have increased in some areas experiencing rapid population growth, these data may be especially useful. By any national standards, the rates are relatively low and reflect the absence of a significant crime problem in both Owyhee County and the Southwest Idaho region in general. While low, the crime rate has increased significantly during the period 1971 through 1976, although most of the increase has been in the burglary and larceny categories. Crimes of violence have occurred very infrequently. Given the magnitude and type of development expected at the Bruneau KGRA, it should not be expected that crime would be an area of particular concern.

Summary data on health care resources in Owyhee County are reported in Table 17. Many low-population areas in the United States suffer from limited numbers of doctors and related health care resources. Owyhee County may fall into this class. Secondary sources report only one physician for the county and no hospitals. Clearly, many residents of the county look to Boise and Mountain Home as sources of medical services. Any significant population growth in Owyhee probably will strain the ability of the limited health care facilities.

Socioeconomics (W. C. Lewis, Lewis and Associates)

Table 18 summarizes 1974 through 1977 data on labor force, unemployment, and employment in Owyhee County. During this period, the

TABLE 14. POPULATION AND EMPLOYMENT FORECAST, 1978, OWYHEE COUNTY

EMPLOYMENT SUMMARY

	1972	1975	1980	1985	1990	1995	2000
AGRICULTURE	1572	1372	1292	1207	1127	1046	1008
MINING	2	30	42	60	77	90	99
CONSTRUCTION	44	78	124	151	188	225	261
FOOD AND KINDRED	9	23	26	29	33	37	42
WOOD PRODUCTS	112	85	90	95	100	104	109
OTHER MANUFACTURING	1	6	7	8	9	10	11
TRANS. COMM. AND UTILS	68	51	59	64	71	77	85
WHSLE AND RETAIL TRADE	331	416	477	501	527	551	575
FINANCE, INS, REAL EST	48	54	60	64	68	72	76
SERVICES AND MISC.	149	184	228	256	288	324	365
STATE AND LOCAL GOVT.	253	287	287	287	287	287	287
FEDERAL GOVERNMENT	53	80	80	80	80	80	80
TOTAL	2666	2666	2779	2807	2851	2927	3022

FORECAST SUMMARY

	1970	1975	1980	1985	1990	1995	2000
TOTAL POPULATION	6420	7180	7700	8090	8490	8660	8730
TOTAL EMPLOYMENT *	2660	2660	2770	2800	2850	2920	3020
LABOR FORCE **	2320	2650	2760	2810	2850	2920	3020
TOTAL SCHOOL ENROLLMENT	1870	1870	1900	2070	2430	2570	2510
NURSERY	0	0	0	0	0	0	0
KINDERGARTEN	70	113	140	173	190	180	173
ELEMENTARY	1170	1120	1140	1460	1640	1670	1580
HIGH SCHOOL	570	540	530	410	530	640	670
COLLEGE	40	60	70	70	70	70	70
HOUSEHOLD HEADS	1870	1930	2150	2180	2250	2190	2170

* EMPLOYMENT BASE YEAR = 1972
** LABOR FORCE BASE YEAR = 1970
** LABOR FORCE IS DEPENDENT UPON UNEMPLOYMENT RATE AND THE AVERAGE NUMBER OF JOBS HELD BY EACH WORKER

COMPONENTS OF POPULATION GROWTH
SUMMARY

	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
TOTAL CHANGE	760	520	384	403	167	73
NATURAL INCREASE	471	701	806	770	773	867
BIRTHS	814	1062	1185	1164	1167	1259
DEATHS	343	361	379	386	394	392
MIGRATION	331	-198	-476	-427	-693	-911
EMPLOYMENT	331	-198	-476	-427	-693	-911
RETIREMENT	3	0	0	0	0	0

Source: Idaho Dept. of Water Resources and Center for Research, Grants and Contracts, Boise State University, July, 1978.

TABLE 15. NAME, ENROLLMENT, AND LOCATION OF SCHOOLS NEAR BRUNEAU KGRA (Owyhee County), 1977-1978

City	School	Grades	Enrollment
Bruneau	Rimrock Junior-Senior High School	7-12	257
Bruneau	Bruneau Elementary School	K-6	71
Grand View	Grand View Elementary School	K-6	178

Source: Fennell, 1977.

TABLE 16. CRIME FREQUENCIES AND RATES PER 100,000 POPULATION, 1971-1976, OWYHEE COUNTY

	1971	1972	1973	1974	1975	1976
Part I Crimes (Rates)	115 (1,761.4)	121 (1,704.2)	138 (1,895.6)	225 (3,081.4)	259 (3,361.0)	235 (3,075.5)
Murder	0 (-)	0 (-)	0 (-)	0 (-)	4 (51.9)	0 (-)
Rape	0 (-)	1 (14.1)	1 (13.7)	0 (-)	0 (-)	2 (26.2)
Robbery	0 (-)	0 (-)	1 (13.7)	0 (-)	0 (-)	1 (13.1)
Aggravated assault	4 (61.3)	5 (70.4)	5 (68.7)	18 (246.5)	21 (272.5)	16 (209.4)
Burglary	22 (337.0)	41 (577.5)	44 (604.4)	62 (849.1)	72 (934.3)	42 (549.7)
Larceny	84 (1,286.6)	68 (957.7)	78 (1,071.4)	131 (1,794.0)	144 (1,868.7)	161 (2,107.1)
Motor vehicle theft	5 (76.6)	6 (84.5)	9 (123.6)	14 (191.7)	18 (233.6)	13 (170.1)

Source: Idaho Law Enforcement Planning Commission, 1978.

TABLE 17. SUMMARY DATA ON HEALTH CARE CAPABILITY, 1975, OWYHEE COUNTY

	Owyhee County
Physicians:	
Number	1
Persons per medical doctor	7,400
Ambulance Services available?	Yes
Hospitals:	
Number	--
Acute care beds	--

Source: Idaho Division of Budget, Policy Planning, and Coordination, 1978

TABLE 18. LABOR FORCE, UNEMPLOYMENT, UNEMPLOYMENT RATE, AND EMPLOYMENT, 1974-1977, OWYHEE COUNTY

Year	Labor Force	Unemployment	Unemployment Rate	Employment
			%	
1974	3,602	194	5.4	3,408
1975	3,646	247	6.8	3,399
1976	4,096	225	5.5	3,871
1977	4,515	208	4.6	4,307

Source: Idaho Department of Employment Security, 1977, 1978a, and 1978b.

unemployment rate has ranged between 4.6 and 6.8%. Relative to the regional rate, this must be regarded as a low-unemployment county. The average level of unemployment in 1977 was 208 workers. This is an indicator of the labor pool available to new industry; of course, some of that unemployment is seasonal and does not reflect the availability of workers for other industries. It is estimated that new development requiring as many as 100 additional workers would not strain the ability of the local labor market to meet the increased demand. However, it must be realized that the local labor market is characterized by relatively full employment.

Detailed employment data for the period 1971 through 1976 are summarized in Tables 19 and 20. Total employment has increased steadily over the six-year period from 2515 in 1971 to 3083 in 1976. The largest percentage increases have been in the agricultural, construction, and finance, insurance, and real estate sectors. Agriculture and state and local government are relatively the most important sectors as measured by the location quotients reported in Table 20.

Summary data on housing in the county are reported in Table 21. Although the data are interesting, they were collected in 1970 and now are of limited value.

The ability of a local economy to supply residents with retail goods and services is an area of interest. Number and average size of retail and service establishments in the county are provided by the 1972 Census of Business. Selected data from that source are summarized in Tables 22 and 23. Because the county has no city with 2500 inhabitants, the only data reported are for the county. It can be concluded, however, that most of the retail and service activity is located in the urban centers along Highway 78 in the northern part of the county. Even then, the data indicate a relatively small number of establishments. Many residents have a somewhat limited range of choice, and some undoubtedly travel long distances to meet their retail and service demands.

