THE ECOLOGY OF GEOTHERMAL SPRINGS IN SOUTH-CENTRAL IDAHO

by

Robert K. Moseley
Conservation Data Center

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Idaho Department of Fish and Game
600 South Walnut, P.O. Box 25
Boise, ID 83707
Jerry M. Conley, Director

Sawtooth National Forest
Idaho Department of Fish and Game

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ABSTRACT

Geothermal springs in Idaho have been studied from a geohydrological and resource exploitation standpoint for many years. More recently their recreational potential has been popularized in several guidebooks. There have been very few studies, however, on the biology and ecology of geothermal areas of the state, and no assessment made of the conservation status and restoration potential of thermally-influenced communities. Nearly all geothermal springs in Idaho have been disturbed to some degree, ranging from diversion of the entire flow at the source to construction of primitive bathing pools. Most springs in the state occur on public land managed by the Forest Service and, to a lesser extent, the Bureau of Land Management, whose policies require them to manage biological communities in a sustainable way. The Conservation Data Center and the Sawtooth National Forest undertook this cooperative study to collect basic biological information on thermophilic (heat-loving) species and communities in south-central Idaho to provide the Forest Service with biological and ecological information to help set reasonable management and restoration goals at hot springs under their jurisdiction.

My study included 37 geothermal springs in a 5000 square-mile region of south-central Idaho, in Custer, Blaine, Camas, and small portions of Gooding and Elmore counties. I review what is known about the biology and ecology of hot springs in Idaho, in general, and at the hot springs in the study area, in particular, that was available from the literature, personal communications, and largely from my sampling in 1994 and 1995. Sections of the report cover three general areas: (1) the physical setting of hot springs in south-central Idaho, including the geologic setting and attributes of geothermal water, such as discharge, temperature, and chemistry; (2) the biological and ecological characteristics, including aquatic microbial communities, invertebrate animals, flora and rare plant species associated with the hot springs, and thermally-influenced wetland vegetation; and (3) conclusions and management recommendations about specific areas that synthesize the physical and biological information.

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INTRODUCTION

Geothermal springs in Idaho have been studied from a geohydrological and resource exploitation standpoint for many years (Ross 1970, Parliman and Young 1992). More recently their recreational potential (Ross and Savage 1967) has been cataloged in several popular guidebooks (Loam 1990; Litton 1990; 1993; Gersh-Young 1995). There have been very few studies, however, on the biology and ecology of geothermal areas of the state, and no assessment made of the conservation status and restoration potential of thermally-influenced communities. With the exception of microbial communities (*cf*. Brock 1978), Idaho is not unique in this respect.

Initial interest on the biology of hot springs in Idaho surrounded *Epipactis gigantea*, a rare species (Conservation Data Center 1994) that inhabits thermally-influenced areas in the mountainous portion of its distribution in the state. Several inventories have been conducted that outline its distribution, abundance and conservation status at hot springs (Henderson 1982; Moseley 1989a; Mancuso 1991; Lind 1992). Floristic, cyanobacterial, and aquatic invertebrate samples have also been collected at a few springs in the state (Brues 1932; Baird 1991; Braman *et al*. 1995).

Nearly all geothermal springs in Idaho have been disturbed to some degree, ranging from diversion of the entire flow at the source, to construction of primitive bathing pools. Most springs in the state occur on public land managed by the Forest Service and, to a lesser extent, the Bureau of Land Management (BLM), whose policies require them to manage biological communities in a sustainable way. Recent calls have also been made by geoscientists to catalog and develop management plans for unique and geologically significant features on federal lands, including hot springs (Maley and Randolph 1993).

The Sawtooth National Forest manages many hot springs on the Fairfield and Ketchum ranger districts and the Sawtooth National Recreation Area. The Fairfield Ranger District is interested in limiting resource damage at Worswick Hot Spring, and restoring the natural communities at the site, if possible. As part of their effort, the Conservation Data Center (CDC) and the Sawtooth National Forest undertook this cooperative study to collect basic biological information on thermophilic (heat-loving) species and communities in a wide area of south-central Idaho to provide the Forest Service with biological and ecological information necessary to set reasonable management and restoration goals at Worswick Hot Spring, in particular, and other hot springs under their jurisdiction, in general.

My study included 37 geothermal springs in a 5000 square-mile region of south-central Idaho, in Custer, Blaine, Camas, and small portions of Gooding and Elmore counties (Figure 1; Table 1). I visited or observed from a distance 31 of the springs during September, 1994, and July - September, 1995; six springs on private land were inaccessible to me.

Figure 1. Map of the study area in south-central Idaho, showing the location of 37 hot springs. Numbering system corresponds to the CDC occurrence number in Table 1.

Table 1. Hot springs in the south-central Idaho study area, listed by major drainage system. Occurrence number refers to the three-digit code used by the CDC to track species and communities, in this case the "thermal springs aquatic community." Ownership abbreviations: FS = Sawtooth National Forest; BLM = Shoshone District, Bureau of Land Management; PVT = private; IDL = Idaho Department of Lands. Visit refers to visit by Moseley in 1994 and/or 1995.

Hot Spring	Occurrence Number	Location	Owner	USGS Quad	Visit
South Fork Boise River					
Willow Creek	070	4N 11E S34 SE4	FS	Cayuse Point	yes
Baumgartner	051	3N 12E S7 SE4	FS	Jumbo Mountain	yes
Lightfoot Bar	068	3N 13E S7 SE4	FS	Boardman Creek	yes
Skillern	067	4N 14E S24 SE4	FS	Paradise Peak	yes
Bluff Creek - Upstream	066	4N 14E S12 NW4	FS	Baker Peak	yes
Bluff Creek - Downstream	065	4N 14E S12 NW4	FS	Baker Peak	yes
Preis	069	3N 14E S19 SE4	FS	Sydney Butte	yes
Worswick	064	3N 14E S28	FS	Sydney Butte	yes
Camas Prairie/Bennett Hills					
Dry Creek	071	3S 14E S9 SE4	BLM	Fir Grove Mountain	yes
Hot Springs Landing	072	1S 17E S23 NE4	PVT	Magic Reservoir W	yes
Elk Creek	094	1N 15E S14 NE4	PVT	Cannonball Mt	no
Wardrop	075	1N 13E S32 NE4	PVT	Smoky Dome	yes
Barron Spring	095	1S 13E S34 NW4	PVT	Corral	no
Cow Creek	096	1S 12E S16 NW4	PVT	Hill City	no
Little Wood River					
Condie	073	1S 21E S14 SE4	PVT	Carey	yes
Huff Creek	074	1S 22E S1 N2	BLM	Paddelford Flat	yes
Big Wood River					
Hailey	076	2N 18E S18 SE4	PVT	Hailey	yes
Clarendon	077	3N 17E S27 SE4	PVT	Mahoney Butte	yes
Frenchman's Bend	078	4N 16E S36 NE4	FS	Griffin Butte	yes
Guyer (Bald Mountain)	079	4N 17E S1 NE4	PVT	Griffin Butte	yes
Easley	080	5N 16E S10 SW4	FS	Easley Hot Spring	yes
Russian John	081	6N 16E S32 SW4	FS	Easley Hot Spring	yes

Table 1. Continued.

Hot Spring	Occurrence Number	Location	Owner	USGS Quad	Visit
Salmon River					
Pierson Spring	082	8N 14E S27 SE4	PVT	Alturas Lake	no
Rocky Mountain Ranch	083	9N 14E S18	FS	Obsidian	yes
Stanley	084	10N 13E S3 SW4	FS	Stanley	yes
Upper Elkhorn	085	11N 13E S36 NW4	IDL	Stanley	yes
Lower Elkhorn	086	11N 13E S25 SE4	FS	Stanley	yes
Mormon Bend	087	11N 14E S29 NE4	FS	East Basin Creek	yes
Basin Creek Campground	088	11N 14E S21 SE4	FS	East Basin Creek	yes
Kem	007	11N 14E S22 SW4	FS	East Basin Creek	yes
Sunbeam	008	11N 15E S19 NW4	FS	Sunbeam	yes
Robinson Bar	089	11N 15E S34 NE4	PVT	Robinson Bar	no
Slate Creek	090	10N R16ES30NW4	FS	Livingston Creek	yes
Torreys	002	11N 16E S29NW4	FS	Thompson Creek	yes
Sullivan	091	11N 17E S27	PVT	Clayton	no
West Pass Creek	092	8N 17E S32 NW4	FS	Ryan Peak	yes
Bowery	093	8N 17E S31 S2	FS	Ryan Peak	yes

Two springs listed in Waring (1965) and Ross (1970), numbers 89 and 125, may be erroneous reports. The legal location given for spring #89 (T10N R13E S12 NW4 of SW4) is in the Little Casino Creek drainage, east of Stanley. Although Ross (1970) gives a discharge rate of 200 gallons per minute, there is no other sources that give its location, including the USGS quad. Spring #125 (T3N R11E S9 NW4) may be a mistaken location for Willow Creek Hot Spring. Parliman and Young (1992) give water chemistry data for a geothermal spring in the Little Smoky Creek drainage south of Preis Hot Spring (T3N R14E S30 NE4 of NE4 of NE4). I did not visit this spring.

The sections that follow cover three general topics regarding hot spring ecology in south-central Idaho: (1) the physical setting and attributes of geothermal water in south-central Idaho; (2) the biological and ecological characteristics; and (3) conclusions and management recommendations.

GEOLOGICAL SETTING

Thermal water in Idaho is encountered in rocks from Precambrian to Holocene age, with the largest number of warm and hot springs originating from volcanic or granitic rocks of Mesozoic or Cenozoic age (Ross 1970). It is believed that meteoric water (atmospheric precipitation) sinks to depths of two or more miles, where it is heated by hot rocks and circulated through fracture systems along faults (Maley 1987; Alt and Hyndman 1989). Although the source of thermal waters in Idaho is obscure, occurrences can be grouped into four general types relative to their associated rocks (Ross 1970):

> 1. Water in and around Mesozoic and Tertiary plutons. Most of these occurrences are in or near areas containing large numbers of Tertiary dikes or other Tertiary intrusions. It is possible that these areas are also major fault zones.
>
> 2. Water in or near fault zones in Tertiary volcanic rocks.
>
> 3. Water in or near normal faults bordering complexly-folded and faulted mountain ranges composed of pre-Tertiary sedimentary rocks.
>
> 4. Water moving along aquifers in Tertiary and Quaternary volcanic- or sedimentary-filled basins.

Thermal springs in the study area occur in all settings except number 3, faults in pre-Tertiary sedimentary rocks. Below is a description of the geological setting in each of the drainage basins (from Ross 1970). See also Appendix 1, which contains CDC occurrence records for thermal springs aquatic communities in the study area that contain information on the underlying geology of each spring.

<u>South Fork Boise River</u>

All the springs in this area are in granitic rock, much of which is cut by mafic and pegmatitic dikes. The rocks surrounding Worswick Hot Spring, which is one of the largest in the study area, is brecciated, bleached, and silicified, and is probably at the intersection of several fault zones.

<u>Camas Prairie/Bennett Hills</u>

The Camas Prairie is an alluvial-filled graben bounded on the north by Cretaceous granitic rocks, and the south by Tertiary silicic volcanic rocks. Thermal springs emanate from all three geological settings. Springs on the Camas Prairie that arise in alluvium are thought to have their heat source as steam or hot water rising from depth and diffusing through the sediments. The thermal spring at Hot Springs Landing is in Quaternary basalt.

Big and Little Wood Rivers

Most of the thermal springs in this region arise in pre-Tertiary metamorphic rocks or in alluvium near metamorphic bedrock. Condie Hot Springs, in the Little Wood River drainage, arises in Quaternary basalt.

Salmon River

Many of the springs along the Salmon River, downstream from Stanley, occur along a NE-trending shear zone. Other springs are also along major faults or at the intersection of fault zones. Most springs in this drainage emanate from granitic rocks or from alluvium near granitic bedrock. The springs at West Pass Creek and Bowery are two of the few springs in the study area to originate in silicic volcanic rocks, while Sullivan and Slate Creek hot springs are in pre-Tertiary metamorphic rocks.

CHARACTERISTICS OF THE WATER

Discharge

Spring discharge measurements have been made at most (all?) springs in the study area, many of which are reported in Ross (1970). The Forest Service has recently measured discharge at most of the hot springs on the Sawtooth National Forest, as documentation for filing Federal water claims (later withdrawn) in the Snake River Basin water rights adjudication process. Discharge data for the 37 springs in the study area are shown in Table 2 (see also Appendix 1). Source of the data is primarily Ross (1970) and, secondarily, from Adjudication Claims Summary Reports from the Idaho Department of Water Resources for each Notice of Claim filed by the Forest Service. The Forest Service claim data was generally used to fill gaps in Ross' data, because the amount of flow claimed in a water right does not necessarily correlate to the total discharge from the spring.

Worswick Hot Spring, along Little Smoky Creek in the South Fork Boise River drainage, and Guyer Hot Spring, west of Ketchum in the Big Wood River drainage, have the largest flows in the study area. The flow from Guyer Hot Spring is totally diverted into pipes at the source. Worswick Hot Spring emanates from more than a dozen sources over about a 10-acre area, having a combined flow of over 1 cfs (Ross 1970). Several hot springs in the study area have flows of less than 0.1 cfs (Table 2). There are several small geothermal seeps below high water line along the Salmon River whose discharge has probably not been measured.

Table 2. Water discharge, temperature and selected chemistry attributes from 37 hot springs in south-central Idaho (cfs = cubic feet per second).

Hot Spring	Discharge (cfs)	Temperature (°C)	pH	Conductivity (*u*mhos/l)
Willow Creek	0.286	35-53	9.5	221
Baumgartner	0.22	38-50	9.1	258
Lightfoot Bar	0.078	43-63	9.1	343
Skillern	0.471	54	9.4	285
Bluff Creek - Upstream	0.02	26-36	9.4	316
Bluff Creek - Downstream	----	40	9.3	289
Preis	0.02	41	9.6	344
Worswick	1.1	51-86.5	9.0	334
Dry Creek	0.37	----	----	----
Hot Springs Landing	0.3	74.5	6.6	1440
Elk Creek	----	54	9.0	424
Wardrop	0.2	65	9.3	249
Barron Spring	0.23	69	8.0	486
Cow Creek	----	----	----	----
Condie	0.4-0.8	44-52	7.3	607
Huff Creek	0.14	27-42	7.0	578
Hailey	1.35	60	9.6	326
Clarendon	0.13	50	9.1	387
Frenchman's Bend	0.2	58.5	9.1	324
Guyer (Bald Mountain)	1.0-4.0	70.5	8.8	410
Easley	0.05-1.7	37	9.6	334
Russian John	0.02-0.076	32-39	9.2	324
Pierson Spring	0.7	42-49	9.3	243
Rocky Mountain Ranch	0.8	41-47	9.4	277
Stanley	0.13	34-41	8.8	273
Upper Elkhorn	----	56-59	9.4	326
Lower Elkhorn	----	55-57	9.1	430
Mormon Bend	----	55	9.2	382
Basin Creek Campground	0.29	59	8.8	304
Kem	0.02	56.5	9.5	343
Sunbeam	0.864	76	9.0	394
Robinson Bar	0.02-0.15	56	9.4	351
Slate Creek	0.43	50	8.6	443
Torreys	----	32	9.3	381
Sullivan	----	40	6.9	1030
West Pass Creek	0.2	52	8.5	643
Bowery	0.7	43-52	8.5	562

Temperature

Water temperatures from the spring sources have been reported for most geothermal sites in the study area by Ross (1970) and Parliman and Young (1992). I also collected temperature data from all springs visited in 1995. These temperatures are shown in Table 2 (see also Appendix 1). A range is given for sites with multiple sources having different temperatures. Temperatures range from 26ºC (79ºF) for one of the sources at Bluff Creek - Upstream to 86.5ºC (188ºF) for several of the sources at Worswick Hot Springs. The Dry Creek spring, in the Bennett Hills was not measured, but is probably the coolest geothermal feature in the study area. The mean temperature of all measured springs in the study area is 53.5ºC (128.3ºF), while the median (50%) temperature is 52ºC (125.6ºF). Parliman and Young (1992) summarized the same metrics for 1120 geothermal-spring and well samples in Idaho, between 1921 and 1991, as follows: range = 8.5ºC (47.3ºF) to 95ºC (203ºF); mean = 40.5ºC (113ºF) and; median = 37.0ºC (98.6ºF).