TABLE 19. EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES, 1971-1976 (Full- and Part-Time), OWYHEE COUNTY

ITEM	1971 1/	1972 1/	1973 1/	1974 1/	1975 2/	1976 2/
EMPLOYMENT BY PLACE OF WORK						
TOTAL EMPLOYMENT 3/	2,515	2,587	2,691	2,816	2,825	3,083
NUMBER OF PROPRIETORS	878	874	871	886	880	877
FARM PROPRIETORS	647	646	647	649	644	639
NONFARM PROPRIETORS	231	228	224	237	236	238
TOTAL WAGE AND SALARY EMPLOYMENT	1,637	1,713	1,820	1,930	1,945	2,206
FARM	585	605	619	691	691	921
NON-FARM	1,052	1,108	1,201	1,239	1,254	1,285
PRIVATE	533	628	711	745	743	775
AG.SERV.,FOR.,FISH.,AND OTHER 4/	(D)	47	53	48	(D)	(D)
MINING	(D)	(D)	(D)	3	(D)	(D)
CONSTRUCTION	33	43	73	74	77	63
MANUFACTURING	96	128	111	117	119	114
NON-DURABLE GOODS	(D)	(D)	(D)	21	27	(D)
DURABLE GOODS	(D)	(D)	(D)	96	92	(D)
TRANSPORTATION AND PUBLIC UTILITIES	(D)	56	61	63	50	51
WHOLESALE TRADE	(D)	(D)	(D)	29	89	92
RETAIL TRADE	195	212	229	250	193	211
FINANCE,INSURANCE,AND REAL ESTATE	25	27	29	32	36	34
SERVICES	108	102	114	129	121	132
GOVERNMENT AND GOVERNMENT ENTERPRISES	519	480	490	494	511	510
FEDERAL, CIVILIAN	91	90	79	83	85	73
FEDERAL, MILITARY	69	66	61	64	61	59
STATE AND LOCAL	359	324	350	347	365	378

1/ ESTIMATES BASED ON 67 SIC.
2/ ESTIMATES BASED ON 72 SIC.
3/ CONSISTS OF WAGE AND SALARY JOBS PLUS NUMBER OF PROPRIETORS.
4/ INCLUDES NUMBER OF JOBS HELD BY U.S. RESIDENTS WORKING FOR INTERNATIONAL ORGANIZATIONS.
PRIMARY SOURCE FOR PRIVATE NON-FARM EMPLOYMENT: ES-202 COVERED WAGES - IDAHO DEPT. OF EMPLOYMENT
(D) NOT SHOWN TO AVOID DISCLOSURE OF CONFIDENTIAL DATA. DATA ARE INCLUDED IN TOTALS.

Source: Regional Economic Information System, Bureau of Economic Analysis, August, 1978.

TABLE 20. EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES, 1971-1976 (Full- and Part-Time--Summary Analytics), OWYHEE COUNTY

ITEM	1971 1/	1972 1/	1973 1/	1974 1/	1975 2/	1976 2/
EMPLOYMENT BY PLACE OF WORK						
TOTAL EMPLOYMENT 3/	2,515	2,587	2,691	2,816	2,825	3,083
NUMBER OF PROPRIETORS	878	874	871	886	880	877
FARM PROPRIETORS	647	646	647	649	644	639
NONFARM PROPRIETORS	231	228	224	237	236	238
TOTAL WAGE AND SALARY EMPLOYMENT	1,637	1,713	1,820	1,930	1,945	2,206
FARM	585	605	619	691	691	921
NON-FARM	1,052	1,108	1,201	1,239	1,254	1,285
PRIVATE	533	628	711	745	743	775
AG.SERV.,FOR.,FISH.,AND OTHER 4/	(D)	47	53	48	(D)	(D)
MINING	(D)	(D)	(D)	3	(D)	(D)
CONSTRUCTION	33	43	73	74	77	83
MANUFACTURING	96	128	111	117	119	114
NON-DURABLE GOODS	(D)	(D)	(D)	21	27	(D)
DURABLE GOODS	(D)	(D)	(D)	96	92	(D)
TRANSPORTATION AND PUBLIC UTILITIES	(D)	56	61	63	50	51
WHOLESALE TRADE	(D)	(D)	(D)	29	89	92
RETAIL TRADE	195	212	229	250	193	211
FINANCE,INSURANCE,AND REAL ESTATE	25	27	29	32	36	34
SERVICES	108	102	114	129	121	132
GOVERNMENT AND GOVERNMENT ENTERPRISES	519	480	490	494	511	510
FEDERAL, CIVILIAN	91	90	79	83	85	73
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1/ ESTIMATES BASED ON 67 SIC.
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4/ INCLUDES NUMBER OF JOBS HELD BY U.S. RESIDENTS WORKING FOR INTERNATIONAL ORGANIZATIONS.
PRIMARY SOURCE FOR PRIVATE NON-FARM EMPLOYMENT: ES-202 COVERED WAGES - IDAHO DEPT. OF EMPLOYMENT
(D) NOT SHOWN TO AVOID DISCLOSURE OF CONFIDENTIAL DATA. DATA ARE INCLUDED IN TOTALS.

Source: Regional Economic Information System, Bureau of Economic Analysis, August, 1978.

TABLE 21. SELECTED HOUSING CHARACTERISTICS, 1970, OWYHEE COUNTY

Characteristics			Total	Rural
Number of year-round units			2,087	2,087
Onwer occupied:	Number		1,253	1,253
	Percent		60.0%	60.0%
Vacant units			215	215
Vacancy rate			10.3%	10.3%
With all plumbing facilities:		Number	1,847	1,847
		Percent	88.5%	88.5%
On public sewer:	Number		767	767
	Percent		36.8%	36.8%
Median value--owner occupied			$9,000	$9,000
Contract rent--renter occupied			56	56

Source: U. S. Bureau of the Census, 1972c.

TABLE 22. SUMMARY RETAIL TRADE DATA, 1972, OWYHEE COUNTY

		Owyhee County
All establishments:	Number	73
	Sales (000)	$7,499
Establishments with payroll:	Number	44
	Sales (000)	$6,696
	Payroll (000)	$691
	Employees	170
Number of establishments:		
Building materials, hardware, etc.		5
General merchandise		5
Food stores		9
Automotive dealers		2
Service stations		13
Apparel and accessory stores		--
Furniture and home furnishings		3
Eating and drinking places		20
Drug stores		3
Miscellaneous		13

Source: U. S. Department of Commerce, 1976c.

TABLE 23. SUMMARY SELECTED SERVICES DATA, 1972, OWYHEE COUNTY

		Owyhee County
All establishments:	Number	48
	Receipts (000)	$752
Establishments with payroll:	Number	12
	Receipts (000)	$370
	Payroll (000)	67
	Employees	16

	Owyhee County	
	Number	Receipts
Hotels, motels, etc.	7	$ 84
Automotive repair	5	79
Miscellaneous repair	8	113
Amusement and recreation	10	161
Legal services	1	(D)

(D) -- not reported to avoid disclosure of individual firm data.

Source: U. S. Department of Commerce, 1976f.

Income data by type and industry are reported in Table 24. County per capita income of $3232 in 1976 is the lowest in the ten-county Southwest Idaho region and is only 50% of the national level. This below-average per capita income level is largely explained by a precipitous decline in farm income between 1974 and 1976.

Income in agriculture accounts for more than 26% of total earnings in the county. General data on that sector are reported in Table 25. These data are important because agriculture may be significantly impacted by geothermal resource development. Average farm size is large, averaging in excess of 440 ha, with the largest share of this being in rangeland. Only 2% of county land area (17% of all farmland) is irrigated. Because geothermal resource development may impact the quantity and quality of water available, there is need to assess the agricultural situation in the immediate vicinity of the Bruneau KGRA.

Summary data on land use and ownership are reported in Table 26. By far the largest land use is rangeland, which accounts for almost 94% of total county land area. The federal government owns more than 77% of all the land, and this poses a special set of problems for industrial development of any type.