Most geothermal springs in the study area fall near the middle of the range reported above, with 18 being between 47ºC (116.6ºF) and 60ºC (140ºF). Only four springs are greater than 70ºC (158ºF), Guyer, Hot Springs Landing, Sunbeam, and Worswick. Worswick Hot Spring is exceptional, being 10ºC (21ºF) hotter than the second hottest spring, Sunbeam Hot Spring.

Chemistry

Selected water chemistry data from most geothermal springs in the study area are reported by Ross (1970) and Parliman and Young (1992), the latter source reporting up to 23 different water chemistry attributes for each sample. I also measured pH, conductivity, and alkalinity at all springs visited in 1995. Specific conductance and the pH of all springs measured in the study area are shown in Table 2 (see also Appendix 1).

Characterization of water chemistry is important because the distribution of plants and animals in aquatic systems change markedly with even subtle changes in water chemistry attributes. A description of water chemistry, therefore, must be an essential part of an ecological characterization of an aquatic community (Cowardin *et al.* 1979). The two key water chemistry characteristics are salinity and hydrogen-ion concentration. Conductivity is an expression of salinity (Rabe and Chadde 1994), and is a measure of the number of charged ions in the water (*e.g.*, Ca^{2+}, Na^{+}, $SO4^{2-}$), or, put another way, it is a measure of total dissolved solids. Soft water has low conductivity, whereas, hard water has high conductivity. It has been claimed that the richer the body of water in charged ions, the higher the biological activity (Welch 1952; Goldman and Horne 1983).

Hydrogen ion concentration is expressed as pH. pH values of the 35 springs for which this attribute was measured, range from 6.6 at Hot Springs Landing, to 9.6 at Preis Hot Spring, Hailey Hot Spring and Easley Hot Spring (Table 2). The average pH of all samples is 8.9, while the median value is 9.1. For comparison to the state as a whole, in analysis of pH values from 1058 geothermal samples from Idaho, the range was 4.6 to 10.2 and the average and median were 8.3 (Parliman and Young 1992). Cowardin *et al.* (1979) define waters having a pH between 5.5 and 7.4 as circumneutral and those with pH greater than 7.4 as alkaline. Rabe *et al.* (1994) add a highly alkaline class to their classification for waters with pH greater than 8.4. Following the classification of Rabe *et al*. (1994), most springs in the study area are highly alkaline (30), with only four springs being circumneutral and one being alkaline.

Specific conductance of the 35 springs measured, range from 221 micromhos at Willow Creek Hot Spring to 1440 micromhos at Hot Springs Landing (Table 2). The average conductance of all samples is 418 micromhos, while the median value is 343 micromhos. Parliman and Young's (1992) analysis 1155 samples from Idaho hot springs revealed a range from 100 to 28,000 (!) micromhos, an average of 689 micromhos, and a median of 388 micromhos. By comparison, samples from the study area have lower dissolved solids than the hot springs in the rest of the state. Rabe and Chadde (1994) follow the aquatic classification of Stewart and Kantrud (1972), where waters with conductance of less that 500 micromhos are defined as fresh, 500-2000 micromhos are slightly brackish, 2000-5000 micromhos are moderately brackish, 5000-15,000 micromhos are brackish, and 15,000-45,000 micromhos are saline. Hot Springs Landing and Sullivan Hot Springs have the highest conductivities in the study area, nearly 400 micromhos greater than the next nearest reading at West Pass Creek. These two springs also have the two lowest pH values.

Savage and Rabe (1979) developed a classification of aquatic communities in Idaho to compliment the classifications being developed for terrestrial systems. Rabe *et al*. (1994) later modified that portion of the original classification dealing with meandering glide and spring streams into a hierarchial system. Although originally developed for cold water streams, the modified classification is applicable to geothermal springs. Table 3 shows the hierarchial classification of the 35 springs in the study for which water chemistry data has been collected. Chemistry data has not been collected for Cow Creek, which is in the Broad Valley landform class and Dry Creek, in the Narrow Valley class.

MICROBIAL COMMUNITIES

The wealth of biological diversity contained in microbial communities of hot springs is little understood, or even imagined, by most ecologists and land managers in Idaho. Just as microbial life constitutes much of the biodiversity on the planet, the microbial communities of hot springs comprise enormously diverse systems that are only beginning to be understood. Most of this section will be a review of thermophilic microorganisms, microbial ecology, and the commercial interest in thermostable compounds derived from hot spring organisms. The last part will discuss what we know about microbial communities in Idaho and the study area.

Table 3. Classification of 35 geothermal streams in the study area based on landform and water chemistry (after Rabe *et al*. 1994).

Stream Type	Landform	Chemistry	Geothermal Spring
Spring	*Narrow Valley*	*Circumneutral*	Sullivan
		Highly Alkaline	Willow Creek
			Baumgartner
			Lightfoot Bar
			Skillern
			Bluff Creek - Upstream
			Bluff Creek - Downstream
			Preis
			Worswick
			Elk Creek
			Hailey
			Clarendon
			Frenchman's Bend
			Guyer
			Easley
			Russian John
			Pierson Spring
			Rock Mountain Ranch
			Stanley
			Upper Elkhorn
			Lower Elkhorn
			Mormon Bend
			Basin Creek Campground
			Kem
			Sunbeam
			Robinson Bar
			Slate Creek
			Torrey's
			West Pass Creek
			Bowery
	Broad Valley	*Circumneutral*	Hot Springs Landing
			Condie
			Huff Creek
		Alkaline	Barron Spring
		Highly Alkaline	Wardrop

Thermophilic Microorganisms

Considerable progress has been made during the last 20 years in our understanding of the relationship of life on earth. For many years life was classified into five Kingdoms: Animals, Plants, Fungi, Protists, and Monera (a system still taught in most biology classes). Recent advances in molecular biology have allowed scientists to formulate a new classification of life based on genetic relationships. All life is now considered to fall into three primary groupings, or domains (Woese 1994) - the Bacteria (Monera, in part), the Archaea (also part of the old Monera), and the Eucarya (includes Animals, Plants, Fungi, and Protists of the old classification). The members within each domain share many common molecular characteristics, making, as Carl Woese (1994) put it, "each of the three as distinct an entity for the biologist, as elephants, ants, and flowers are for the layman." It is the Bacterial and Archaeal domains that comprise thermophilic microorganisms. In fact, initially the Archaea were thought to be confined to high temperature systems, although recent discoveries have found them to be more widespread. Cynanobacteria (previously called blue-green algae) are the most common of the Bacteria in hot springs.

The classification, identification, and cataloging of microbial diversity has also made enormous progress in the last 10-15 years, and these new methods have been applied specifically to hot spring environments (Pace *et al*. 1995). Traditional microbial taxonomy requires that the organism be isolated, cultured in a laboratory, and described and classified based on morphological features, similar to macrotaxonomy. The problem with this method is that not every organism can be cultured in an enriched medium in a laboratory, and it is likely that the species that can be cultured only represent a small sampling of the diversity of life at high temperatures. In fact, Norman Pace estimates that only 0.001-0.1 percent of naturally occurring microorganisms are cultivatable with standard techniques (Pace *et al*. 1995).

Molecular phylogenetic techniques have been devised to detect and characterize microbial organisms in mixed, naturally occurring populations, without the requirement for cultivation. These techniques are quicker, easier, and more inclusive than culture techniques (Woese 1994). They utilize ribosomal RNA (rRNA) gene cloning and sequencing, the results of which are analyzed phylogeneticaly using the Ribosomal Database Project collection of >2000 sequences (Pace *et al*. 1995). Organisms described and cataloged in this way are called phylotypes or sequence types, terms that are more or less equivalent to species, which is the term I will use throughout the discussion. These techniques may eventually be used to answer basic biogeographic questions about distributions of species and levels of endemism in thermophilic microorganisms (Castenholz 1995).

A recent example of this technique is the analysis of the often studied, but never cultivated, "pink filaments" from Yellowstone National Park's Octopus Spring outflow, which revealed several novel species. The dominant filament, dubbed EM 17, is a relative of *Aquifex pyrophilus*, described from a marine hot spring off Iceland (Reysenbach *et al*. 1994). Although showing enormous potential for the future, these new techniques are not widely available and no hot springs in Idaho have been censused in this manner.

Microbial Communities

Characterization of the composition and structure of microbial communities is in its formative stages, as compared to macroecology, while ecosystem functions and processes are probably better studied (David Ward, Montana State University, Bozeman, personal communication, 1995). The functional aspects of microbial systems, including physiology and productivity have been well reviewed (Castenholz 1969; Brock 1970; 1978). Much emphasis was given in these early papers to the upper temperature limit of life, which was known to be greater than 95ºC (203ºF) for bacteria. Recent studies of microorganisms from sea-floor thermal vents on the Mid-Atlantic Ridge put the optimal temperature for growth of an Archaeal species at 107ºC (225ºF) and the maximum temperature for survival at 113ºC (235ºF; Huber *et al*. 1995). The upper temperature limit for photosynthetic organisms is 70-73ºC (158-163ºF; Castenholz 1969; Ward *et al*. 1987). Above this temperature, microorganisms reduce hydrogen, sulfur, or other ions for energy.

Recent work has begun on characterizing the composition and structure of hot spring communities. Although none have taken place in Idaho, following are several examples from Yellowstone National Park, Wyoming, that highlight the potential for assessing microbial biodiversity in hot springs of the state. All of these examples are from pH and temperature ranges that are similar to Idaho hot springs. At the upper temperature limit, Reysenbach *et al*. (1994) sampled a bacterial community at 84-88ºC (183--180ºF) and identified three species, EM 3, EM 17, and EM 19. Structurally, they found the community to be dominated by EM 17. Also using phylogenetic analysis, Barns *et al.* (1994) identified 98 species from a sample of 74ºC-(165ºF-)sediment from another pool in Yellowstone. This analysis revealed a previously unknown Kingdom of Archaea (Barns *et al*. 1995).

In many cases, microbial communities are found as laminated cyanobacterial mats up to a few centimeters thick. Species are distributed in these mats along both vertical and horizontal (thermal) gradients (Peary and Castenholz 1964; Castenholz 1969; Ward *et al*. 1987). Ward *et al.* (1987) and Ferris *et al.* (1995) studied a cyanobacterial mat occurring at 55ºC (131ºF) using both the traditional enrichment culture and molecular phylogenetic techniques. The enrichment cultures yielded 11 species, while the rRNA sequencing yielded 45 species from the same mat. This compares to only 30 species, known largely through culturing, from Yellowstone National Park as a whole (Lindstrom 1995). The rapid expansion of collections and rRNA-sequencing assays of microorganisms from extreme environments indicates that the biosphere is far more diverse than biologists previously thought (Adams *et al*. 1995).

Disturbance of Microbial Communities

Few studies have looked at the effect of disturbance on microbial communities. Brock and Brock (1969) studied a Yellowstone hot spring in which a severe hail storm destroyed the cyanobacterial mats along a significant portion of the thermal gradient. In terms of species composition, the mat appeared to completely recover within six months. Recovery of the structural attributes of microbial mats are still unknown (David Ward, Montana State University, personal communication, 1995). On a smaller scale, Brock and Brock (1969) observed that mats partially destroyed by elk and buffalo trampling also quickly recover.

Peary and Castenholz (1964) found that different strains or ecotypes (or possibly species) of the cyanobacteria *Synechococcus* occur in different parts of the thermal gradient of a hot spring effluent channel. If any portion of the thermal gradient is disrupted, such as by diversion, at least a portion of the microbial diversity at a hot spring can be lost. It appears, however, that if the hydrological and chemical features of the springs remain intact, the biological components can quickly restore themselves (Brock and Brock 1969).

Commercial Interest in Thermophiles

An interesting story has been unfolding during the last decade that involves the commercial use of compounds found in microbial thermophiles and whether or not the public, through a governmental agency, should gain any monetary benefits from the commercial use of biological compounds derived from publicly protected areas. The story involves the hot springs in Yellowstone National Park, the microorganism *Thermus aquaticus*, the thermostable enzyme Taq polymerase, and $300 million.

Numerous popular and technical articles have been written recently concerning bioprospecting for commercially useful products in "extremophiles", in general (*e.g.*, Clark and Kelly 1990; Adams *et al*. 1995; Broad 1995; Hassler 1995), and the Yellowstone-Taq story, in particular (*e.g.*, Guyer and Koshland 1989; Varley 1993; Miller 1994; Robbins 1994; Milstein 1995; National Science and Technology Council 1995).

The Yellowstone-Taq story is worth repeating because it involves hot springs close to Idaho and has implications for land managers. The following summary is taken from many of the above articles, as well as other sources. In 1966, Thomas Brock discovered, and later described, the bacterium *Thermus aquaticus* in Mushroom Pool in Yellowstone's Lower Geyser Basin. He submitted a culture of the bacteria to the national storehouse of such organisms, the American Type Culture Collection, where, in 1983, researchers from Cetus Corporation screened *T. aquaticus* for thermostable enzymes that would speed DNA replication in the laboratory. This replication method, Polymerase Chain Reaction or PCR, had been developed some years earlier but was a very slow process because the original enzyme catalysts broke down upon heating. The isolation of Taq (short for *T. aquaticus*) polymerase, which evolved at 79°C (176°F), revolutionized PCR by facilitating the replication of huge amounts of DNA from very small samples, as little as a few cells. PCR, in turn, has developed into one of the most powerful tools in modern biology. PCR is now used in a wide variety of biological, medical and criminal applications that have an immense benefit to society, including DNA fingerprinting, disease diagnosis, matching transplant organs to recipients, resolution of paternity, evolutionary biology, gene sequencing, and many more. Taq was named the first "Molecule of the Year" in 1989 by the journal *Science* and the developers of PCR won the Nobel Prize for Chemistry in 1993.

What makes this story even more interesting is that in 1991 Cetus patented PCR, then sold the rights to the giant Swiss pharmaceutical company Hoffmann-LaRoche for $300 million, from which it now makes an estimated $100 million a year. Taq is one of the premier examples of the ability to generate wealth from biodiversity at the level of the molecule. Needless to say, there is now tremendous interest within the biotechnology industry in screening extremophiles for potential commercial applications. Of the 225 free research collecting permits issued by Yellowstone National Park in 1995, 30 were for microbial collections, and many of those were issued to commercial parties. Many of these bioprospectors are drawn to Yellowstone because the geothermal features have not been disturbed and the full compliment of microbial diversity is intact. Other major geothermal fields in the world, such as in New Zealand, Italy, and Iceland, have been entirely exploited, which lessens their usefulness for bioprospecting (Eric Mathur, Recombinant BioCatalysis Inc, LaJolla, CA, personal communication, 1995).

There is now a debate underway on whether the public should benefit monetarily from the commercial use of microbial resources that have been protected in Yellowstone. Or, are the immense benefits society derives from exploitation of these thermostable compounds enough of a pay back? This was the central issue of a three-day conference on Yellowstone thermophiles that was recently held at Old Faithful. Officials at Yellowstone National Park are now reviewing patent law to see what role, if any, the government should play, beyond the free research collecting permits now issued by the park.

<u>Microbial Communities in Idaho Hot Springs</u>

The microbial communities of Idaho hot springs have not been well studied. The few that I know of are described below.

In 1993, Sarah Walker, Clearwater National Forest, collected cyanobacterial samples from Stanley Hot Spring, in the Lochsa River drainage. Two species, *Phoridium laminosum* and *Mastigocladus laminosus*, were identified from this 48°C (118°F) spring by Richard Castenholz, University of Oregon. Both species are found in hot springs worldwide, below temperatures of about 58°C (136°F). Other studies have apparently taken place at Jerry Johnson Hot Springs, also in the Lochsa drainage, by a researcher from the University of Montana (S. Walker, personnel communication, October 1995).

In southeastern Idaho, Jeff Braman, Stratagene Inc., collected a cyanobacterium from Squaw Springs, along the Bear River near Preston, from which he and coworkers isolated a DNA polymerase, a nucleic acid modifying enzyme (J. Braman, Stratagene Inc., LaJolla, CA, personal communication, 1995). They are now evaluating the biotechnological applications of this thermostable compound (Braman *et al*. 1995).

I collected microbial samples from two hot springs in the study area, Worswick and Skillern. Three samples at each site were sent to Richard Castenholz for assessment. The sampling sites were as follows:

Worswick Hot Spring

Sample 1	Taken from the source spring, temperature 81ºC (179ºF); white filamentous and thin pink mat. This sample is from water hotter than photosynthetic species can survive.
Sample 2	From ca. 5 m below one of the sources, temperature 53ºC (127ºF); greenish filamentous material in running water and thin orange mat in quiet area adjacent to channel.
Sample 3	3 m below source spring, temperature 53ºC (127ºF); 1 cm thick mat sitting on gravel in quiet "eddy" of stream (entire mat 30 x 17 cm).

Skillern Hot Spring

Sample 1	Taken ca. 2 m below source, temperature 54.5ºC (130ºF); orange material clinging tightly to gravel and pink-orange filamentous material in swift current of channel center.
Sample 2	From rocky bench ca. 2 m below source, temperature 51ºC (124ºF); thin orange mat on gravel in swift portion of channel.
Sample 3	Taken ca. 10 m below source, temperature 48ºC (118ºF); thick mat on steep rocky face (ca 45º slope) covered with flowing water.

As of mid-December, 1995, the specimens sent to the University of Oregon remain unidentified.

INVERTEBRATE ANIMALS

Invertebrate communities of hot springs are well-studied in the United States (Robinson and Turner 1975), especially in the west, where Brues (1924; 1928; 1932) prepared an extensive catalog of animals in thermal springs. The invertebrate animals Brues (1932) identified in samples from the nine Idaho hot springs listed below are shown in Table 4.

1. Heise Hot Spring, Bonneville County
2. White Arrow Hot Spring, Gooding County
3 & 4. 8 miles NE of Mountain Home, Elmore County (2 springs)
5. Indian Spring, Power County
6. Lava Hot Spring, Bannock County
7 & 8. Cleveland (N of Preston), Franklin County (2 springs)
9. Wayland Hot Spring, Franklin County

Apparently, no collections were made at Heise Hot Spring because it was too badly disturbed by resort development. The upper temperature limit for any of his Idaho collections was 42°C (108°F) for several taxa at Mountain Home and Cleveland hot springs. Wickstrom and Castenholz (1973) found that an ostracod (seed shrimp) from a hot spring in Oregon survived temperatures as high as 55°C (131°F) for short incubation periods, the highest reported temperature tolerance of any aquatic invertebrate.

Table 4. Invertebrates collected by Brues (1932) at hot springs in Idaho (taxonomy is taken directly from Brues (1932) and may not be current).

Species	Hot Spring	Temperature (°C)	pH
CRUSTACEA			
OSTRACODA			
Cypridae			
Cyprinotus sp. nov.?	Indian Spring	32.5	8.4
Chlamydotheca bruesi Blake	Cleveland	42.0	8.5
ISOPODA			
Thermacaridae			
Thermacarus nevadensis Marshall	Cleveland	39.1	8.1
INSECTA			
ODONATA			
Coenagriidae			
Argia sp.	Indian Spring	32.5	8.4
DIPTERA			
Chironomidae			
Orthocladus sp.	Indian Spring	32.5	8.4
Stratiomyiidae			
Stratiomyia sp. 1	Cleveland	39.1	7.5
Stratiomyia sp. 3	Cleveland	38.0	7.5
Odontomyia sp. 3	Cleveland	39.1	7.5
Odontomyia sp. 5	Cleveland	39.1	7.5
Oxycera sp.	Cleveland	39.1	7.5
	Cleveland	36.7	8.1
Ephydridae	Wayland	36.0	8.0
COLEOPTERA			
Haliplidae			
Bidessus affinis Say.	Wayland	36.0	8.0
Agabus griseipennis Lec.	Mt. Home	42.4	9.6+

Table 4. Continued.

Species	Hot Spring	Temperature (°C)	pH
Hydrophilidae			
Helophorus lineatus Say.	Wayland	36.0	8.0
	Cleveland	28.2	7.5
Tropisternus californicus Lec.	White Arrow	41.0	8.6
	Cleveland	28.2	7.5
Tropisternus sublaevis Lec.	White Arrow	41.0	8.6
	Mt. Home	42.4	9.6+
Tropisternus sp. (larvae)	Cleveland	41.2	7.5
Paraymus subcuperus Say.	White Arrow	39.0	8.6
	Mt. Home	35.5	9.6+
	Cleveland	28.2	7.5
Enochrus conjunctus Fall.	Cleveland	28.2	7.5
Enochrus nebulosus Say.	Cleveland	28.2	7.5
	Mt. Home	35.5	9.6+
Laccobius agitis .	Cleveland	39.1	8.1
Heteroceridae			
Heterocerus sp.	Cleveland	41.2	7.5
	Wayland	36.0	8.0
Dytiscidae			
Laccophilus sp.	Cleveland	38.0	7.5
MOLLUSCA			
Parapholigidae			
Physa propinqua Tryon	Lava H. Spr.	40.0	---
Physa spp.	Cleveland	---	---

While studying possible development scenarios at Worswick Hot Spring, specialists from Beck and Baird collected insects in the area (Baird 1991). They found nothing peculiar, but the species list is currently unavailable (Dan Baird, Beck and Baird, Boise, ID, personal communication, 1995).

I sampled aquatic invertebrates in the channels below three hot springs in the study area, Lightfoot Bar, Huff Creek, and Slate Creek. This sampling was very preliminary. Please refer to Brues' more extensive list in Table 4 for a better view of possible invertebrate diversity of hot springs in the study area. Samples were identified by the Idaho Department of Health and Welfare, Bureau of Laboratories, Boise. The results appear in Table 5.

Table 5. Invertebrates collected at three hot springs in south-central Idaho in 1995.

Species	Hot Spring	Temperature (°C)	pH
[identifications pending]			

There is a moderately thermophilic amoeboid protozoan that should be of particular interest to land managers because of its potential as a human pathogen. Members of the genus *Naegleria* are single-celled organisms that have internal bacteria acting as symbionts or commenseals (Pennak 1978). At least three species, *N. fowleri, N. australiensis,* and *N. luminensis*, inhabit moderately hot water [ca. 37°C (99°F)] in the Yellowstone region. This motile organism can enter the human body through an orifice, usually the nose, where it causes amoebic meningitis. Basically, it digests the brain. Surveys in the Yellowstone region have identified high levels of *Naegleria* at several hot springs. Many springs have been posted by the Park Service to prevent human exposure, and one commercially-developed site in Grand Teton National Park, Huckleberry Hot Springs, has been closed due to consistently high levels of the protozoan (Ramaley and O'Dell 1995).

Another troublesome invertebrate, this time an arachnid, has been reported from hot springs in Idaho. Vulcan Hot Spring along the South Fork Salmon River, Boise National Forest, is said to contain a biting mite. Apparently those familiar with the hot spring dump chlorine bleach in the spring before soaking to kill them off (Michelle McCammon, Boise National Forest, personal communication, 1995). This mite may be present in other hot springs of central Idaho as well.

FLORA

Aside from the inventories conducted for the thermophilic rare plant, *Epipactis gigantea*, no floristic surveys have been place that specifically catalog the flora of thermally-influenced wetlands in Idaho. The following sections provide such a catalog, as well as a discussion of the distribution and conservation status of three rare species found in the study area. Hitchcock and Cronquist (1973) is used as the reference for plant nomenclature, except algae, which follows Prescott (1978). All plant collections are deposited at the University of Idaho Herbarium.

Wetland Flora Associated with Hot Springs

Table 6 provides a catalog of plant species found at the 25 hot springs that I inventoried in the study area during 1994 and 1995. Only those species occurring in thermally-influenced wetlands around the springs were included in the survey. Excluded were species associated with cold water of nearby riparian zones. The table is divided into major plant groups, and then arranged alphabetically by family.

Table 6. Wetland flora of hot springs in the study area. Numbers in the hot spring distribution column refer to CDC occurrence numbers from Table 1. Non-native species are designated with an "*" and herbarium collections are designated with RKM.

Species	Hot Springs
GREEN ALGAE	
Characeae	
Chara sp.	074, 092, 093
PTERIDOPHYTES	
Equisetaceae	
Equisetum arvense	002, 066
Equisetum laevigatum	068
CONIFERS	
Pinaceae	
Pinus contorta	081
DICOTS	
Apiaceae	
Berula erecta	074
Cicuta douglasii RKM	051, 068, 069
Sphenosciadium capitellatum	067

Table 6. Continued.

Species	Hot Springs
Apocynaceae	
Apocynum cannabinum	002
Asclepiadaceae	
Asclepias speciosa	074
Asteraceae	
Achillea millefolium	064, 086
Aster chilensis RKM	008, 051, 064, 065, 066, 067, 068, 069, 070, 080, 081, 083, 084, 086, 087, 088, 090, 092, 093
Aster eatonii RKM	074, 092, 093
*Cirsium arvense**	068
*Cirsium vulgare**	008, 064, 066, 067, 068, 069, 070, 081, 086, 090, 092, 093
Conyza canadensis var. *glabrata* RKM	008, 064, 065, 066, 067, 068, 069, 070, 087, 088, 090, 093
Helianthus annuus	074
Helianthus nuttallii	074
Helianthus petiolaris RKM	051, 064, 067
*Lactuca serriola**	065, 066, 067, 069
Matricaria matricarioides	088/
Senecio pseudaureus	067, 069, 081, 084, 086, 092, 093
Solidago canadensis RKM	067, 068, 069, 070, 074, 081, 084, 086, 093
*Taraxacum officinale**	064
Betulaceae	
Alnus incana	002, 065, 067, 070
Brassicaceae	
*Rorippa nasturtium-aquaticum**	071, 083, 090
Caryophyllaceae	
Cerastium arvense	066, 070, 086, 087
Cornaceae	
Cornus stolonifera	074
Euphorbiaceae	
Euphorbia serpyllifolia RKM	064, 068, 070
Fabaceae	
Astragalus canadensis	093
Trifolium longipes	068, 070

Table 6. Continued.

Species	Hot Springs
*Trifolium pratense**	088
*Trifolium repens**	064, 086, 088, 090
Gentianaceae	
Gentiana affinis	084, 093
Lamiaceae	
Mentha arvense	051, 064, 067, 068, 083, 086, 092, 093
Mentha spicata RKM	064
Prunella vulgaris var. *lanceolata*	070
Lentibulariaceae	
Utricularia vulgare	083
Onagraceae	
Epilobium palustre	093
Epilobium watsonii var. *occidentale* RKM	064, 066, 067, 068, 069, 070, 074, 081, 083, 086,090, 092, 093
Oenothera hookeri	051, 066, 067, 068, 069, 070, 092, 093
Plantaginaceae	
*Plantago lanceolata**	064, 068, 070
Plantago major var. *major**	002, 064, 067, 068, 069, 070, 081, 086, 088, 090, 092
Polemoniaceae	
Polemonium occidentale	069
Polygonaceae	
*Rumex acetosella**	070
*Rumex crispus**	008, 064, 067, 068, 070, 074, 083, 090
Primulaceae	
*Anagallis arvensis**	064
Primula incana	093
Ranunculaceae	
Ranunculus cymbalaria	008, 068, 074, 081, 092, 093
Rosaceae	
Geum macrophyllum	064, 066, 086
Potentilla anserina	074
Potentilla gracilis	064, 086, 093
Potentilla fruticosa	064, 081, 084, 093
Rosa woodsii	067, 074

Table 6. Continued.

Species	Hot Springs
Salicaceae	
Salix geyeriana	074, 093
Salix lasiandra	071
Salix lutea	071
Saxifragaceae	
Parnassia palustris	093
Scrophulariaceae	
Castilleja exilis	074
Castilleja miniata	067
Mimulus guttatus RKM	008, 051, 064, 065, 066, 067, 068, 069, 070, 074, 080, 081, 083, 086, 087, 090, 093
*Verbascum thapsus**	064, 065, 066, 067, 069, 086
Veronica americana	051, 066, 074
Valerianaceae	
Valeriana edulis	084
Violaceae	
Viola sp.	008, 064, 065, 066, 067, 068, 081, 084, 086, 092, 093
MONOCOTS	
Cyperaceae	
Carex aurea	064, 067
Carex cusickii RKM	051, 067, 069, 081, 083, 086
Carex lanuginosa	008, 051, 067, 070, 081, 084, 093
Carex nebrascensis RKM	064, 067, 068, 069, 070, 074, 080, 081, 083, 084, 086, 093
Carex oederi	067
Carex praegracilis RKM	065, 067, 068, 069
Carex utriculata (syn. *C. rostrata*)	069, 084
Carex simulata	080, 081, 083, 086, 092
Carex stipata	070
Eleocharis palustris	051, 071, 093
Eleocharis pauciflora	065, 066, 070, 081, 083, 084, 086, 093
Eleocharis rostellata RKM	008, 064, 067, 068, 069, 074, 080, 092, 093
Scirpus acutus	084, 093
Scirpus americanus RKM	051, 068, 074, 081, 084, 092, 093
Scirpus microcarpus	051, 068, 070

Table 6. Continued.