Land-use control mechanisms are also inventoried in Table 26. While the county has a planning and zoning commission, secondary sources report no comprehensive plan, subdivision ordinance, or zoning ordinance. Selected data on assessed value and property tax charges for 1977 are reported in Table 27. Assessed value of all property per capita is almost $2500 with per capita property taxes averaging $197. On real and personal property only, per capita tax charges are $147.

Heritage Resources (R. Knudson and M. Pfaff, Idaho Water Resources Research Institute)

Paleontological Resources. An unpublished graduate thesis[48] provides the basic information on the fossil resources of the Bruneau KGRA. Harper mapped Chalk Hills, Glenns Ferry, and Bruneau Formations

TABLE 24. PERSONAL INCOME BY MAJOR SOURCES, 1971-1976
(Thousands Of Dollars), OWYHEE COUNTY

ITEM	1971 1/	1972 1/	1973 1/	1974 1/	1975 2/	1976 2/
TOTAL LABOR AND PROPRIETORS INCOME BY PLACE OF WORK 3/						
BY TYPE						
WAGE AND SALARY DISBURSEMENTS	7,372	8,501	9,679	11,399	12,664	15,312
OTHER LABOR INCOME	274	333	438	524	545	837
PROPRIETORS INCOME 4/	3,832	4,191	9,810	9,904	1,667	562
FARM	2,507	2,618	8,123	8,133	-330	-1,596
NON-FARM 4/	1,325	1,573	1,687	1,771	1,997	2,158
BY INDUSTRY						
FARM	5,023	5,584	11,399	12,343	4,163	4,429
NON-FARM	8,455	7,441	8,528	9,484	10,703	12,284
PRIVATE	4,026	4,857	5,858	6,549	7,271	8,535
AG.SERV.,FOR.,FISH.,AND OTHER 5/	(D)	326	321	341	(D)	(D)
MINING	(D)	(D)	(D)	(L)	(D)	(D)
CONSTRUCTION	600	754	1,256	1,389	1,431	1,689
MANUFACTURING	618	699	682	789	891	1,090
NON-DURABLE GOODS	(D)	(D)	(D)	203	275	(D)
DURABLE GOODS	(D)	(D)	(D)	586	616	(D)
TRANSPORTATION AND PUBLIC UTILITIES	(D)	524	587	694	626	650
WHOLESALE TRADE	(D)	(D)	(D)	233	820	885
RETAIL TRADE	1,459	1,585	1,878	2,083	1,829	2,089
FINANCE,INSURANCE, AND REAL ESTATE	172	234	197	255	300	345
SERVICES	586	618	654	749	844	994
GOVERNMENT AND GOVERNMENT ENTERPRISES	2,429	2,584	2,670	2,935	3,432	3,749
FEDERAL, CIVILIAN	892	948	919	988	1,145	1,164
FEDERAL, MILITARY	83	95	94	102	110	116
STATE AND LOCAL	1,454	1,541	1,661	1,845	2,177	2,469
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE						
TOTAL LABOR AND PROPRIETORS INCOME BY PLACE OF WORK	11,478	13,025	19,927	21,827	14,866	16,706
LESS: PERSONAL CONTRIBUTIONS FOR SOCIAL INSURANCE BY PLACE OF WORK	354	419	493	623	658	777
NET LABOR AND PROPRIETORS INCOME BY PLACE OF WORK	11,124	12,606	19,434	21,204	14,208	15,929
PLUS: RESIDENCE ADJUSTMENT	780	901	891	900	960	1,140
NET LABOR AND PROPRIETORS INCOME BY PLACE OF RESIDENCE	11,904	13,507	20,325	22,104	15,168	17,069
PLUS: DIVIDENDS, INTEREST, AND RENT 7/	1,678	1,962	2,395	2,987	3,123	3,477
PLUS: TRANSFER PAYMENT	2,490	2,795	3,181	3,923	4,716	4,989
PERSONAL INCOME BY PLACE OF RESIDENCE	16,072	18,264	25,901	29,014	23,007	25,535
PER CAPITA PERSONAL INCOME (DOLLARS)	2,368	2,571	3,617	3,920	3,052	3,232
TOTAL POPULATION (THOUSANDS)	6.8	7.1	7.2	7.4	7.5	7.9

1/ ESTIMATES BASED ON 1967 SIC. 2/ ESTIMATES BASED ON 1972 SIC.

3/ CONSISTS OF WAGE AND SALARY DISBURSEMENTS, OTHER LABOR INCOME, AND PROPRIETORS' INCOME.
PRIMARY SOURCE FOR PRIVATE NON-FARM WAGES; ES-202 COVERED WAGES -IDAHO DEPARTMENT OF EMPLOYMENT

4/ INCLUDES THE CAPITAL CONSUMPTION ADJUSTMENT FOR NON-FARM PROPRIETORS.

5/ INCLUDES WAGE AND SALARIES OF U.S. RESIDENTS WORKING FOR INTERNATIONAL ORGANIZATIONS.

7/ INCLUDES THE CAPITAL CONSUMPTION ADJUSTMENT FOR RENTAL INCOME OF PERSONS.

(D) NOT SHOWN TO AVOID DISCLOSURE OF CONFIDENTIAL INFORMATION; DATA ARE INCLUDED IN TOTALS.

(L) LESS THAN $50,000. DATA ARE INCLUDED IN TOTALS.

Source: Regional Economics Information System, Bureau of Economic Analysis, July, 1978.

TABLE 24. (continued)

ITEM	PERCENT OF U.S.	PERCENT OF STATE	% TOTAL EARNINGS	PERCENT CHANGE 76/71	PERCENT CHANGE 76/75	LOCATION QUOTIENT U.S.	LOCATION QUOTIENT STATE
TOTAL LABOR AND PROPRIETORS INCOME BY PLACE OF WORK 3/							
BY TYPE							
WAGE AND SALARY DISBURSEMENTS	.0017	.53		108	21		
OTHER LABOR INCOME	.0011	.35		204	40		
PROPRIETORS INCOME 4/	.0006	.11		-85	-65		
FARM	-.0088	-.85		-164	384		
NON-FARM 4/	.0031	.68		63	11		
BY INDUSTRY							
FARM	.0177	1.29	26.47	-12	6	11.0835	2.8219
NON-FARM	.0012	.37	73.53	90	15	.7533	.8114
PRIVATE	.0010	.32	51.09	112	17	.6399	.7072
AG.SERV.,FOR.,FISH.,AND OTHER 5/	(D)	(D)	(D)	(D)	(D)	(D)	(D)
MINING	(D)	(D)	(D)	(D)	(D)	(D)	(D)
CONSTRUCTION	.0028	.55	10.11	182	18	1.7615	1.2067
MANUFACTURING	.0004	.16	6.52	76	22	.2518	.3557
NON-DURABLE GOODS	(D)	(D)	(D)	(D)	(D)	(D)	(D)
DURABLE GOODS	(D)	(D)	(D)	(D)	(D)	(D)	(D)
TRANSPORTATION AND PUBLIC UTILITIES	.0008	.25	3.89	(D)	4	.5208	.5429
WHOLESALE TRADE	.0013	.36	5.30	(D)	8	.7895	.7941
RETAIL TRADE	.0019	.49	12.50	43	14	1.1922	1.0762
FINANCE,INSURANCE, AND REAL ESTATE	.0006	.24	2.07	101	15	.3919	.5268
SERVICES	.0006	.19	5.95	70	18	.3620	.4190
GOVERNMENT AND GOVERNMENT ENTERPRISES	.0020	.58	22.44	54	9	1.2631	1.2213
FEDERAL, CIVILIAN	.0026	.65	6.97	30	2	1.6204	1.4224
FEDERAL, MILITARY	.0006	.16	.69	40	5	.3942	.3510
STATE AND LOCAL	.0020	.59	14.78	70	13	1.2626	1.2853
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE							
TOTAL LABOR AND PROPRIETORS INCOME BY PLACE OF WORK	.0016	.46		46	12		
LESS: PERSONAL CONTRIBUTIONS FOR SOCIAL INSURANCE BY PLACE OF WORK	.0014	.39		119	18		
NET LABOR AND PROPRIETORS INCOME BY PLACE OF WORK	.0016	.46		43	12		
NET LABOR AND PROPRIETORS INCOME BY PLACE OF RESIDENCE	.0017	.49		43	13		
PLUS: DIVIDENDS, INTEREST, AND RENT 7/	.0018	.59		107	11		
PLUS: TRANSFER PAYMENTS	.0026	.81		100	6		
PERSONAL INCOME BY PLACE OF RESIDENCE	.0019	.54		59	11		