Species	Hot Springs
Iridaceae	
Sisyrinchium angustifolium	067, 081, 092, 093
Juncaceae	
Juncus balticus	002, 064, 068, 069, 084, 092, 093
Juncus bufonius	068, 070
Juncus ensifolius	008, 051, 064, 065, 066, 067, 068, 070, 080, 081, 083, 084, 086, 093
Juncus tenuis RKM	008, 064, 065, 066, 067, 068, 069, 070, 086, 093
Juncus torreyi	074
Juncaginaceae	
Triglochin maritima RKM	092, 092, 093
Triglochin palustre	081, 092
Lemnaceae	
Lemna minor	068
Liliaceae	
Smilacina racemosa	086
Smilacina stellata	093
Orchidaceae	
Epipactis gigantea	051, 067
Habenaria dilatata	051, 067, 069, 070
Spiranthes romanzoffiana	064, 067, 083, 084, 093
Poaceae	
Agropyron sp? (rhizomatous w/ awns)	083, 086, 092, 093
Agrostis scabra	008, 064, 067, 069, 074, 081, 083, 084, 086, 090, 092, 093
*Agrostis alba** RKM	002, 008, 051, 064, 066, 067, 068, 069, 070, 074, 081, 083, 084, 086, 090, 092, 093
Alopecurus aequalis	066
Calamagrostis canadensis	093
Calamagrostis neglecta	069, 074, 080, 081, 084, 092, 093
Deschampsia cespitosa	064, 067, 080, 081, 088
*Echinochloa crusgalli** RKM	008, 064, 067
Elymus glaucus	081
Glyceria grandis	064, 066, 067, 068, 070, 074, 086
Hordeum brachyantherum	002, 074

Table 6. Continued.

Species	Hot Springs
Muhlenbergia andina RKM	051, 067, 084, 092, 093
Muhlenbergia asperifolia RKM	092
Muhlenbergia richardsonis RKM	008, 051, 064, 065, 066, 067, 068, 070, 080, 081, 083, 084, 086, 090, 092, 093
Panicum occidentale	008, 051, 064, 065, 067, 068, 070, 074, 083, 088
Phalaris arundinacea	074
*Phleum pratense**	067, 068, 069, 070, 081, 084, 086, 090, 093
*Polypogon monspeliensis**	074
*Poa compressa**	066, 067
*Poa pratense**	002, 066, 067, 070, 084, 087, 092, 093
Potamogetonaceae	
Potamogeton filiformis	074
Typhaceae	
Typha latifolia	070

The flora is comprised of 115 species in 38 families. A similar number was reported from the vicinity of 13 hot springs in Nevada by Freeman and Mahoney (1977), however, their study included many upland species, so is not directly comparable. Three species are considered rare in Idaho, *Epipactis gigantea, Epilobium palustre*, and *Primula incana*, which are discussed in the next section. The grass family (Poaceae) is the largest family, containing 20 species, followed by the sedge family (Cyperaceae) with 15 species, and aster family (Asteraceae) with 14 species. *Carex* (sedge) is the largest genus with nine species. The most widespread species is *Aster chilensis*, occurring at 19 of the 25 springs (76%) floristicly sampled. Other widespread species include *Mimulus guttatus* and *Agrostis alba*, both occurring at 17 sites (68%), and *Muhlenbergia richardsonis*, occurring at 16 sites (64%). Nineteen species (17% of the flora) are non-native and, for the most part, they are uncommon. Four species are widely distributed, however, although none are community dominates in the thermally-influenced wetlands studied: *Agrostis alba* (17 sites or 68%), Cirsium vulgare (12 sites or 48%), *Plantago major* (11 sites or 44%), and *Phleum pratense* (9 sites or 36%).

Wetlands surrounding Skillern and Bowery hot springs are the most floristicly diverse, each having 43 species. This compares with only 34 species at Worswick Hot Spring, which is the spring with the most extensive thermally-influenced wetlands. While not as species-rich, Huff Creek is extraordinary in the study area by having nine native species that were only found at this spring: *Berula erecta, Asclepias speciosa, Helianthus annuus, H. nuttallii, Cornus* *stolonifera, Castilleja exilis, Phalaris arundinacea, Potamogeton filiformis,* and *Potentilla anserina*.

Rare Species

Three rare species were found associated with thermally-influenced wetlands in the study area, *Epipactis gigantea, Epilobium palustre*, and *Primula incana* (Conservation Data Center 1994). Populations of *Epipactis gigantea* occur at two springs in the South Fork Boise River drainage, Skillern and Baumgartner. The latter two species both occur only at Bowery, in the East Fork Salmon River drainage. Following is a discussion of each species, including information on conservation status, taxonomy, identification, distribution, and management, recommendations. The discussion of *Epipactis gigantea* is a modified version of Mancuso (1991). Discussions of *Epilobium palustre* and *Primula incana* are largely taken from Moseley *et al*. (1991) and also Moseley *et al.* (1994) for the former species.

***Epipactis gigantea* Dougl. ex Hook.**

CURRENT STATUS USFS Region 1- Sensitive Species
USFS Region 4- exSensitive Species
USFWS - None
Idaho Native Plant Society - State Priority 1
Heritage Rank - G4/S3

TAXONOMY

Family: Orchidaceae (Orchid)

Common Name: Giant helleborine

Description: Giant helleborine is a large perennial herb, with leafy stems, 1-3 feet tall from short rhizomes. The leaves are without petioles and up to 8 inches long. The herbage can be rough or mostly smooth to the touch. The numerous flowers are borne singly in a long, narrow, mostly one-sided, leafy-bracted inflorescence at the top of the stems. The brownish flowers have two upper petals that are shorter and broader than the sepals, the lower petal is sac-like (Moseley 1989b).

Distinguishing Features and Similar Species: Its relatively large stature, many long leaves, and many brownish-colored flowers hanging on one side of a long raceme, combine to make giant helleborine a distinctive species when it is in flower. In a vegetative state, giant helleborine can be confused with some members of the orchid genus *Habenaria*, or more likely with *Smilacina stellata*, in the lily family. These species can occur sympatricly with giant helleborine. The prominently clasping leaf bases and taller habit of giant helleborine distinguishes it from *Smilacina*, and its generally more numerous and larger leaves and taller habit from *Habenaria*.

DISTRIBUTION

Range: Giant helleborine occurs from central Mexico northward throughout the western United States and into southern British Columbia. Brunton (1986) notes that its range is entirely within cordilleran areas. In Idaho, giant helleborine has been documented at 53 sites, but is believed to be extirpated from at least two of these. All populations, except two, occur south of the Salmon River, with the majority found in the west-central part of the state. Populations occur at two springs in the study area, as follows (see Appendix 2 for CDC occurrence records for rare plants):

> Baumgartner Hot Springs - CDC occurrence 022; discovered in 1989; Very few stems remaining around downstream spring source - highly impacted by human trampling. Upstream spring source totally developed and diverted.
>
> Skillern Hot Springs - CDC occurrence 053; discovered in 1995. Excellent population. Ramets abundant on seepy cliff faces.

Habitat and Associated species: In general, giant helleborine occurs in moist areas along streambanks, lake margins, seeps and springs, especially near thermal waters (Hitchcock 1969). All mountain populations of giant helleborine in Idaho are associated with hot springs or seeps. It occurs at cold springs in the desert. At Baumgartner, a low-density, highly-impacted population occurs in a narrow zone along the channels below the springs. At Skillern, *E. gigantea* occurs as a dense population covering an extensive area on near vertical and vertical cliff-faces that are kept moist by hot seeps across the face (see Appendix 2 for more specific habitat information).

CONSERVATION STATUS

Conservation Status - Idaho: Giant helleborine was first recognized as a conservation concern in Idaho in the mid-1960's, when it was included on a list of protected plants in the state wildflower protection act (Idaho Code, Chapter 18-3911). In his treatment of giant helleborine for the Idaho rare plant project of the Idaho Natural Areas Council, Henderson (1981) recommended a status of State Threatened, due to numerous and varied threats to its habitat. Giant helleborine is a USFS Region 1 Sensitive Species (USDA Forest Service 1994), and, until recently, was a Region 4 Sensitive Species (Spahr *et al.* 1991). Against the recommendations of most botanists asked to participate, including myself, it was dropped from the recent revision of the Region 4 list.

The Idaho Native Plant Society considers giant helleborine a Priority 1 species (Idaho Native Plant Society 1995). The Priority 1 category of the Idaho Native Plant Society refers to taxa "endangered of becoming extinct in the foreseeable future in Idaho, if factors contributing to their decline or habitat degradation or loss continue". The Idaho Conservation Data Center currently ranks giant helleborine as G4 S3 [G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery, S3 = either very rare and local throughout Idaho, or found locally in a restricted range or because of other factors making it vulnerable to extinction (Conservation Data Center 1994)].

Conservation Status - Elsewhere: *Epipactis gigantea* is considered to be of conservation concern in British Columbia, Montana, Washington, Wyoming, Colorado, Oklahoma and South Dakota.

Threats: Throughout its range, giant helleborine is subject to various current or potential threats. In Idaho, habitat at almost all known sites has been altered, and several populations are known to be extirpated or at critically low numbers. The population at Baumgartner has appeared to decline in abundance between my visits in 1989 and 1995. It is highly impacted by trampling of recreationists. In contrast, the Skillern population is one of the most extensive I've seen in the state and is largely undisturbed due to its steep habitat.

Management Implications: Management objectives at these hot springs should recognize that preserving the integrity of the hot springs habitat is crucial to maintaining the giant helleborine populations present. Active management of recreational use at Baumgartner should be implemented to stem further decline of the species.

***Epilobium palustre* L.**

CURRENT STATUS USFS Region 4 - None
USFS Region 1 - Sensitive
USFWS - None
Idaho Native Plant Society - Priority 2
CDC Rank - G5 S2

TAXONOMY

Family: Onagraceae (Evening-primrose)

Common Name: Swamp willow-weed

Description: Swamp willow-weed has an erect, simple to few-branched stem that is approximately 1 to 1.5 feet tall. Turions (small white bulbs) are present at the lower stem/upper root interface. The flowers are small, generally light pink to white, and are borne on the end of the branches and stem. The leaves are narrow and somewhat revolute (margins rolled downward). The entire plant has a pale appearance due to a fine covering of small, straight, appressed hairs all pointing in the same direction.

Distinguishing Features and Similar Species: Swamp willow-weed is readily distinguished from other willow-weeds occurring in wetlands of the study area by its grayish-strigillose appearance in combination with the presence of turions.

DISTRIBUTION

Range: Swamp willow-weed is distributed from Alaska to the Cascades of central Washington, east to the Atlantic coast and south in the Rockies to Colorado. In the Northern Region of the Forest Service, the Ecosystem Classification Handbook (USDA Forest Service 1987) lists it as occurring in Idaho, Montana, and South Dakota.

In Idaho, swamp willow-weed is now known from 28 occurrences in three, widely disjunct areas: 1) the panhandle in Bonner, Boundary, and Kootenai counties; 2) East Fork of the Salmon River and Chilly Slough in Custer County; and 3) Island Park - Henrys Lake - Teton Basin area in Fremont and Teton counties. In the study area, CDC occurrence 005 (see Appendix 2) occurs at Bowery Hot Spring. The population is limited in extent and contains very few plants.

Habitat and Associated Species: The population at Bowery occurs in an *Eleocharis rostellata* community with a saturated organic substrate (Appendix 2). It is sympatric with another rare species, *Primula incana*.

CONSERVATION STATUS

Conservation Status - Idaho: The rarity of swamp willow-weed in Idaho was recently brought to our attention as a result of floristic studies of Idaho's peatlands by Rob Bursik (1990). Based on his data, swamp willow-weed was recommended for inclusion on the rare plant list for the state at the annual Idaho Rare Plant Conference in 1989. It is currently a Forest Service Sensitive Species in Region 1 for the Idaho Panhandle National Forests (USDA Forest Service 1994). It is Priority 2 species for Idaho (Idaho Native Plant Society 1995). Priority 2 includes those species that are likely to be classified as Priority 1 within the foreseeable future in Idaho, if factors contributing to their population decline or habitat degradation or loss continue. The Idaho CDC currently ranks swamp willow-weed as G5 S2 [G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery; S2 = imperiled in Idaho, because of rarity or because other factors demonstrably make it vulnerable to extinction (Conservation Data Center 1994)].

Threats: No threats were readily apparent to Bowery hot Spring, although the area is open to cattle grazing, which could significantly impact these wetlands if grazed at high intensities.

Management Implications: Current management of the Bowery population appears compatible with its long-term viability. Land managers should be aware of this population and the sympatric *Primula incana*, and give them special consideration when planning development projects in the vicinity.

***Primula incana* Jones**

CURRENT STATUS USFS Region 1 - None
USFS Region 4 - None
USFWS - None
Idaho Native Plant Society - Priority 1
CDC Rank - G4 S1

TAXONOMY

Family: Primulaceae (Primrose)

Common Name: Jones' primrose

Description: Tall slender plants with a basal rosette of elliptic leaves, the blade gradually narrowing to a broadly winged petiole. The scape is naked and terminated by a capitate cluster of from 7-19 lavender flowers. The plant is heavily farinose (covered with a meal-like powder), especially in the young leaves and on the calyx and upper stem.

Distinguishing Features and Similar Species: Jones' primrose is a distinctive species with heavily farinose leaves, tall scape, and flat-tipped bracts subtending tight umbels of small, lavender flowers. Elongation of the scape continues throughout anthesis and pedicels lengthen as seeds ripen. Thus, the characteristic tight umbels do not persist beyond anthesis, and individuals in fruiting stage may be many times taller than those in early flowering stage (Kelso 1991).

The only other lowland, wet-site primrose in the area is *Primula alcalina*, endemic to three meadows in the Birch Creek, Little Lost River, and Lemhi valleys. The habitats of the two species are similar, but they are easily distinguished as follows (from Cholewa and Henderson 1984; Kelso 1991):

> *Primula incana* - Flowers homostylous (anthers at one level in the corolla tube); calyx 5-8 mm long; corolla 5.8-8.2 mm long, lavender; leaves strongly farinose on lower surface, denticulate.
>
> *Primula alcalina* - Flowers distylous (anthers at two levels in the corolla tube); calyx 4-5.7 mm long; corolla 4.3-6.2 mm long, white; leaves not farinose or farinose only on the lower surface when young, entire or denticulate.

DISTRIBUTION

Range: The distribution of Jones' primrose includes Utah and Colorado, north to Alaska in western North America. It is rare throughout the southern porion of its range in the United States, including, Colorado, Idaho, Montana, Utah, and Wyoming (Kelso 1987). In Idaho it is known from only two, widely disjunct areas: the upper East Fork of the Salmon River at Bowery Hot Spring, Custer County, and on private land in Woods Creek Fen, Teton Basin, Teton County.

The Bowery population contains several hundred plants.

Habitat and Associated Species: Throughout its range, Jones' primrose occurs in alkaline clay soil (Kelso 1987). At Bowery Hot Spring, it occurs in an *Eleocharis rostellata* community.

CONSERVATION STATUS

Conservation Status - Idaho: Jones' primrose is a Priority 1 species on the Idaho Native Plant Society's list of rare plants in Idaho (Idaho Native Plant Society 1995). Priority 1 species are in danger of becoming extinct or extirpated from Idaho in the foreseeable future if identifiable factors contributing to its decline continue to operate; these are species whose populations are present only at critically low levels or whose habitats have been degraded or depleted to a significant degree. The Idaho CDC currently ranks Jones' primrose as G4 S1 [G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery; S1 = critically imperiled in Idaho because of extreme rarity or because of some factor of its biology making it especially vulnerable to extinction (Conservation Data Center 1994)].

Conservation Status - Elsewhere: Jones' primrose is very rare in Utah.

Threats: No threats were readily apparent to the Bowery population, although the area is open to cattle grazing, which could significantly impact these wetlands at high levels.

Management Implications: Current management of the Bowery population appears compatible with its long-term viability. Land managers should be aware of this population and the sympatric *Epilobium palustre*, and give them special consideration when planning development projects in the vicinity.

VEGETATION

Few studies have specifically described vegetation of thermally-influenced wetlands. Freeman and Mahoney (1977) sampled vegetation along transects around hot springs in Nevada, only a portion of which was wetland. Mattson (1984) described a "thermally influenced wetland type" from the central plateau in Yellowstone National Park. Because his study area fell outside the large geothermal basins of the park, his type is a heterogeneous mix of minor, mostly graminoid dominance types. Lesica (1990) cataloged wetland communities at hot springs in southwestern Montana, although he did no sampling. As discussed later, the general wetland classifications produced for southern Idaho and vicinity are partially useful in characterizing the vegetation of thermally-influenced areas in south-central Idaho.

At the hot springs visited in 1994 and 1995 (Table 1), I cataloged the wetland associations occurring in the thermally-influenced zone (Table 7; Appendix 1). As with the floristic inventory, I did not include vegetation occurring along streams influenced largely by cold water.

In some cases, the zone influenced by thermal water was very narrow and there was little or no vegetation development, just scattered plants. This occurred at springs that: (1) are below high water along rivers (*e.g.*, Kem Hot Spring and others along the Salmon River), (2) flowed out of bedrock directly into cold water (*e.g.*, Bluff Creek - Downstream), or (3) where trampling by humans (*e.g.*, Upper Elkhorn), livestock (*e.g.*, Dry Creek), or elk (*e.g.*, Bluff Creek - Upstream) eliminated vegetation. At these sites no associations were recorded or, in some cases, continuous stands of vegetation constitute only minor coverage (Table 8).

Table 7. Native plant associations occurring in thermally-influenced wetlands near hot springs in south-central Idaho. Hot springs not visited during 1994-1995 are not included. Codes in plot column refer to ecology plots sampled by Moseley (data on file at the CDC). If column is blank, then no plots were sampled.

Hot Spring	Association	Plot
Willow Creek	*Eleocharis pauciflora*	95RM001
Baumgartner	*Carex cusickii*	95RM002
	Scirpus americanus	
Lightfoot Bar	*Eleocharis rostellata*	95RM003
Skillern	*Eleocharis rostellata*	95RM004
	Carex cusickii	95RM005
Bluff Creek - Upstream	None	
Bluff Creek - Downstream	None	
Preis	*Eleocharis rostellata*	95RM006
	Carex nebrascensis (minor)	
	Carex utriculata (minor)	
Worswick	*Eleocharis rostellata*	95RM007, 95RM008
	Carex nebrascensis (minor)	
Dry Creek	*Salix lasiandra* (minor)	
	Eleocharis palustris (minor)	
Hot Springs Landing	None	
Wardrop	None	
Condie	None	
Huff Creek	*Scirpus americanus*	95RM029
Hailey	*Eleocharis palustris* (minor)	
Clarendon	None	
Frenchman's Bend	None	
Guyer (Bald Mountain)	None	
Easley	*Eleocharis rostellata* (disturbed)	

Table 7. Continued.

Hot Spring	Association	Plot
Russian John	*Eleocharis pauciflora*	
	Juncus balticus (minor)	
Rocky Mountain Ranch	*Eleocharis pauciflora*	95RM031
Stanley	*Eleocharis pauciflora*	95RM030
	Scirpus americanus	
Upper Elkhorn	None	
Lower Elkhorn	*Eleocharis pauciflora*	
Mormon Bend	None	
Basin Creek Campground	None	
Kem	None	
Sunbeam	*Eleocharis rostellata* (minor)	
Slate Creek	None	
Torreys	None	
West Pass Creek	*Eleocharis rostellata*	
	Scirpus americanus	
Bowery	*Eleocharis pauciflora*	
	Eleocharis rostellata	95RM032, 95RM033
	Scirpus americanus	

At many sites the thermal wetland zone extended over several square meters, with some, such as Worswick or Bowery, extending over one or more acres. In most of these larger areas, I sampled the floristic composition and structure of the communities, following the methods of Bourgeron *et al*. (1992). This ecological sampling system is used throughout western North America by Natural Heritage Programs and Conservation Data Centers, and is based on the USFS Northern Region ECODATA methodology (Jensen *et al.* 1994).

In most cases, the associations occurring around hot springs are widespread types that have been described in general wetland classifications and are only facultatively thermophilic in the study area. One exception is the *Eleocharis rostellata* association, which appears to be a hot spring obligate in the study area and throughout much of Idaho, although there are examples of this type occurring in non-thermal areas of eastern Idaho. Except for the small stand of *Salix lasiandra* at Dry Creek, all other types are dominated by graminoids, mostly as near-monocultures, with few associated forbs and an occasional shrub.

Five of the nine associations are minor occurrences and will not be discussed further. The minor types are *Eleocharis palustris* (Tuhy and Jensen 1982; Youngblood *et al.* 1985; Padgett *et al.* 1989), *Juncus balticus* (Tuhy 1981; Tuhy and Jensen 1982; Mutz and Queiroz 1983; Youngblood *et al*. 1985; Padgett *et al*. 1989), *Carex nebrascensis* (Mutz and Queiroz 1983; Youngblood *et* *al*. 1985), *Carex utriculata* (= old *C. rostrata*; Tuhy 1981; Tuhy and Jensen 1982; Youngblood *et al*. 1985; Padgett *et al*. 1989), and *Salix lasiandra* (Caicco and Wellner 1983; Evenden 1989; Manning and Padgett 1992). I encountered four major associations, *Eleocharis rostellata, Eleocharis pauciflora, Carex cusickii,* and *Scirpus americanus,* in which I placed 13 ecological plots (Table 7). In the remainder of this section I discuss the composition and structure of these four types, as well as their distribution, conservation status, management, and restoration potential (if known). Stand data for the four types appears in Table 8. The 13 community plot forms are in Appendix 3.

Table 8. Average canopy cover and constancy for species recorded in four thermally-influenced wetland associations in south-central Idaho. ELRO = *Eleocharis rostellata* c.t., ELPA = *Eleocharis pauciflora* c.t., CACU = *Carex cusickii* c.t., SCAM = *Scirpus americanus* c.t. Canopy cover is in percent; followed by constancy in parentheses. T = trace (<1% cover).

Species	Association			
	ELRO n=7	ELPA n=3	CACU n=2	SCAM n=1
Shrubs				
Potentilla fruticosa	T (14)	0	0	0
Graminoids				
Agropyron sp. (?)	0	T (33)	0	0
Agrostis scabra	T (14)	1 (33)	T (50)	0
Agrostis stolonifera	1 (43)	1 (33)	T (50)	0
Calamagrostis canadensis	T (29)	0	0	0
Carex cusickii	0	0	94 (100)	0
Carex nebrascensis	2 (57)	0	0	0
Carex praegracilis	T (14)	0	T (50)	0
Deschampsia cespitosa	T (14)	0	0	0
Eleocharis pauciflora	0	77 (100)	0	0
Eleocharis palustris	0	0	10 (50)	0
Eleocharis rostellata	78 (100)	0	0	20 (100)
Glyceria grandis	T (14)	0	T (50)	0
Juncus balticus	T (14)	0	0	0
Juncus ensifolius	T (29)	4 (66)	T (50)	0
Juncus tenuis	1 (29)	1 (33)	T (50)	0
Muhlenbergia andina	T (14)	0	0	0
Muhlenbergia richardsonis	T (29)	7 (33)	0	0
Panicum occidentale	T (14)	0	0	0

Table 8. Continued.

Species	Association			
	ELRO	ELPA	CACU	SCAM
Poa pratensis	T (14)	0	0	0
Scirpus americanus	T (14)	0	2 (50)	98 (100)
Scirpus microcarpus	0	1 (33)	5 (50)	0
Forbs				
Aster chilensis	2.5 (57)	2 (33)	15 (100)	0
Cicuta douglasii	0	0	2 (50)	0
Cirsium vulgare	0	T (33)	0	0
Epilobium palustre	T (14)	0	0	0
Epilobium watsonii	T (29)	T (33)	T (50)	1 (100)
Habenaria dilatata	0	0	T (100)	0
Helianthus nuttallii	0	0	0	1 (100)
Mimulus guttatus	T (29)	10 (100)	T (100)	0
Oenothera hookeri	0	0	T (50)	0
Solidago canadensis	T (14)	0	0	0
Spiranthes romanzoffiana	T (14)	0	0	0
Trifolium longipes	0	1 (33)	0	0
Viola sp.	T (14)	0	0	0

Eleocharis rostellata **Association**

Eleocharis rostellata is a member of the sedge (Cyperaceae) family and is unique among that family in the study area (including *Carex, Scirpus* and *Eleocharis*) by being stoloniferous. The strong, arching stolons are firmly rooted at each end and can cause people to stumble while walking through a dense stand. *Eleocharis rostellata* occurs at nine hot springs (Table 6), but was extensive enough only at seven to be considered a plant association (Table 7). I sampled plots in this association at five sites: Bowery (2 plots), Worswick (2 plots), Preis, Skillern, and Lightfoot Bar. Similar to most other herbaceous community dominants in the study area, *E. rostellata* forms near-monocultures. The average number of associated species for the seven plots is 7, ranging from 0 to 11, none avenging more that 10% cover in a sample (Appendix 3).

While *Eleocharis rostellata* averages 78% cover in the sampled stands (Table 8), there are two distinct phases of this community: stands with greater than 90% cover of *E. rostellata* and stands with less than 70%. The former phase is characterized by a dense sward of vegetation, mostly *E. rostellata*, occurring on relatively deep organic soils that, at Preis Hot Springs, form a quaking mat. It also tends to occur on flat to gentle slopes. Examples of this phase were sampled at

Preis, Bowery, and Worswick hot springs. The latter phase is more open, with considerable areas of bare soil, gravel, rock, and open water on the surface. This phase was sampled at Worswick, Lightfoot Bar, and Skillern. The open phase appears to be restricted to mineral substrates and can occur on gentle as well as very steep slopes (35^{o} at Lightfoot Bar). Substrates in both phases are saturated throughout the year, often with water running over the ground surface through the stands.

The *Eleocharis rostellata* association is rare in Idaho, where it is known from the seven hot springs in the study area, as well as several sites in eastern Idaho that have been sampled as part of a wetlands conservation planning project by the CDC. The eastern Idaho sites are not in thermally-influenced wetlands. The CDC gives it a state conservation rank of S2 (on a relative 1 to 5 scale based on rarity and threats).

Elsewhere, this association is known only from Montana and Wyoming. In Montana, Hansen *et al*. (1995) lumped all combinations of *E. rostellata* and *E. pauciflora* into an *E. pauciflora* habitat type due to similarities in environmental conditions and management concerns. Observations in Montana by Lesica (1990), however, indicate that the *E. rostellata* association is distinct and, similar to Idaho, at least partially thermophilic. In fact, *E. rostellata* is considered a threatened species in Montana because of development at thermal areas for recreation (Lesica and Shelly 1991). It is also a rare species in Washington (Washington Natural Heritage Program 1994). In Wyoming, the *E. rostellata* association is common in the geothermal basins in Yellowstone National Park, but apparently is uncommon elsewhere in the state (Jennifer Wipple, Yellowstone National Park, personal communication,1995).

Management information for this association can be found in Hansen *et al*. (1995), which they include with the *Eleocharis pauciflora* habitat type. Trampling damage of the wet, organic soils of this association occurs readily with any livestock grazing. Because of the unstable nature of the substrate, livestock are usually restricted, which minimizes soil disturbance problems. Livestock may graze forage plants in this association, but overgrazing can cause compositional changes to species of lower palatability. The palatability and revegetation characteristics for the community dominant, *E. rostellata*, are probably similar to those of *E. pauciflora*, discussed in the next section.

***Eleocharis pauciflora* Association**

The *Eleocharis pauciflora* (syn.= *E. quinqueflora*) association was found at six hot springs in the study area and was sampled at three: Willow Creek, Rocky Mountain Ranch, and Stanley (Table 7). *Eleocharis pauciflora* forms dense, near-monocultures in the community. None of the 12 associated species averages greater than 10% cover and only two, *Juncus ensifolius* and *Mimulus guttatus*, occur in two or more plots (Table 8). This community generally occurs on level slopes and organic soils, although large cobbles can occur at the surface.

This association is widespread in montane areas of central Idaho where it has been described by Tuhy and Jensen (1982) and Mutz and Queiroz (1983). *Eleocharis pauciflora* associations have been described throughout the Pacific Northwest and Rocky Mountains in Oregon (Kovalchik 1987; Crowe and Clausnitzer 1995), Utah (Padgett *et al.* 1989), Nevada (Manning and Padgett 1992), Wyoming (Mattson 1984), and Montana (Hansen *et al*. 1995). Lesica (1990) found this association in thermally-influenced areas of southwestern Montana. The CDC gives it a state conservation rank of S4 (on a relative 1 to 5 scale based on rarity and threats).

Hansen *et al*. (1995) discuss management implications for the *Eleocharis pauciflora* habitat type and the palatability and revegetation potential for the community dominant, *E. pauciflora*. This information is summarized below. Trampling damage of the wet, organic soils of this association occurs readily with livestock grazing. Because of the unstable nature of the substrate, domestic livestock use is usually restricted, which minimizes soil disturbance problems. Livestock may graze forage plants in this association, but overgrazing can cause compositional changes to species of lower palatability. *Eleocharis pauciflora* is considered to have low palatability for horses, sheep, and cattle, and fair to poor food value for big game, upland game, non-game birds, and small mammals. It has good food value for waterfowl, which feed on the seeds. *Eleocharis pauciflora* has medium annual biomass production, when compared to members of the same lifeform. Because of its densely rhizomatous habit, it has high erosion control potential and short-term revegetation potential, while they consider it to have medium long-term revegetation potential.

Carex cusickii Association

Carex cusickii occurs at six hot springs (Table 6), but only at Baumgartner and Skillern were the stands extensive enough to be considered an association. The type is especially well-represented at Skillern Hot Spring, however, I sampled the community at both sites (Table 7). Although *C. cusickii* is loosely caespitose, it still forms dense stands that limit the number of associated species. This is similar to all other herbaceous associations in the area, which are dominated by densely rhizomatous species. This community occupies sites that are saturated by warm seeps throughout the growing season and have organic soils. The stand at Baumgartner was on level ground below the spring source, while the Skillern stand was on a 5^{o} slope.

The *Carex cusickii* association has been observed elsewhere in Idaho (*e.g.*, Bursik and Moseley 1995), although the two plots from the study area appear to be the first sampled in the state. The Idaho type is probably related to those described from northeastern Oregon (Crowe and Clausnitzer 1995) and northeastern Washington (Kovalchik 1993), however, my plots share no species in common with the principal species listed in their publications. The *C. cusickii* association is rare on the landscape, but is widely distributed throughout the northern and central part of Idaho. The CDC gives it a state conservation rank of S3 (on a relative 1 to 5 scale based on rarity and threats). Its rangewide conservation status is not well understood at present.

Crowe and Clausnitzer (1995) discuss the management implications for the *Carex cusickii* association, which is summarized below. The total dry herbaceous biomass ranged from 1387 to 4033 lbs/acre. They recommended against grazing domestic livestock on these sites because of the potential to damage the fragile, wet soils. This association may provide cover and forage (especially the seeds of *C. cusickii*) for small mammals and birds.