3/ CONSISTS OF WAGE AND SALARY DISBURSEMENTS, OTHER LABOR INCOME, AND PROPRIETORS' INCOME.
PRIMARY SOURCE FOR PRIVATE NON-FARM WAGES: ES-202 COVERED WAGES -IDAHO DEPARTMENT OF EMPLOYMENT
4/ INCLUDES THE CAPITAL CONSUMPTION ADJUSTMENT FOR NON-FARM PROPRIETORS.
5/ INCLUDES WAGE AND SALARIES OF U.S. RESIDENTS WORKING FOR INTERNATIONAL ORGANIZATIONS.
7/ INCLUDES THE CAPITAL CONSUMPTION ADJUSTMENT FOR RENTAL INCOME OF PERSONS.
(D) NOT SHOWN TO AVOID DISCLOSURE OF CONFIDENTIAL INFORMATION, DATA ARE INCLUDED IN TOTALS.

Source: Regional Economics Information System, Bureau of Economic Analysis, July, 1978.

TABLE 25. GENERAL AGRICULTURAL DATA, 1974, OWYHEE COUNTY

Number of farms	553
Land in farms (acres)	617,511
Average farm size (acres)	1,117
County land area (acres)	4,889,920
Percent in farms	12.6%
Value of land and buildings	
Total (000)	$126,450
Per farm	$228,661
Per acre	$205
Cropland (acres)	133,038
Percent of all land	2.7%
Percent of all farmland	21.5%
Irrigated land (acres)	107,389
Percent of all land	2.2%
Percent of all farmland	17.4%
Quantity of irrigation water applied (ac ft)	347,928
Per acre (ac ft)	3.3
Value of agricultural products sold--total (000)	$39,205
Average per farm	$70,896

Source: U. S. Bureau of the Census, 1977.

TABLE 26. SUMMARY DATA ON LAND USE, LAND OWNERSHIP, AND LAND-USE CONTROL MECHANISMS, 1976-1977, OWYHEE COUNTY

	Acres	% of Total
Land Use--1976:		
Urban	--	--
Agricultural	191,700	3.9
Rangeland	4,585,000	93.5
Other	126,800	2.6
Land Ownership--1977:		
Federal government	3,777,613	77.3
State government	330,955	6.8
Private	779,641	15.9
Local government	1,711	--
Land-Use Control Mechanisms:		
Planning and Zoning Commission	Yes	
County Comprehensive Plan	No	
Subdivision Ordinance	No	
Zoning Ordinance	No	

Source: Idaho Division of Budget, Policy Planning, and Coordination, 1978

TABLE 27. SUMMARY DATA ON ASSESSED VALUE AND PROPERTY TAX CHARGES, 1977, OWYHEE COUNTY

Assessed value of all property--total (000)	$19,733
Per capita	$2,498
All property tax charges--total (000)	$1,557
Per capita	$197
Property tax charges-real and personal property--total (000)	$1,165
Per capita	$147
Measures of uniformity in assessment ratios:	
Weighted assessment ratio	14.49
Regression index	1.07
Coefficient of variation	56.22

Source: Idaho State Tax Commission, 1977a.

within the KGRA, all of which frequently produce molluscan, plant, and vertebrate fauna. Harper noted freshwater gastropod and mammalian (camel, rhinoceros, citellid rodent, beaver, Hipparion) fossils in the Chalk Hills outcrops just across the southern border of the KGRA on the east side of the Bruneau River. No other paleontological materials were recovered within or immediately adjacent to the KGRA, and it appears that Harper rather intensively surveyed that area hoping to find more specimens.

Prehistoric Resources. In 1937 an extensive and intensive archaeological survey was conducted in the Bruneau Canyon by Godfrey Olsen, [49] sponsored by the American Indian, Heye Foundation of New York. He and his crew spent four months surveying 80 km of canyon bottom and a 1/2-km-wide, 100-km-long strip on either side of the canyon; they found more than 200 camp, village, quarry, and burial sites. They undoubtedly scoured the Bruneau KGRA during this survey, but unfortunately, the notes and collections from that survey have never been published and are now apparently lost.[50]

In 1971-1972, Idaho State University conducted a second major reconnaissance of the Bruneau Canyon,[50] this time for the Bureau of Land Management. However, their survey is also of little direct applicability to the Bruneau KGRA in that they stopped at the canyon mouth, just at the southern KGRA border. They did record one prehistoric site within the KGRA, a small scatter of lithic material with two baskets that is assumed to represent a small campsite. This is the only recorded archaeological survey that relates to the KGRA at all.

The ethnographic information available suggests that there is a high probability of prehistoric cultural materials being remnant in the Hot Spring locality. The Bruneau valley was known historically to be the home territory of a group of Shoshonis who were usually referred to as "Bruneau Shoshoni"[51,52,53] and were closely associated with the Boise Shoshoni in the mid-nineteenth century. Harris[54,55] also comments that some of the Western Shoshoni who exploited the game and fish resources of the Bruneau were White Knife Shoshoni from

Nevada who seasonally moved north into the fishing areas. In any event, there is good documentation of major fishing camps at the confluence of the Bruneau and the Snake; Steward[56] noted 30 lodges there when he crossed the Bruneau on 21 August 1812. Steward and Voegelin[57] commented that the Bannock occasionally camped and fished at the Bruneau mouth, and Hough[58] also recorded a fishing camp at that locality. Even more pertinent to the Bruneau KGRA, however, is Steward's[59] map of southern Idaho Indian villages and camps, on which he marks a winter village site approximately at Hot Spring; nowhere in his text does he discuss this location. Murphy and Murphy[60] also note the village, however, and specify that it is located at Hot Spring on the west side of the Bruneau just north of the mouth of the canyon. Steward ascribed no tribal name to the Hot Spring village on his map; Murphy and Murphy refer to it as Shoshoni. In addition, the "Indian Bath Tub," a large hot spring just southeast of the KGRA, has pictographs in association.[61] Thus, historical and ethnographic records support relatively heavy use of the Bruneau Valley from south to north, and the presence of a winter village or camp within the Bruneau KGRA strengthens the probability that significant prehistoric cultural resources are remnant in the area and need identification and effective management. The combination of anadromous fish resources, relatively warm winters, extensive hot springs, and plentiful game in the area probably have made it a desirable home for thousands of years.

In addition to citing the ethnographic literature, comment should be made about the diversity and temporal breadth of materials found adjacent to the Bruneau KGRA. Pavesic and Hill's[50] survey upriver from Hot Spring found 173 prehistoric sites, many of them on floodplain terraces; they make no comment as to the temporal span represented by those deposits. Murphey[62,63] has recently completed extensive surveys of the Tuana section of the Snake River Plain and the Devil's Creek area, both southeast of the Bruneau Canyon with very similar environments. He recorded several hundred sites that cover a full 10 000 years of human adaptation to the region. There is no reason not to assume that a similar time span could be represented

even in the small Bruneau KGRA, considering the array of natural resources available there.

Historical Resources. A number of historic records are available for the Bruneau KGRA. Ogden crossed the Bruneau on 2 July 1828[64] and probably was within the KGRA; he left no specific descriptions. Cattle were first brought into the Bruneau area in 1868.[65] The earliest Government Land Office survey plats[66] indicate a cabin within the KGRA by 1874; homesteaders living in the area hid out in Roberson Cave during the Bannock War of 1878, when they feared for their lives.[67] While there are probably no extensive historic architectural remains within the Bruneau KGRA,[65] archaeological remnants of homestead, school, or other structures of the Hot Spring community[68] could occur and need to be considered before development of major plans for the area.

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APPENDIX A

SNAKE RIVER BASIN ENVIRONMENTAL PROGRAM REPORTS

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SNAKE RIVER BASIN ENVIRONMENTAL PROGRAM REPORTS

Reports prepared as part of the Snake River Basin environmental program are listed below. Copies of these reports are available from the editors at EG&G Idaho, Inc., Box 1625, Idaho Falls, Idaho 83401.

EGG-2001 — S. G. Spencer, B. F. Russell, and J. F. Sullivan, editors, Potential use of Geothermal Resources in in the Snake River Basin: An Environmental Overview.

EGG-GTH-5001 — S. G. Spencer and B. F. Russell, editors, Vulcan Hot Springs KGRA: An Environmental Analysis.

EGG-GTH-5002 — S. G. Spencer and B. F. Russell, editors, Crane Creek KGRA: An Environmental Analysis.

EGG-GTH-5003 — S. G. Spencer and B. F. Russell, editors, Castle Creek KGRA: An Environmental Analysis.

EGG-GTH-5004 — S. G. Spencer and B. F. Russell, editors, Bruneau KGRA: An Environmental Analysis.

EGG-GTH-5005 — S. G. Spencer and B. F. Russell, editors, Mountain Home KGRA: An Environmental Analysis.

EGG-GTH-5006 — S. G. Spencer and B. F. Russell, editors, Raft River KGRA: An Environmental Analysis.

EGG-GTH-5007 — W. Cris Lewis, Lewis and Associates, Geothermal Development in Southwest Idaho: The Socioeconomic Data Base.

PG-G-79-001 J. K. Applegate, GeoTechniques, KGRA Comprehensive Completion Report: Seismicity.

PG-G-79-002 J. K. Applegate, GeoTechniques. KGRA Comprehensive Completion Report: Subsidence.

PG-G-79-003 N. Savage, Idaho Water Resources Research Institute, Snake River Basin KGRA Environmental Report: Soils.

PG-G-79-004 E. Bentley, GeoTechniques, KGRA Comprehensive Completion Report: Air Quality.

PG-G-79-005 M. Delisio, GeoTechniques, KGRA Comprehensive Completion Report: Meteorology.

PG-G-79-006 R. Knudson and M. Pfaff, Idaho Water Resources Research Institute, Heritage Resources and Known Geothermal Resource Areas in Idaho: A Preliminary Review.

PG-G-79-007 C. L. Miller and C. C. Warnick, Idaho Water Resources Research Institute, Assessment of Hydrology and Water Quality Data of the KGRAs of the Snake River Basin.

PG-G-79-008 C. D. Jorgensen and R. L. Johnson, Brigham Young University, Literature Review and Assessment of Terrestrial Ecological Data for Selected KGRAs in the Snake River Plain, Idaho.

PG-G-79-009 R. Hardyman, GeoTechniques, KGRA Comprehensive Completion Report: Geology.

PG-G-79-010 K. P. McCarthy and J. F. Sullivan, EG&G Idaho, Inc., Aquatics of Five Snake River Basin KGRAs,

PG-G79-011 B. Moore, N. Savage, J. S. Gladwell, and C. C. Warnick, Idaho Water Resources Research Institute, A Summary of the Assessments of Geothermal Resource Use Limitations of Bruneau, Castle Creek, Crane Creek, Mountain Home, and Vulcan Hot Springs KGRAs.

APPENDIX B

BRUNEAU KGRA SOIL MAPPING UNITS AND SOIL DESCRIPTIONS

APPENDIX B

BRUNEAU KGRA SOIL MAPPING UNITS AND SOIL DESCRIPTIONS

The separations on the general soil map are identified by letters or by a combination of letters and numbers such as A, B1, B2, C1, etc. These symbols represent soil mapping units consisting of a group of identified soils. These maps are of little value unless the soils they represent are described. The following sections on soil mapping units and soil descriptions will discuss the soil characteristics important for interpretation of the individual soil for irrigation.

SOIL MAPPING UNITS OF A

A1 621-281a-281b-909d Mapping Unit: Deep, well-drained soils on nearly level to sloping lacustrine sediments on lake terraces, terrace escarpments and mixed alluvium on alluvial fans.

A2 281a-909b-909a Mapping Unit: Deep, well-drained soils on nearly level to sloping lacustrine sediments on dissected lake terraces and mixed alluvium on alluvial fans.

A3 034-281a Mapping Unit: Very shallow and deep, well-drained soils on nearly level to very steep lacustrine sediments in Badlands and mixed alluvium on alluvial fans.

A4 909d-909b Mapping Unit: Moderately deep, well-drained soils on steep and very steep lacustrine sediments on dissected lake terraces, terrace escarpments and mixed alluvium on alluvial fans.

A5 034-909d Mapping Unit: Very shallow and moderately deep, well-drained soils on very steep dissected lacustrine sediments in Badlands and on terrance escarpments.

A6 909b-909d-599b Mapping Unit: Moderately deep and deep, well-drained soils on gently sloping to very steep lacustrine sediments on dissected lake terraces and terrace escarpments.

A7 909d-752 Mapping Unit: Moderately deep and very shallow soils on very steep lacustrine sediments on terrace escarpments and in Canyon Rockland.

The major soils in these mapping units are developing in lacustrine sediments on lake terraces, terrace escarpments and in mixed alluvium on alluvial fans interspersed with Badlands and some Rockland. They occur on nearly level to very steep slopes.

The major soils occur in 7 different combinations of mapping units based on kinds of soils and percent composition. These soils are developing in essentially the same kind of parent materials derived from/or in the Payette Formation and related strata.

The mean annual precipitation is estimated to be about 150 to 230 mm. The mean annual soil temperature is about 10 to 11 degrees C. The frost-free period is more than 120 days. The elevations range from about 670 to 1400 m.

The soils are deep, moderately deep, shallow, very shallow and are well-drained. The surface textures among the subunits of these mapping units are dominated by silt loam and gravelly loam with miscellaneous land type Badlands that are also silty. Some minor areas include fine sand loam and Rockland. These soils are generally calcareous at or near the surface. The underlying materials are stratified lacustrine sediments ranging from gravelly materials to loamy and silty sediments with some strata high in sodium salts and high concentrations of calcium carbonate. The slopes are variable, ranging from long, uniform nearly level alluvial fans and lake terraces to short, complex, very steep slopes of the terrance escarpments and highly dissected lacustrine sediments of the Badlands.

The major soils and miscellaneous land types in the various mapping units are 034, 281a, 281b, 599b, 621, 752, 909a, 909b and 909d. The minor soils, each representing less than 15% of the area in their respective mapping units, are 037, 350a, 564a, 599a, 632a, 704b, 890a, 890b, 909c, and 1000.

SOIL MAPPING UNITS OF B

B1 599a Mapping Unit: Deep, well-drained soils on nearly level to very gently sloping mixed alluvium on alluvial fans, pediments and stream terraces.

B2 599a-529a-599b Mapping Unit: Deep and moderately deep, well-drained soils, on nearly level to sloping mixed alluvium on alluvial fans, lake terraces, pediments and stream bottoms.

B3 599a-1001 Mapping Unit: Deep, well-drained soils on nearly level mixed alluvium on alluvial fans and stream terraces.

B4 296-599c-599d Mapping Unit: Moderately deep and deep, well-drained soils on gently sloping to steep, mixed alluvium on hills, alluvial fans, pediments and stream terraces.

B5 599b-357-752 Mapping Unit: Deep, shallow and very shallow, well-drained soils on gently sloping to very steep residuum on rhyolitic hills and mixed alluvium on alluvial fans.