***Scirpus americanus* Association**

Scirpus americanus (syn. = *Scirpus olneyi*) occurred at seven hot springs (Table 6), but at only five sites, Bowery, West Pass, Stanley, Baumgartner, and Huff Creek, did I consider it extensive enough to be considered an association (Table 7). The most extensive stand was in the swale below the Huff Creek spring, where the only plot was sampled (Table 7). The community has very low species diversity. This is probably due to the dense rhizomatous habit of *S. americanus* that forms nearly complete cover, leaving little space for other species. At Huff Creek, only three other species occurred in the plot, *Eleocharis rostellata* with 20% cover, and *Epilobium watsonii* and *Helianthus nuttallii* each with about 1% cover (Table 8). There is a tremendous difference in height of the *Scirpus* at Huff Creek compared to other occurrences in the study area. At Huff Creek stems are six or more feet tall, while elsewhere it is around two feet tall. This difference probably results from the relatively warm climate found at Huff Creek, which lies at the northern edge of the Snake River Plain. Other sites are in mountain valleys affected by cold air drainage and pooling.

My plot at Huff Creek is apparently the only one sampled in Idaho. The *Scirpus americanus* association has not been described in any wetland classifications from Idaho, but is probably more common than this lack of information would indicate. Most of the classifications done in the state are from mountainous regions, where *Scirpus americanus* is not common. As classification work is expanded to lower-elevation areas of southern Idaho, more occurrences may be located and characterized. For now, the *Scirpus americanus* association is considered rare in Idaho, where it has a conservation rank of S1 (on a relative 1 to 5 scale based on rarity and threats). Its rangewide conservation status is not well understood at present.

Hansen *et al*. (1995) described a *Scirpus pungens* habitat type from central and eastern Montana that includes all combinations of *S. pungens* and *S. americanus* due to similarities in environmental conditions and management concerns. *Scirpus pungens* is not known from Idaho. With only one plot to compare, the Huff Creek community does not appear to be the same as the Montana type, however, more sampling is needed to determine the relationship of Idaho stands to those in Montana (Hansen *et al.* 1995) as well as other states in the Great Basin and southern Rocky Mountains where *S. americanus* types have been described (Bourgeron and Engelking 1994).

The management information found in Hansen *et al*. (1995) for the *Scirpus pungens* habitat type is probably applicable to the *S. americanus* association found in Idaho. This information is summarized below. Herbage production is high, however, palatability is low to moderate. *Scirpus* is seldom grazed by livestock, provided other forage sources are available, or the site is in fairly deep water. If water levels drop or upland forage is limited, however, livestock may utilize this association heavily. At Huff Creek during August 1995, there was no standing water and cattle had created trails through the community, but grazing appeared minimal. This association is an important source of shade, hiding cover, and food for wildlife. This is especially true for the tall stands, such as at Huff Creek. *Scirpus* is used by muskrats for construction of huts and waterfowl use this type for nesting and hiding cover. This association buffers wind and wave action when stands are located near open bodies of water (although not in the study area), and stands along streams help filter out sediments and build banks. The rehabilitation opportunities for this association are high. *Scirpus americanus* is probably fairly drought tolerant, being able to persist through several years of dry conditions. It is a prolific seed producer and dissemination occurs by both wind and water. Rhizomes spread into exposed areas, rapidly colonizing mud flats and drawdown areas.

CONCLUSIONS AND RECOMMENDATIONS

Below is a series of conclusions and recommendations concerning the management and conservation of biotic and ecological resources at hot springs in south-central Idaho. Most are specific to individual springs, although a couple have wider applicability. These conclusions and recommendations are a synthesis of the biological and ecological information presented in preceding sections and are directed at the public land manager.

1. All Hot Springs Have Been Disturbed. This report represents the first biological and ecological assessment of all hot springs within a large portion of the state. All of the 37 hot springs studied have been disturbed by humans to some degree, ranging from total destruction or diversion to minor disturbances associated with bathing. This pattern is repeated across Idaho and the region. During 20 field seasons of studying the biological resources of Idaho, I have seen only one hot spring that had no sign of human disturbance. I hope this report brings to light some of the fascinating and often unique biota and ecological conditions associated with geothermal features in central Idaho, and leads to a greater appreciation among land managers for the need to protect high quality sites from further destruction and restoration of those that are extraordinary.

Because of they are a conservation concern in the state, the CDC tracks the condition and status of thermal spring communities. We developed a convenient reporting form to use in surveying the physical and biological attributes of a spring community and the ecological condition of the site (Appendix 4). I encourage public agency biologists to inventory hot springs under their jurisdiction and submit the Thermal Spring Community Observation Report to the CDC as documentation.

2. Outstanding Areas. Four hot springs managed by the Sawtooth National Forest and the Shoshone District BLM are outstanding due to their biological and ecological diversity and, in three cases, their relatively undisturbed state: Worswick , Skillern, Huff Creek, and Bowery. Each of these areas should be given special management consideration by land managers.

Worswick Hot Spring is extraordinary largely because of its high flow and high temperature. It has the greatest flow of any of the undiverted springs (Guyer Hot Spring has a similar discharge, but is totally diverted). This large flow emanates from over a dozen sources spread over several acres, making Worswick one of the largest thermally-influenced sites in the study area. Worswick also has the highest temperature of all the springs sampled, being 10°C (21°F) greater than the second hottest, Sunbeam Hot Spring. Because it has the longest thermal gradient, the diversity of microbial communities is highest of all springs in the study area. For example, water emanating from the source of Worswick is nearly 15°C (27°F) hotter than photosynthetic organisms are able to survive, hence the achlorophyllous white filamentous organisms and pinkish microbial mats. The thermally-influenced wetlands surrounding Worswick also contain extensive examples of both the open and closed phases of the *Eleocharis rostellata* association, a globally rare plant community. Worswick Hot Spring is administered by the Fairfield Ranger District, Sawtooth National Forest.

Skillern Hot Spring, also administered by the Fairfield Ranger District, has the largest population of *Epipactis gigantea*, probably in the state, but certainly in central Idaho. This rare species occurs in the extensive "hanging gardens" found on the steep cliff faces irrigated by hot water from the several spring sources. Along with Bowery Hot Spring, Skillern is the most floristicly diverse hot spring studied. The site also contains extensive microbial mats, as well as high quality occurrences of the *Eleocharis rostellata* and *Carex cusickii* associations. Probably because it is nearly three miles from the road, Skillern is relatively undisturbed. The Big Smoky Creek Trail traverses immediately above the highest spring source and trampling has denuded a small area around the spring. A primitive bathing pool has been built on a bench at the base of the cliff, certainly destroying some of the hanging garden and microbial communities. Both of these disturbances are relatively minor and most of the area is undisturbed.

Huff Creek occurs on land administered by the Monument Resource Area, Upper Snake River Districts BLM, at the northern edge of the Snake River Plain. In south-central Idaho, it is the only publicly-owned sites that is not in a mountain valley. Due probably to this physiographic location, resulting in warmer environmental conditions, Huff Creek wetlands contain nine native species found at no other sites in the study area. It also contains the most extensive occurrence of the *Scirpus americanus* association, a state-rare community. Cattle grazing has impacted the vegetation around the spring source and, to a lesser degree, in the *S. americanus* stand.

Bowery Hot Spring, managed by the Sawtooth National Recreation Area, Sawtooth National Forest, is extraordinary in several ways. It is one of the two most floristicly diverse sites in the study area, it contains populations of two rare plants, has extensive stands of the rare *Eleocharis rostellata* association, and is second only to Worswick Hot Spring in the amount of area influenced by thermal water. The occurrence of *Primula incana* at Bowery is of particular note, being one of only two known populations in the state. Also of note is the relatively high conductivity of the water of Bowery and the nearby West Pass springs. Cattle grazing takes place in the vicinity, but does not appear to be impacting the thermally-influenced wetlands. A small tub has been placed at the lower end of the spring, near the high water line along the East Fork Salmon River. The tub and impacts from bathers is having minimal impact on the site.

3. Management of Worswick Hot Spring is of particular concern to the Fairfield Ranger District due to the past and ongoing disturbances to this outstanding spring system. Worswick was the site of a resort during the heyday of mining in the area (Loam 1980), although it is now completely obliterated. The area has been fenced to exclude livestock, but elk still heavily use the area, especially in the winter. The site is also easily accessible to recreationists, who have constructed primitive bathing pools at the lower end and created many trails through the site.

The Forest Service should be vigilant in maintaining the fence and controlling cattle, who seem to regularly enter the exclosure and doing considerably trampling damage to the wetlands. The extensive trampling and vehicle impacts of bathers is largely limited to ground and vegetation outside the thermally-influenced area, however, this use could probably be concentrated into fewer areas than at present using barricades and gates. Several bathing pools have been constructed in the channel of Worswick Creek, using its cold water to dilute the extremely hot water from the springs, making soaking tolerable. This has impacted microbial and algal communities at the cool end of the thermal gradient, but with the tremendous input of hot water there are still segments of the relatively cool Worswick Creek that maintain good filamentous mats. No pools have been constructed in channels originating exclusively from hot water springs.

From the amount of hiker-created trails in the area, it appears that there is considerable curiosity about the geothermal features at Worswick. The Forest Service should probably construct an interpretative trail through the area, concentrating the trampling to a smaller area than is currently taking place. Interpretive signing or brochures explaining the physical setting and unique organisms that inhabit the area may help satisfy this curiosity more than at present and enhance biological protection.

4. Sunbeam Hot Spring is highly disturbed, but has the second hottest spring in south-central Idaho. This long thermal gradient probably means that Sunbeam has greater microbial diversity than most other hot springs in the study area. Sunbeam and Worswick are the only two springs with temperatures above the upper limits of photosynthetic organisms. Land managers should be made aware of this extraordinary feature of Sunbeam Hot Spring.

5. *Epipactis gigantea* at Baumgartner Hot Spring. The small population of *E. gigantea* occurring around the lower spring at Baumgartner is heavily impacted by trampling from recreationists who hike the interpretive trail. It appears to have declined between my visits in 1989 and 1995. The lower spring is the only remaining naturally flowing source at the site. The other source is totally diverted through pipes to a bathing pool. Recreational use should be diverted away from the steep creekbanks below the spring. *Epipactis gigantea* is a hardy, rhizomatous forb that will readily recolonize appropriate habitat along the creekbank when the intense trampling ceases.

6. Assessing Microbial Diversity. Microbial organisms are the most interesting, probably the most diverse, and definitely the least understood biotic component of hot springs in Idaho. My sampling of microbes at Worswick and Skillern was very rudimentary. A more thorough assessment of microbial diversity should be conducted at selected springs in the area using phylogenetic techniques.

7. Amoebic Meningitis. Caused by the protozoan *Naegleria* spp., amoebic meningitis is a potentially deadly condition in humans. Three *Naegleria* species are known from hot springs in the Yellowstone Region, where one commercial establishment was closed due to high levels of the pathogen. As far as I know, no surveys have been conducted in Idaho.

8. Bioprospecting. Land managers with hot springs under their jurisdiction should be made aware that there is tremendous commercial interest in thermophilic microbes, and this interest is expected to grow in the next few years. Most of the activity in our region is taking place in Yellowstone National Park, although at least one hot spring in Idaho, near Preston, has had microorganisms sampled for potentially useful thermostable compounds. From any given hot spring, these commercial "bioprospectors" take very small amounts of material. The National Park Service is currently trying to determine what approach the agency should take in permitting this potentially lucrative biotic exploration.

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APPENDIX 1

Conservation Data Center occurrence records for the 37 "thermal springs aquatic communities" in the study area.

NOTE: The EORANK field on the occurrence forms is the Site Quality Rank from the Thermal Spring Community Observation Report (Appendix 4) and is a relative scale from undeveloped to totally developed, as follows:

A Site largely undisturbed, except possibly a small pool away from source.

B Site little disturbed, largely natural; minor recreational development and/or concentrated animal use.

C Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

D+ Site totally disturbed, but still somewhat seminative; good restoration potential.

D- Site developed with nothing natural at source; little/no restoration potential.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 002

Site Name: TORREYS

County: Custer

USGS quadrangle: THOMPSON CREEK

Latitude: 441515N   Longitude: 1143636W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N016E	29	BO	SE4SW4NW4

Location:Warm spring on the S side of the Salmon River, ca 0.25 river mile W of Cold Creek and ca 0.6 river mile W of Torreys.

Survey Date: 1995-08-28
Last Observed: 1995-08-28
First Observed: UNKNOWN

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data:1992: Area surveyed by Bob Moseley, Idaho CDC, and Susan Bernatas, SAIC. Epipactis gigantea not present. 1995: Area thoroughly surveyed by Moseley. One source spring, temperature 32 degrees C, conductivity 381 umhos, pH 9.3, and total alkalinity 94 mg/l as $CaCO_3$.

Habitat Description:Bedrock geology: river alluvium. Surrounding vegetation: Pseudotsuga menziesii forest. One spring discharges into a pool above mean high water, but below extreme high water along the Salmon River. It occasionally gets scoured by floods. Warm water trickles down through big river rocks for 8 m to the river. Very little vegetation in the thermally influenced area.

Minimum Elevation: 5720 feet
Size: 100 SQ M

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments:
Primitive pool excavated at the source and a small pool constructed between the source and the river. Immediately upstream is a picnic area used by outfitters for clients on the day float from Sunbeam to Torrey's. A considerable amount of trampling of the area results. Light use by wildlife probably in the winter.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 007

Site Name: KEM HOT SPRING

County: Custer

USGS quadrangle: EAST BASIN CREEK

Latitude: 441550N Longitude: 1144839W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N014E	22	BO	NE4SW4SW4

Location:Below State Route 75, N side of the Salmon River, ca 0.5 mile downstream of the confluence with Basin Creek. Other names of this spring include Basin Creek, Basin Creek Bridge, and Cove hot spring.

Survey Date: 1995-08-25
Last Observed: 1995-08-25
First Observed: 1970

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data: Parliman and Young (1992) from a 1983 sample report temperature 56.5 degrees C, conductivity 343 umhos, pH 9.5, and total alkalinity 88 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.02 cfs. 1992: Springs surveyed for Epipactis gigantea (not present) by Bob Moseley, Idaho CDC. 1995: Area thoroughly surveyed by Moseley. 1 source spring, temperature 55 degrees C, conductivity 425 umhos, pH 9.0, and total alkalinity 108 mg/l as CaCO3.

Habitat Description: Bedrock geology: granite. Surrounding vegetation is riparian, Pinus contorta forest on adjacent stream terraces, and sagebrush-steppe on nearby slopes. A single spring discharges into the Salmon River below high water, but above low water. The site is flooded annually. The spring emanates from a granitic outcrop. No vegetation associated with the thermally influenced area due to flooding and recreation developments.

Minimum Elevation: 6040 feet Size: 0.1 AC OR LESS

Ownership Comments:Sawtooth NF, Sawtooth NRA.
Protection Comments: Springs discharge directly into a series of pools built at the river level. The highway is upslope and the area is used for recreation.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 008
Site Name: SUNBEAM HOT SPRINGS
County: Custer
USGS quadrangle: SUNBEAM
Latitude: 441603N Longitude: 1144451W
TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
011N015E 19 BO SE4NW4; unsurveyed

Location:Sunbeam Hot Springs, ca 0.8 mile SW of Sunbeam along State Route 75. Ca river mile 369.