B6 699a-599a-599b Mapping Unit: Shallow and deep well-drained soils on nearly level to sloping mixed alluvium on pediments and alluvial fans on lake terraces.

B7 599b-699a Mapping Unit: Deep and shallow, well-drained soils on nearly level to sloping mixed alluvium on alluvial fans and pediments on stream terraces.

B8 599a-002-040 Mapping Unit: Deep, well-drained soils on nearly level to sloping mixed alluvium on alluvial fans and pediments on lake terraces.

B9 476-599f-599e mapping units: Deep, well-drained soils on nearly level to sloping mixed alluvium on alluvial fans and pediments on lake terraces.

The major soils in these mapping units are developing in mixed alluvium on alluvial fans and pediments on lake and stream terraces and on stream bottoms. They occur on nearly level to sloping landforms.

The major soils occur in 9 different combinations of mapping units based on kinds of soils and percent composition. These soils are developing in essentially the same kind of parent material derived from the Payette Formation and related strata mixed with basaltic and rhyolitic alluvial materials from the adjacent hills and mountains. Some of the sediments have scattered areas of Rockland and residuum in rhyolitic mountains.

Annual precipitation is estimated to be about 150 to 230 mm. Annual temperature is about 10 to 11 degrees C. The frost-free period is more than 120 days. The elevations range from about 700 to 1400 mm.

The soils are deep, moderately deep, shallow, very shallow and well-drained. The surface textures are dominated by gravelly loam, loam, fine sandy loam and channery loam. Minor areas among the subunits include loamy sand, silt loam, very stony loam and sandy loam. These soils are generally calcareous at or near the surface and one soil has a lime-silica hardpan. The underlying materials are stratified stream alluvium, lacustrine sediments or rhyolitic bedrock in some areas. The slopes are variable with the largest portion being rather broad, long and nearly level to very gently sloping; the remaining areas are rather narrow, short to long and sloping to steep terraces and terrace escarpments.

The major soils and miscellaneous land types in the various mapping units are 002, 040, 296, 357, 476, 529, 599a, 599b, 599c, 599d, 599e, 699a, 752 and 1001. The minor soils, each representing less than 15% of the area in their respective mapping units, are 350a, 481a, 481b, 529b, 699b, 704b, 890a, 890b, 909c and 909d.

SOIL MAPPING UNITS OF C

C1 1002a-1002b Mapping Unit: Moderately deep, well-drained soils on nearly level to sloping lacustrine sediments on lake terraces.

C2 350c-529a Mapping Unit: Moderately deep, well-drained soils on nearly level to very gently sloping mixed alluvium on stream terraces.

C3 350c-350b Mapping Unit: Moderately deep, well-drained soils on nearly level to sloping mixed alluvium on stream terraces.

C4 281a-350c Mapping Unit: Deep and moderately deep, well-drained soils on nearly level to sloping mixed alluvium on alluvial fans and stream terraces.

The major soils in these mapping units are developing in mixed sandy or silty alluvium on stream terraces and alluvial fans. They occur on nearly level to sloping landforms.

The major soils occur in 4 different combinations of mapping units based on kinds of soils and percent of composition. These soils are developing in essentially the same kind of parent material derived from the Payette Formation and related strata.

The mean annual precipitation is estimated to be about 180 to 230 mm. The mean annual soil temperature is estimated to be about 10 to 11 degrees C. The elevations range from about 730 to 1100 mm.

The soils are moderately deep, deep and well-drained. The surface textures are dominated by gravelly sandy loam, loam and silt loam. Minor areas within the subunits include sand and sandy loam. These soils are calcareous at or near the surface. The underlying materials are stratified sand and gravel, loamy material and lacustrine sediments. The slopes are narrow and long.

The major soils are 281a, 350c, 350b, 529a, 1002a and 1002b. The minor soils, each representing less than 15% of the area in their respective mapping units, are 529a, 529b, 704a, 890a, 1002c and 1003.

SOIL MAPPING UNITS OF D

D1 040 Mapping Unit: Deep, somewhat poorly drained soils on nearly level to very gently sloping mixed alluvium on stream bottoms.

D2 083a-083b-281a Mapping Unit: Deep, somewhat poorly and poorly drained soils on nearly level to very gently sloping mixed alluvium on stream bottoms and alluvial fans.

D3 082-083b Mapping Unit: Deep, very poorly and somewhat poorly drained alkaline soils on nearly level to very gently sloping mixed alluvium on stream bottoms.

D4 281a Mapping Unit: Deep, somewhat poorly drained soils on nearly level to very gently sloping mixed alluvium on alluvial fans.

D5 281a-281b-909d Mapping Unit: Deep and moderately deep, somewhat poorly drained and well-drained soils on nearly level to very steep mixed alluvium on alluvial fans and on terrace escarpments.

The major soil in these mapping units are developing in mixed alluvium and lacustrine sediments on stream bottoms, alluvial fans and terrace escarpments. They generally occur on nearly level to very gently sloping landforms with some very steep areas.

The major soils occur in 5 different combinations of mapping units based on kinds of soils and percent of composition. These soils are developing in alluvium essentially from the same kind of parent material derived from or in the Payette Formation and related strata.

The mean annual precipitation is estimated to be about 150 to 230 mm. The mean annual soil temperature is about 10 to 11°C. The frost-free period is more than 120 days. The elevations range from about 670 to 900 mm.

The soils are generally deep with few areas that are moderately deep or shallow. The surface textures are dominated by silt loam and loam. There are minor areas among the subunits that include fine sandy loam, cobbly sandy loam and silty clay loam. These soils are generally calcareous at or near the surface except for some of the sandy soils with drainage problems that may be noncalcareous. The underlying materials are generally stratified sandy or loamy that may or may not be gravelly or cobbly. Alkaline or saline-alkaline areas are associated with somewhat poorly and poorly drained conditions where natural or induced water tables prevail. The soils are generally nearly level to very gently sloping with few areas that are sloping to very steep.

The major soils are 040, 082, 083a, 083b, 281a, 281b and 909d. The minor soils and miscellaneous land types, each representing less that 15% of the area, are 034, 040, 254, 281b, 306a, 306b, 306c, 323, 332, 350c, 521, 583, 616 and 890.

SOIL MAPPING UNITS OF E

E1 890a Mapping Unit: Deep, well-drained soils on nearly level to very gently sloping mixed sandy alluvium on stream terraces.

E2 890a-890b-257a Mapping Unit: Deep, well-drained and excessively drained soils on nearly level to sloping mixed sandy alluvium on stream terraces.

E3 890a-281a Mapping Unit: Deep, well-drained soils on nearly level to very gently sloping mixed sandy alluvium on stream terraces and alluvial fans.

E4 704a-134b Mapping Unit: Deep and moderately deep, excessively drained and well-drained soils on nearly level to steep sand dunes and mixed sandy alluvium on stream terraces and alluvial fans.

E5 704a-890a-257b Mapping Unit: Deep, excessively drained and well-drained soils on nearly level to steep sand dunes and mixed sandy alluvium on stream terraces.

E6 257c-890a Mapping Unit: Deep, excessively drained and well-drained soils on nearly level to very steep mixed sandy alluvium on stream terraces.

E7 886-389-704a Mapping Unit: Moderately deep and deep, well-drained and excessively drained soils on nearly level to steep eolian sand on stream and lake terraces and in sand dunes.

The major soils in these mapping units are developing in mixed sandy alluvium or in sand dunes on stream terraces, lake terraces and alluvial fans. They occur on nearly level to very steep landforms.

The major soils occur in 7 different combinations of mapping units. These soils are developing in alluvial deposits of essentially the same kind of parent materials derived from or in the Payette Formation and related strata.

The mean annual precipitation is estimated to be about 150 to 230 mm. The mean annual soil temperature is about 10 to 11 degrees C. The frost-free period is more than 120 days. The elevations range from about 670 to 900 mm.

The soils are generally deep and excessively drained to well-drained. Some areas are deep to hardpan. The surface textures are dominated by fine sandy loam, loamy fine sand, sandy loam, loamy sand and sand. Only minor areas include silt loam. Most of these soils are calcareous at or near the surface. Others are strongly calcareous in the subsoil and may have a lime-silica hardpan. The underlying materials are either eolian sand or stratified sand and gravel. The slopes vary from short and narrow to broad and long, nearly level stream terraces and alluvial fans to sands hummocks and sand dunes.

The major soils are 134b, 257a, 257b, 257c, 281a, 389, 704a, 886, 890a and 890b. The minor soils, each representing less than 15 percent of the area, are 037, 040, 134a, 174, 564a, 704a and 704b.

SOIL MAPPING UNITS OF R

R1 752-1026 Mapping Unit: Rockland, rough broken and stony canyon land and escarpments.

R2 752-357 Mapping Unit: Rockland and shallow, well-drained soils on very steep rhyolitic mountains and canyons.

R3 752-127 Mapping Unit: Rockland and shallow, well-drained soils on very steep granitic mountains and canyons.

These miscellaneous land types and soils consist of Rockland (basaltic and rhyolitic), rough broken and stony canyon land and escarpments of the rhyolitic and granitic mountains and canyons. These landforms are generally very steep and are scattered throughout the county.

The miscellaneous land types and soils occur in 3 different combinations of kinds of landforms, parent materials and soils. They are mixed geologically with granitic materials at the highest elevations, and with basaltic and rhyolitic materials in the bottoms of canyons of

the basalt areas. Many of these canyons represent fault lines and degradation by stream action.

The climatic conditions in these landforms are widely variable, ranging from 200 mm precipitation in canyons at about 900 m to over 500 mm on rock escarpments at 2100 m. Air temperatures are also widely variable depending on depth of canyon and elevation, but are estimated to range from 5 to 10 degrees C. Frost-free period is estimated to range from 85 to over 120 days. These canyons range from 15 to 240 m deep and effectively isolate many areas across the southern part of the county.

The major miscellaneous land types and soils are 127, 357, 752 and 1026. The only minor soil recognized, representing less than 15% of the area, is 599c.

APPENDIX C

THREATENED AND ENDANGERED PLANT SPECIES

APPENDIX C

THREATENED AND ENDANGERED PLANT SPECIES

. Lomatium hendersonii Coult. and Rose — Proposed Federal Status: THREATENED

APIACEAE (Umbelliferae)

Location: Idaho: OWYHEE County, Oregon: Crook, Jefferson, Wasco and Wheeler counties

Washington: Spokane County

Land Ownership: BLM

Vegetation Type: Sagebrush/grass

Habitat: Fairly good, not clayey, soil at about 1500 m on ridge tops

Hazards: Range improvement programs

Herbarium Data: Number of sites by county: Idaho-OWHYEE-1.

Number of collections in herbaria searched: BOIS-0, BS-0, CIC-1, ID-1, IDF-0, INT-1

Remarks: The Owhyee County population may not be Lomatium hendersonii, and probably is a rare, endangered and endemic species of Lomatium. It is being studied now. Apparently there is only one site known for the Idaho population, but the area is poorly collected. There is another collection reported from eastern Idaho, probably in the Adams-Washington County area, but it has not been seen by the compiler.

Recommendations: Wait until Bert Brehm finishes his study of the Idaho population and recommend for endangered list if it is a new species. In the meantime RETAIN ON THREATENED LIST

References: Mathias 1938

Compiler: Packard

ASTERACEAE (Compositae)

Artemisia papposa Blake and Cronq. Proposed Federal Status THREATENED

Location: Idaho: Blaine, Camas, Elmore, Gooding, Lincoln and Owyhee counties

Oregon: Malheur County

Land Ownership: BLM, private and possibly Idaho Department of Lands

Vegetation Type: Artemisia tridentata - A. arbuscula mosaics of Juniperus occidentalis/Artemisia tridentata

Habitat: Grows with or replaces A. arbuscula in shallow, stony, clayey, often alkaline soil that receives drainage from surrounding areas, 4500 to 6000 ft

Hazards: Grazed by sheep. Range improvement programs

Hervarium Data: Number of sites by county: Idaho - Blaine-1, Camas-3, Elmore-2, Gooding-1, Lincoln-1, Owyhee-3

Number of collections in herbaria searched: BOIS-1, CIC-2 ID-6 IDF-3 UTC-1 WS-3, WTU-1

Remarks: This plant has a fairly broad range but a highly discontinuous distribution. It is abundant in one area on the north end of its range but rare and apparently decreasing in Owyhee County (Eidemiller 1976). It is confined to one habitat, making it vulnerable to anything affecting that habitat.

Recommendations: RETAIN AS THREATENED until we know more about its ecology.

References: Eidemiller 1976, Steele 1975

Compiler: Packard

FABACEAE (Leguminosae)

- Astragalus sterilis Barneby — Proposed Federal Status ENDANGERED

Location: Idaho: OWYHEE County

Oregon: Malheur County

Land Ownership: BLM, possibly private and Idaho Department of Lands

Vegetation Type: Artemisia tridentate/pia sandbergii and shrubby chenopods

Habitat: Bare clay soil

Hazards: Recreationists with off-road vehicles

Herbarium Date: Number of sites by county: Idaho - Owyhee-1 (Barneby 1964)

Number of collections in herbaria searched: BOIS-0, BS-0, CIC-0, ID-0, IDF-0

Remarks: Barneby collected this species on the western border of Owyhee County but apparently it has not been collected there since. It is very rare in Owyhee County, and it has a discontinuous distribution in adjacent Malheur County, Oregon. The species has a range of about 50 x 25 km but is quite infrequent even there.

Recommendations: RETAIN AS ENDANGERED

References: Barneby 1964

Compiler: Packard

FABACEAE (Leguminosae)

- Astragalus purshii Dougl. var. ophiogenes Barneby — Proposed Federal Status ENDANGERED

Location: Idaho: Blaine, Camas, Canyon, Elmore, Gooding, Lincoln and Owyhee counties

Oregon: Malheur County

Land Ownership: BLM, private and possibly Idaho Department of Lands

Vegetation Type: Artemisian tridentata/Poa sandbergii

Habitat: Eroded, dry rocky or sandy river terraces and bluffs or dunes, 770 to 1200 m

Hazards: Range improvement programs

Herbarium Data: Number of sites by county: Idaho - Blaine-1, Camas-1, Canyon-1, Elmore-3, Gooding-2, Lincoln-1, Owyhee-3 (Barneby 1964)

Number of collections in herbaria searched: BOIS-0, CIC-5, ID-2, IDF-0, WS-2

Remarks: This variety has a fairly wide range and is probably of fair abundance in that range. There are four to five forms of A. purshii in this area and only three varietal names available for use which leads to filing herbarium material without varietal identification. Also, since one of the key differences is flower color which fades on drying, one soon learns to leave them all in the field. These situations may account for the sparsity of herbarium data.

Recommendations: On season of collecting should be adequate for this variety. If possible, Barneby should verify the identifications. Herbaria should be reviewed for unlabeled varieties. This variety is probably NEITHER THREATENED NOR ENDANGERED in spite of the scarcity of herbarium material.