Survey Date: 1995-08-25 Last Observed: 1995-08-25 First Observed: 1954-09-08

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.
Aquatic Data: Ross (1970) reports discharge 0.5 cfs, temperature 76 degrees C, and conductivity 409 umhos. Parliman and Young (1992) from a 1983 sample report temperature 76.5 degrees C, conductivity 394 umhos, pH 9.0, and total alkalinity 103 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.864 cfs. 1992: Area surveyed for Epipactis gigantea (not present) by Bob Moseley, Idaho CDC. 1995: Area thoroughly surveyed by Moseley. 2 source springs, temperature 74 degrees C, conductivity 524 umhos, pH 8.7, and total alkalinity 102 mg/l as CaCO3.

Habitat Description:Bedrock geology: granitic. Surrounding vegetation: sagebrush-steppe on slope above springs. Larger upstream source emanates on slope above State Route 75 across an area ca 30 m broad. The water collects in a roadside ditch and flows through a culvert under the road, down the road fill and into the river. The smaller downstream source flows a short distance down the roadcut, under the road, then down another steep slope to the river. The area is highly disturbed but a few plants occur around the sources, as does a yellow-brown algae. Eleocharis rostellata is the most common vascular species and forms a community type above the road at the upstream source.

Minimum Elevation: 6000 feet Size: 0.25 AC

Ownership Comments Sawtooth NF, Sawtooth NRA.

Protection Comments:The area has been developed for bathing and chicken farming since the late 1800's. The site is currently a developed recreation site with interpretive signs, outhouse, and restored CCC-era bathhouse. Primitive pools have been built at river level below both springs. State Route 75 bisects the area. Light wildlife use in the winter. The surrounding land use is transportation and recreation.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 051
Site Name: BAUMGARTNER HOT SPRINGS
County: Camas

USGS quadrangle: JUMBO MTN.

Latitude: 433609N Longitude: 1150413W

TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
003N012E 07 BO SW4SE4
Location: Baumgartner Hot Springs, along the South Fork Boise River, ca 11 miles east of Featherville.

Survey Date: 1995-07-25 Last Observed: 1995-07-25 First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data: Ross (1970) reports discharge 0.22 cfs, temperature 43-49 degrees C, and conductivity 260 umhos. Parliman and Young (1992) from a 1981 sample report temperature 50 degrees C, conductivity 258 umhos, pH 9.1, and total alkalinity 78 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.060 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 source springs, temperature 38 degrees C, conductivity 306 umhos, and pH 8.2.

Habitat Description: Bedrock geology: granite. Surrounding vegetation is Pseudotsuga menziesii forest with Pinus ponderosa dominant. Source springs emanate from hillside and flow onto the river terrace and into the South Fork Boise River. Extensive Carex cusickii community on the flat area; small areas of Scirpus americanus dominate a narrow fringe of higher gradient channel. Epipactis gigantea occurs here.

Minimum Elevation: 4820 feet Maximum Elevation: 5000 feet Size: 0.1 LINEAR MILE

Ownership Comments: Sawtooth NF, Fairfield RD.

Comments: See also Epipactis gigantea 022.

Protection Comments: The eastern source is totally developed and diverted into a pool. The western source is near the nature trail and is heavily trampled. The outlet streams are in good condition. The area is a heavily used, developed campground. The slopes above the springs are undisturbed.
Management Comments:Plot 95RM002 established in Carex cusickii community.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 064
Site Name: WORSWICK HOT SPRINGS
County: Camas
USGS quadrangle: SYDNEY BUTTE
Latitude: 433348N Longitude: 1144747W
TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
003N014E 28 BO NE4SW4, NW4SE4
Location: Worswick Hot Springs. At the confluence of Worswick Creek and Little Smoky Creek. Along Little Smoky Creek Road (FS Road 227).
Survey Date: 1995-07-27 Last Observed: 1995-07-27 First Observed: 1970
EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data: Ross (1970) reports discharge 1.1 cfs, temperature range 51-83 degrees C, and conductivity 325 umhos. Parliman and Young (1992) report a 1983 sample with temperature 86.5 degrees C, conductivity 334 umhos, pH 9.0, and total alkalinity 84 mg/l as CaCO3. 1995: Bob Moseley, Idaho CDC, thoroughly surveyed the area and reports temperature 69-77 degrees C, conductivity 400 umhos, pH 9.0, and total alkalinity 114 mg/l as CaCO3. There are dozens of source springs over several acres.

Habitat Description: Bedrock geology: granite. Surrounding vegetation: mostly sagebrush-steppe; also Pseudotsuga menziesii forest, small plantation above springs. Many very hot sources emanate from an E-facing hillside, W of lower Worswick Creek near its confluence with Little Smoky Creek. Eleocharis rostellata is the most common community in the thermally influenced area, probably occupying several acres. Muhlenbergia richardsoni and Carex nebraskensis are minor cover types. The Eleocharis community can occur as large stands on sloping hillsides with gravelly soil, or as fringe vegetation along the channels. Thick mats of yellow-brown algae occur in hot channels. Blue-green algae occurs near source springs and green algae occupies cooler channels.

Minimum Elevation: 6000 feet Maximum Elevation: 6200 feet Size: 10 ac.

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments: Area was the site of an old resort that is now long gone. Old dams and ditches still remain although they have been breached or are not active. Many primitive pools have been constructed throughout the area. A road runs nearby and several camping sites are within the area. 4wds have driven through the wet areas. Subjective rating of use by wildlife is 3 (1-4 scale, little to heavy) which occurs in all seasons but mostly in the winter.
Management Comments: Site of plots 95RM007 and 95RM008.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 065

Site Name: BLUFF CREEK - DOWNSTREAM

County: Camas

USGS quadrangle: BAKER PEAK

Latitude: 434200N   Longitude: 1144429W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
004N014E	12	BO	center NW4

Location:
Along Big Smoky Creek, ca 8.5 miles up FS Trail 072 from the trailhead at Canyon Campground. Ca 0.5 mile upstream from the mouth of Bluff Creek and ca 0.25 mile downstream from the Bluff Creek - Upstream spring.

Survey Date: 1995-07-26
Last Observed: 1995-07-26
First Observed: 1970

EORANK: A
EORANK Comments: Site largely undisturbed, except possibly a small pool away from the source.
Aquatic Data:
1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. A single source spring with temperature 40 degrees C, conductivity of 289 umhos, pH 9.3, and total alkalinity 83 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation: riparian willow and sagebrush-steppe. A single source pops out of a granite outcrop and cascades for 4 m down the rock face with extensive yellow-green algal mats on the cascade. Below the outcrop the stream flows in the flood channel for 15 m into Big Smoky Creek. Big Smoky infrequently floods the channel so it's mostly hot water with plenty of green algae.

Minimum Elevation: 6320 feet   Size: 20 LINEAR M

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments:
One small pool has been constructed with minor impact. Subjective rating of use by wildlife is 2 (1-4 scale, little to heavy),   mostly occurring during the summer. The trail is ca 50 m upslope
and the area is otherwise in natural condition.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 066

Site Name: BLUFF CREEK - UPSTREAM

County: Camas

USGS quadrangle: BAKER PEAK

Latitude: 434206N Longitude: 1144418W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
004N014E	12	BO	NE4NW4

Location:
Along Big Smoky Creek, ca 8.5 miles up FS Trail 072 from the trailhead at Canyon Campground. Ca 0.25 mile upstream from the Bluff Creek - Downstream spring and ca 0.75 mile upstream from the mouth of Bluff Creek.

Survey Date: 1995-07-26
Last Observed: 1995-07-26
First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact. Very heavy elk use at this site.
Aquatic Data:
Idaho Department of Water Resources reports a diversion rate of 0.02 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 source springs with temperature 26-36 degrees C, conductivity 316 umhos, pH 9.4, and total alkalinity 94 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation is Pseudotsuga menziesii forest and sagebrush-steppe. Two source areas emanate from a granite outcrop and flow downslope a short distance into Big Smoky Creek. Widely scattered patches of vegetation - mostly bare ground with significant erosion of sandy soils due to concentrated elk use.

Minimum Elevation: 6360 feet Size: 30 LINEAR M

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments:
One small pool has been constructed with minor disturbance. Subjective rating of wildlife use is 4 (1-4 scale, little to heavy) in all seasons, mostly by elk with some use by deer as well.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 067
Site Name: SKILLERN HOT SPRINGS
County: Camas
USGS quadrangle: PARADISE PEAK

Latitude: 433851N Longitude: 1144854W

TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
004N014E 29 BO SW4SE4
Location:
Skillern Hot Springs along Big Smoky Creek. Ca 2.5 miles up FS Trail 072 from the trailhead at Canyon Campground.

Survey Date: 1995-07-26 Last Observed: 1995-07-26 First Observed: 1970

EORANK: A
EORANK Comments: Site largely undisturbed, except possibly a small pool away from the source.

Aquatic Data:
Ross (1970) reports a discharge rate of 0.05 cfs. Parliman and Young (1992) from a 1981 sample report temperature 64.5 degrees C, conductivity 285 umhos, pH 9.4, and total alkalinity 73 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.471 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 1 source area on each side of the creek, temperature 54 degrees C, conductivity 382 umhos, pH 8.8, and total alkalinity 95 mg/l as CaCO3.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation is shrub-steppe. 2 source areas on the E and W sides of Big Smoky Creek. The E is ca 300 feet up a hillside and an extensive Eleocharis rostellata community covers the thermally influenced area. There is also a small area of Carex nebraskensis. The W cascades 60 feet down a rock outcrop and adjacent slope. Eleocharis rostellata and Carex cusickii communities are common as well as open rocky areas with yellow-green algal mats and areas dominated by Epipactis gigantea. The vegetation is extraordinarily rich in species.

Minimum Elevation: 5800 feet Maximum Elevation: 6000 feet Size: 3 AC

Ownership Comments:Sawtooth NF, Fairfield RD.

Comments: See also Epipactis gigantea 053.

Protection Comments:
1 large pool constructed on the ledge of the outcrop on the W side of the creek that probably disturbed vegetation during construction. 2 small pools have also been constructed below the high water of Big Smoky Creek. Subjective rating of use by wildlife is 4 on the E side and 2 on the W side (1-4 scale, little to heavy) which occurs during all seasons. The trail traverses immediately above the W spring, but the area is otherwise natural.

Management Comments:
Site of plots 95RM004 and 95RM005.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 068
Site Name: LIGHTFOOT HOT SPRINGS
County: Camas
USGS quadrangle: BOARDMAN CREEK

Latitude: 433616N Longitude: 1145700W

TOWNRANGE:	SECTION:		MERIDIAN:	TRSNOTE:
003N013E	07		BO	SE4

Location:
Lightfoot Hot Springs, on both sides of the South Fork Boise River at Lightfoot Bar.

Survey Date: 1995-07-25 Last Observed: 1995-07-25 First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

Aquatic Data:
Ross (1970) reports discharge 0.07 cfs, temperature 43-63 degrees C, and conductivity 355 umhos. Parliman and Young (1992) from a 1981 sample report temperature 62 degrees C, conductivity 343 umhos, pH 9.1, and total alkalinity 105 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.078 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 4 source springs, temperature 54 degrees C, conductivity 381 umhos, pH 8.6, and total alkalinity 127 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation: Pseudotsuga menziesii forest and sagebrush-steppe. Springs emanate from the base of a slope and warm channels flow across the stream terrace to the river in 2 main channels. Mostly bare ground due to elk use but Scirpus acutus dominates small areas on lower channels and Eleocharis rostellata dominates areas near the upper spring.

Minimum Elevation: 5250 feet Size: 0.25 LINEAR MILE

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments: Both spring creeks on the E side of the river have been dammed with heavy equipment in the past. The road has filled in part of the thermal area on the W side of the river. Wildlife use is heavy in all seasons, mostly by elk feeding on the bar between the 2 spring channels.

Management Comments: Plot 95RM003 established in Eleocharis rostellata community at the upper spring at Lightfoot Bar.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 069
Site Name: PREIS HOT SPRING

County: Camas
USGS quadrangle: SYDNEY BUTTE

Latitude: 433435N Longitude: 1144949W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
003N014E	19	BO	center SE4

Location:
Preis Hot Spring along Little Smoky Creek, ca 3 miles up from its confluence with Big Smoky Creek.

Survey Date: 1995-07-27 Last Observed: 1995-07-27 First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data:
Ross (1970) reports discharge 0.02 cfs, temperature 41 degrees C, and conductivity 340 umhos. Parliman and Young (1992) from a 1981 sample report temperature 41 degrees C, conductivity 344 umhos, pH 9.6, and total alkalinity 87 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.020 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 source springs, temperature 39 degrees C, conductivity 415 umhos, pH 9.0, and total alkalinity 109 mg/l as CaCO3.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation is sagebrush-steppe. Upstream spring has a small pool built at the source - small outlet runs in a narrow channel to Little Smoky Creek. The downstream source is not concentrated; warm water subirrigates a ca 200 sq m area creating a quaking Eleocharis rostellata mat, surrounded by no-so-quaky Carex utriculata and C. nebraskensis communities. The entire system is low gradient.

Minimum Elevation: 5650 feet Size: 1 AC

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments: A major road along Little Smoky Creek has probably filled in a portion of the thermally influenced wetland. A small wood-enclosed pool is at the source of one spring. There is a little wildlife use of the area.
Management Comments: Plot 95RM006 established in Eleocharis rostellata community.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 070

Site Name: WILLOW CREEK HOT SPRING

County: Elmore
USGS quadrangle: CAYUSE POINT

Latitude: 433812N Longitude: 1150747W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
004N011E	34	BO	NE4SE4

Location:
Willow Creek Hot Spring; along Willow Creek <1 mile up FS Trail 019 that starts at the transfer camp at the end of FS Road 008. Ca 2.5 miles N of the South Fork Boise River.

Survey Date: 1995-07-25 Last Observed: 1995-07-25 First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data:
Ross (1970) reports discharge 0.33 cfs, temperature 35-50 degrees C, and conductivity 230 umhos. Parliman and Young (1992) from a 1981 sample report temperature 53 degrees C, conductivity 221 umhos, and pH 9.5. Idaho Department of Water Resources reports a diversion rate of 0.286 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 1 main and 2 small source springs, temperature 50 degrees C, conductivity 278 umhos, pH 8.9, and total alkalinity 93 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granite. Surrounding vegetation: Pseudotsuga menziesii forest with sagebrush openings. Low stream terrace adjacent to Willow Creek. Source springs emanate from upstream end and a low gradient stream traverses the length of the bar. Narrow fringe of vascular plants - no extensive areas. Extensive areas of Plantago lanceolata occupying moist bare ground.

Minimum Elevation: 5220 feet Size: 300 LINEAR FEET

Ownership Comments: Sawtooth NF, Fairfield RD.

Protection Comments: 7 primitive bathing pools of varying size and age have been constructed, some are actively used. Area receives heavy year-round use by elk. A hiking trail runs nearby.
Management Comments: Plot 95RM001 established in Eleocharis community at the site.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 071

Site Name: DRY CREEK HOT SPRING

County: Gooding

USGS quadrangle: FIR GROVE MOUNTAIN

Latitude: 431012N   Longitude: 1144747W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
003S014E	09	BO	SE4SW4SE4, SW4SE4SE4
003S014E	16	BO	NE4NW4NE4, NW4NE4NE4

Location:
Southern slope of the Bennett Hills, upper Dry Creek, near the confluence with Hot Creek. Ca 2 air miles S of Fir Grove Mountain.