References: Eidemiller 1976, Barneby 1964

Compiler: Packard

ASTERACEAE (Compositae)

. Erigeron latus (Nels. & Macbr.) Cronq. Proposed Federal Status ENDANGERED

Location:	Idaho: Owyhee, possible Cassia and Twin Falls counties Idaho endemic
Land Ownership:	BLM, possibly private and Idaho Department of Lands
Vegetation Type:	Juniperus occidentalis/Artemisia tridentata
Habitat:	Rocky soil derived from lava
Hazards:	Range improvement programs
Herbarium Data:	Number of sites by county: Idaho-Cassia-1, Owyhee-3, Twin Falls-1 Number of collections in herbaris searched: BOIS-0, CIC-1, ID-2, IDF-0, RENO-1, UTC-1, WS-3
Remarks:	This has been collected twice for certain. The material deposited at CIC was poorly preserved and although it has the characteristics of the species, identification is uncertain. Some herbaria have a collection of Ergeron from Blaine County. This is not E. latus. The collections from Cassia and Twin Falls counties have not been verified, but these locations are in keeping with the presently known habitat and range.
Recommendations	RETAIN AS ENDANGERED until the material from Cassia and Twin Falls counties is verified. If its range is of that extent, it should be reduced to threatened status.
References	Cronquist 1947
Compiler	Packard

BRASSICACEAE (Cruciferae)

. Draba douglasii Gray — Propose Federal Status THREATENED

Location: Idaho: Ada, Cassia, Custer, Elmore, Gooding and Owyhee counties

Oregon: Baker, Grant, Harney Lane, Malheur and Union counties

Nevada: Clark, Elko, Humboldt, Lauder, Ormsby, Storey Washoe and White Pine counties

California: Mendocino, Modoc, Plumas and San Bernadino counties

Washington: Klickitat County

Land Ownership: BLM, private and probably Idaho Department of Lands

Vegetation Type: Artemisia tridentata/Poa sandbergii

Habitat: Dry, bare spots where there is little competition from other plants. Soil type may vary from sand to clay, 1200 to 34 000 m

Hazards: Range improvement programs

Herbarium Data: Number of sites by county: Idaho - Ada-1, Cassia-1, Elmore-1, Gooding-1, Owyhee-3

Number of collections in herbaria searched: BOIS-2, CIC-5, IDF-0, INT-1

Remarks: Distribution is highly discontinuous but it ranges from southern Washington to San Bernadino, California.

Recommendations: REMOVE FROM THREATENED LIST

References: Hitchcock 1941

Compiler: Packard

BRASSICACEAE (Cruciferae)

. *Lepidium davisii* Rollins — Proposed Federal Status ENDANGERED

Location: Idaho: Elmore and Owyhee counties

Oregon: Malheur County

Land Ownership: BLM, possibly private and Idaho Department of Lands

Vegetation Type: *Atriplex-Artemisia* zone

Habitat: Hard bottom playas

Hazards: These playas are being used for race tracks, stock watering ponds, and water reservoirs. Their shape and locations make them very vulnerable to disturbance.

Herbarium Data: Number of sites by county: Idaho - Elmore-1, Owhyee-1

Number of collections in herbaria searched: BOIS-0, BS-0, CIC-2, ID-1, IDF-0

Remarks: Only three sites are known for this plant even though it ranges from Elmore County, Idaho, to Malheur County, Oregon. The many highly destructive uses which the habitat receives makes this a very vulnerable species in spite of its range. It is doubtful that more than a few other sites will be found; these will not likely affect the endangered status of this species.

Recommmendations: RETAIN AS ENDANGERED

References: Rollins 1948

Compiler: Packard

FABACEAE (leguminosae)

. Astragalus mulfordiae M. E. Jones — Proposed Federal Status THREATENED

Location: Idaho: Ada, Blaine, Owyhee and Washington counties

Oregon: Malheur County

Land Ownership: BLM, private and possibly Idaho Department of Lands

Vegetation Type: Sagebrush/grass

Habitat: Grows on old river deposits or in sandy places near rivers, 600 to 900 m

Hazards: Housing developments, agriculture

Herbarium Data: Number of sites by county: Idaho - Ada-1, Blaine-1, Owyhee, Washington-1

Number of collections in herbaria searched:
BOIS-0, BS-0, CIC-1, ID-2, IDF-0, UTC-3

Remarks: This plant is known from a total of six sites in Idaho and Oregon: one site is near Boise in an area being developed. It is seldom abundant where it occurs and the sites are usually very small in area.

Recommendations: CHANGE TO ENDANGERED STATUS It has a fairly broad range but is very infrequent.

References: Barneby 1964

Compiler: Packard

LOASACEAE

. Mentzelia mollis Pack — Proposed Federal Status THREATENED

Location. Idaho: Owyhee County

Oregon: Malheur County

Land Ownership: BLM private, and possibly Idaho Department of Lands

Vegetation Type: Desert Shrub

Habitat: Volcanic ash

Hazards: Recreationists with off-road vehicles (ORVs).
Range improvement programs

Herbarium Data: Number of sites by county: Idaho-OWYHEE-3

Number of collections in herbaria searched: FOIS-0, CIC-6, ID-2, IDF-0

Remarks: This plant is very abundant where it occurs, but its habitat is highly restricted and attracts ORV use. Its range is about 50 x 25 km. It has not been successfully germinated or grown in greenhouse or garden. Range improvement programs have disturbed several sites.

Recommendations: Its small range, restricted habitat and active impact of land use make this plant most vulnerable. Therefore its status should be CHANGED TO ENDANGERED.

References: Glad 1976

Compiler: Packard

PRIMULACEAE

- Primula cusickiana Gray — Proposed Federal Status ENDANGERED

Location: Idaho: Ada, Adams, Blaine, Boise, Camas, Custer, Elmore, Gem, Gooding, Idaho, Owyhee, Valley and Washington counties

Oregon: Wallowa County

Land Ownership: BLM, USFS (Boise, Payette and Sawtooth N.F.), probably private and Idaho Department of Lands

Vegetation Type: Mostly in grass meadows or sagebrush/grass

Habitat: The more northern population grows in mountain meadows in heavy clay soil. The southern populations grow in thin, rocky soil on steep slopes of eroded lake terraces and in seeps or where it is wet in spring.

Herbarium Data: Number of sites by county: Idaho - Ada-9 many since destroyed, Adams-2, Blaine-1, Boise-5, Camas-4, Custer-3, Elmore-7, Gem-1, Gooding-2, Idaho-2, Owyhee-1, Washington-2

Number of collections in herabaria searched: BOIS-3, BS-5, CIC-18, ID-15, IDF-2 INT-9, WS-3, WTU-2

Remarks: Dr. Marion Ownbey once said (pers. comm.) that probably three species of Primula are represented. The Hill City population being one undescribed species, the Boise area population being the now unrecognized P. wilcoxianna, and the more northern population being the typic P. cusickiana. The difference in habitat preference indicates that this might be true. If, as Ownbey indicated, this is actually three species, then the Hill City population is truly endangered and the Boise P. wilcoxiana is possibly threatened. The P. cusickiana of the Wallowa Mountains and west-central Idaho is neither endangered nor threatened.

Recommendations: RETAIN ON ENDANGERED LIST until the taxonomy of these populations has been clarified. Then remove or reduce in status any segment of the complex that does not warrant protection.

References: Eidemiller 1976, Holmgren and Holmgren 1974, Williams 1936

Compiler: Packard

SCROPHULARIACEAE

. Penstemon elegantulus Pennell — Proposed Federal Status THREATENED

Location: Idaho: Owyhee County, "overlooking Snake River Canyon in Wallowa Co., Ore. and adjacent Ida." (Hitchcock & Cronquist 1973)

Land Ownership: Either BLM or private, (judging from single collection in Idaho)

Vegetation Type: The area of the single Idaho specimen is Abies lasiocarpa forest mixed with Artemisia tridentata var. vaseyana shrub.

Habitat: "decaying granite hillside," "trail sides"

Herbarium Data: Number of sites by county: Idaho - Owyhee-1, Oregon - Wallowa-2 (C. Johnson, USFS, pers. comm.) A collection from Kootenai County is in very poor shape and due to the disjunction in geography and habitat is not counted here.

Number of collections in herbaria searched: BOIS-0, BS-0, CIC-0, ID-1?, IDF-0 IDS-0, WS-1

Remarks: Our information is very poor. The Oregon population seems about as sparse as Idaho's. To be expected at intermediate points above Hell's Canyon.

Recommendations: RETAIN AS THREATENED

Compiler: Johnson