Survey Date: 1995-07-26
Last Observed: 1995-07-26
First Observed: UNKNOWN

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data:
Idaho Department of Water Resources reports a diversion rate of 0.370 cfs. 1995: Several source springs. Water is warm, less than 80 degrees F. Area thoroughly surveyed by Bob Moseley, Idaho CDC.

Habitat Description:
Bedrock geology: volcanic. Surrounding vegetation is sagebrush-steppe. A series of warm springs surface in the dry creek bed of Dry Creek over a distance of ca 50 m, producing a nice spring creek. Mostly Salix lasiandra overstory with Rorippa nasturtium-aquaticum and Lemna minor in the creek and a few chewed off Eleocharis palustris along the water's edge. The drainage does flash flood, which may account for the lack of well developed vegetation in addition to heavy grazing by cattle.

Minimum Elevation: 5120 feet   Size: 50 LINEAR M

Ownership Comments: Upper Snake River Districts BLM, Bennett Hills RA, and state land.

Protection Comments:
Area is heavily grazed by cattle in the summer.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 072

Site Name: HOT SPRINGS LANDING

County: Blaine

USGS quadrangle: MAGIC RESERVOIR WEST

Latitude: 431941N Longitude: 1142355W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001S017E	23	BO	center N2NE4

Location:
Hot Springs Landing at the N end of Magic Reservoir.

Survey Date: 1994-09-19
Last Observed: 1994-09-19
First Observed: 1970

EORANK: D
EORANK Comments: Site developed with nothing natural at the source; little/no restoration potential.
Aquatic Data:
Ross (1970) reports discharge 0.3 cfs and temperature 36 degrees C. 1994: Cursory visit by Bob Moseley, Idaho CDC. 1 source spring, very hot water with high discharge rate.

Habitat Description:
Bedrock geology: volcanic (basalt). Surrounding vegetation is sagebrush-steppe. Totally disturbed habitat.

Minimum Elevation: 4800 feet
Maximum Elevation: feet
Size: 50 OR MORE LINEAR M

Ownership Comments:
Private land.

Protection Comments:
Spring is developed (for greenhouses?) and channelized, totally devoid of natural vegetation. Disturbance is ongoing. A tub has been placed at the edge of the reservoir. Surrounding land is used for grazing, reservoir, and some kind of industrial activity around the spring.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 073

Site Name: CONDIE HOT SPRING

County: Blaine

USGS quadrangle: CAREY

Latitude: 431957N Longitude: 1135458W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001S021E	14	BO	NW4SE4, SE4SE4

Location:
2 hot springs at the NE end of Carey Lake. 1 is N of U.S. Route 20/26/93, the other is S of the highway (Condie Hot Spring). Ca 1.5 air miles NE of Carey, just outside the Carey Lake WMA.

Survey Date: 1995-08-08
Last Observed: 1995-08-08
First Observed: 1970

EORANK: D?
EORANK Comments:
Aquatic Data:
Ross (1970) reports discharge 1.0 cfs and temperature 44 degrees C. Parliman and Young (1992) from a 1972 sample report temperature 52 degrees C, conductivity 607 umhos, pH 7.3, and total alkalinity 295 mg/l as $CaCO_3$. Both Ross and Parliman and Young data are from the SE4SE4 spring (Condie). Idaho Department of Water Resources reports diversion rates at the spring N of the highway as 0.04-0.06 cfs and S of the highway (Condie) as 0.08 cfs. 1995: Cursory visit by Bob Moseley, Idaho CDC.

Habitat Description:
Bedrock geology: basalt or alluvium. Surrounding vegetation is sagebrush-steppe. Spring source and channel N of the highway is not visible in a thick stand of Typha. Condie Hot Spring (S of the highway) was not visited and may be developed.

Minimum Elevation: 4770 feet
Size:

Ownership Comments: Private land adjacent to state land (IDFG).

Protection Comments: Condie Hot Spring (SE4SE4) appears to be in the middle of a ranch/agriculture operation with a lot of disturbance in the immediate vicinity. The source may be developed. Surrounding landuse is agriculture and wildlife habitat (Carey Lake WMA).

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 074
Site Name: Huff CREEK
County: Blaine
USGS quadrangle: PADDELFORD FLAT
Latitude: 432157N Longitude: 1134647W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001S022E	01	BO	N2

Location: Hot springs at the head of Huff Creek, less than 0.25 mile N of U.S. Route 20/26/93. Between the southern edge of the Pioneer Mountain foothills and lava plains. Ca 10 miles E of Carey. Also known as Wild Rose Hot Spring.

Survey Date: 1995-08-08 Last Observed: 1995-08-08 First Observed: 1970
EORANK: B
EORANK Comments: Site little disturbed, largely natural; minor recreational development and/or concentrated animal use.

Aquatic Data: Ross (1970) reports temperature 27 degrees C. Parliman and Young (1992) from a 1989 sample report temperature 42 degrees C, conductivity 578 umhos, pH 7.0, and total alkalinity 233 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.14 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2+ source springs, temperature 37 degrees C, conductivity 690 umhos, and pH 6.6.

Habitat Description: Bedrock geology: probably metamorphic, near contact with volcanics. Surrounding vegetation is sagebrush-steppe. Thermally influenced wetland occurs in a small basin between a lava flow and the foothills of the Pioneer Mtns. Creek runs along the N edge of the lava flow. Vegetation is largely a near monotypic stand of Scirpus americanus. A small patch of Eleocharis rostellata is also present. A small stand of Salix geyeriana with heavily grazed understory occurs below the thermally influenced zone. Sources downstream on private land are mostly natural, dominated by Scirpus americanus, although a primitive pool has been excavated in the channel.

Minimum Elevation: 4920 feet Maximum Elevation: 5000 feet Size: 3 AC

Ownership Comments: Upper Snake River Districts BLM, Monument RA, and private land.

Protection Comments: No pool development at the NE4 (BLM) spring. A dirt road runs along the uphill edge of the wet area. Cattle heavily graze the periphery of both springs, but very little grazing of the Scirpus americanus occurs. Subjective rating of use by domestic livestock is 3 (1-4 scale, little to heavy) occurring during the summer. A pool has been developed at the private spring.
Management Comments: Plot 95RM029 is located in the small stand of Salix geyeriana.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 075

Site Name: WARDROP HOT SPRING

County: Camas

USGS quadrangle: SMOKY DOME

Latitude: 432258N Longitude: 1145554W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001N013E	32	BO	NW4NE4

Location:
Between Corral Creek and Lansing Creek at the N edge of the Camas Prairie. Ca 3 miles N of Corral.

Survey Date:
Last Observed: 1989
First Observed: 1924-07-13

EORANK: D
EORANK Comments: Developed spring, extent of development is unknown.

Aquatic Data:
Ross (1970) reports conductivity 325 umhos. Parliman and Young (1992) from a 1989 sample report temperature 65 degrees C, conductivity 249 umhos, pH 9.3, and total alkalinity 99 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate from the springs totaling 0.2 cfs.

Habitat Description:
Bedrock geology: alluvium near granite. Surrounding area is agricultural land. Spring is developed.

Minimum Elevation: 5160 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land.

Protection Comments:
Developed spring near residential buildings. Extent of development is unknown. Surrounding land use is agricultural and residential.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 076

Site Name: HAILEY HOT SPRINGS

County: Blaine

USGS quadrangle: HAILEY

Latitude: 433020N Longitude: 1142117W

TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
002N018E 18 BO NW4SE4

Location:
Hailey Hot Springs, lower Democrat Gulch near the confluence with Croy Creek. Ca 2 miles W of Hailey.

Survey Date: 1994-09-19
Last Observed: 1994-09-19
First Observed: 1954-08-10

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data:
Ross (1970) reports discharge 0.1 cfs and temperature 58 degrees C. Parliman and Young (1992) from a 1988 sample report temperature 60 degrees C, conductivity 326 umhos, pH 9.6, and total alkalinity 78 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a measured flow of all hot springs as 1.35 cfs.
1994: Cursory visit by Bob Moseley, Idaho CDC.

Habitat Description:
Surrounding vegetation is sagebrush-steppe. Developed springs, but, despite lots of alteration, large areas of Eleocharis palustris and Salix communities remain - restoration potential exists.

Minimum Elevation: 5440 feet
Maximum Elevation: feet
Size: 2 AC

Ownership Comments: Private land.

Protection Comments: Springs have been ditched, dammed, drained, and piped. Surrounding land use is farming, ranching, and most recently ranchette development. The area receives light summer use by domestic livestock.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 077

Site Name: CLARENDON HOT SPRINGS

County: Blaine

USGS quadrangle: MAHONEY BUTTE

Latitude: 433337N Longitude: 1142451W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
003N017E	27	BO	W2W2SE4

Location:
Clarendon Hot Springs along Deer Creek. Ca 4.5 miles up FS Road 097 from U.S. Route 93.

Survey Date: 1994-09-19 Last Observed: 1994-09-19 First Observed: 1940-11-01

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

Aquatic Data:
Ross (1970) reports discharge 0.2 cfs and temperature 52 degrees C. Parliman and Young (1992) from a 1988 sample report temperature 50 degrees C, conductivity 387 umhos, pH 9.1, and total alkalinity 77 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.130 cfs. 1995: 1 source spring. Cursory visit by Bob Moseley, Idaho CDC.

Habitat Description:
Surrounding vegetation is sagebrush-steppe and riparian. Spring source not developed. Water flows down a moderately steep slope (25%), with a narrow thermally-influenced zone, and into a reservoir before dumping into Deer Creek.

Minimum Elevation: 5700 feet
Maximum Elevation: feet
Size: 50 LINEAR M

Ownership Comments: Private land adjacent to Sawtooth NF, Ketchum RD.

Protection Comments: Reservoir has been developed. Some water may possibly be diverted into nearby houses for heating. The surrounding land use is residential.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 078

Site Name: FRENCHMANS BEND

County: Blaine

USGS quadrangle: GRIFFIN BUTTE

Latitude: 433827N Longitude: 1142914W

TOWNRANGE:	SECTION:		MERIDIAN:	TRSNOTE:
004N016E	36		BO	NE4NE4

Location:
Also known as Warfield Hot Spring. Along Warm Springs Creek, ca 6.5 air miles SW of Ketchum.

Survey Date: 1994-09-19
Last Observed: 1994-09-19
First Observed: 1970

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data:
Ross (1970) reports discharge 1.0 cfs. Parliman and Young (1992) from a 1988 sample report temperature 58.5 degrees C, conductivity 324 umhos, pH 9.1, and total alkalinity 80 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.020 cfs. 1995: 3 source springs. Area thoroughly surveyed by Bob Moseley, Idaho CDC.

Habitat Description:
Surrounding vegetation is Pseudotsuga menziesii forest. All sources emanate near high water of Warm Springs Creek. Pools developed at all sources and road fill impinges on the uphill side of sources on the N side of the creek. No vegetation.

Minimum Elevation: 6240 feet

Ownership Comments:
Sawtooth NF, Ketchum RD; adjacent to private land.

Protection Comments:
Pools have been developed and road fill impinges on the uphill side of the sources on the N side of the creek.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 079

Site Name: GUYER HOT SPRINGS

County: Blaine

USGS quadrangle: GRIFFIN BUTTE

Latitude: 434100N Longitude: 1142435W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
004N017E	15	BO	E2NE4

Location:
Guyer Hot Springs (also known as Bald Mountain Hot Springs).
Along Warm Springs Creek at the W end of the Ketchum city limits.

Survey Date: 1994-09-19 Last Observed: 1994-09-19 First Observed: 1970

EORANK: D
EORANK Comments: Site developed with nothing natural at the source; little/no restoration potential.

Aquatic Data:
Ross (1970) reports discharge 1.0 cfs and temperature 77 degrees C. Parliman and Young (1992) from a 1987 sample report temperature 70.5 degrees C, conductivity 410 umhos, pH 8.8, and total alkalinity 78 mg/l as $CaCO_3$. Idaho Department of Water Resources reports diversion rates ranging from 1.0 to 4.0 cfs.
1994: Cursory visit by Bob Moseley, Idaho CDC.

Habitat Description:
Surrounding vegetation is Pseudotsuga menziesii forest. Developed springs.

Minimum Elevation: 5920 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land adjacent to Sawtooth NF, Ketchum RD.

Protection Comments:
Springs are totally developed and diverted for heating of homes along lower Warm Springs Creek in Ketchum.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 080

Site Name: EASLEY HOT SPRINGS

County: Blaine

USGS quadrangle: EASLEY HOT SPRINGS

Latitude: 434645N Longitude: 1143219W

TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
005N016E 10 BO NE4SW4; unsurveyed

Location:
Easley Hot Springs along the S side of the Big Wood River ca 14 road miles N of Ketchum.

Survey Date: 1994-09-19 Last Observed: 1994-09-19 First Observed: 1970

EORANK: D
EORANK Comments: Site developed with nothing natural at the source; little/no restoration potential.

Aquatic Data: Ross (1970) reports discharge 0.2 cfs and temperature 37 degrees C. Parliman and Young (1992) from a 1988 sample report temperature 37.5 degrees C, conductivity 334 umhos, pH 9.6, and total alkalinity 68 mg/l as CaCO3. Idaho Department of Water Resources reports flows from two springs at 0.17 and 0.05 cfs. 1994: 4 source springs. Area thoroughly surveyed by Bob Moseley, Idaho CDC.

Habitat Description: Surrounding vegetation is Pseudotsuga menziesii forest. The majority of the hot water is plumbed at the source on the hillside above the pool. 3 small springs surface on the floodplain along the Big Wood River below the pool. Small area of Eleocharis rostellata. Muhlenbergia richardsonis also prominent in places.

Minimum Elevation: 6600 feet Size:

Ownership Comments:Sawtooth NF, along boundary of Ketchum RD and Sawtooth NRA.

Protection Comments:
Developed residential/summer home area. Majority of springs are plumbed at the source for showers, pools, and heating.

Management Comments: The land is currently leased to the Idaho Baptist Convention.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 081
Site Name: RUSSIAN JOHN HOT SPRING
County: Blaine
USGS quadrangle: EASLEY HOT SPRINGS
Latitude: 434820N Longitude: 1143458W
TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
006N016E 32 BO SW4SW4; unsurveyed

Location:
Upper Big Wood River valley, near Russian John Guard Station. Ca 17 road miles N of Ketchum.

Survey Date: 1995-08-08 Last Observed: 1995-08-08 First Observed: 1970
EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

Aquatic Data: Ross (1970) reports discharge 0.1 cfs and temperature 39 degrees C. Parliman and Young (1992) from a 1988 sample report temperature 34 degrees C, conductivity 324 umhos, pH 9.2, and total alkalinity 78 mg/l as CaCO3. Idaho Department of Water Resources reports diversion rates ranging from 0.020 to 0.076 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 3 source springs, temperature 32 degrees C, conductivity 409 umhos, pH 9.4, and total alkalinity 84 mg/l as CaCO3.

Habitat Description: Bedrock geology: alluvium (granitic?). Surrounding vegetation is largely shrub-steppe with some coniferous forest. Spring W of road discharges on a slope. The stream spreads out and a wide area of Eleocharis pauciflora dominates the thermally influenced area of the slope and is heavily grazed by deer. Lots of green algae in the stream. On a gentle slope below the road, 2 more thermal areas discharge in addition to the stream from the upper spring. Mostly open water with much exposed soil or gravel and rocks. Very low cover of Eleocharis pauciflora. Juncus balticus is prominent in graminoid turf adjacent to the E. pauciflora community, possibly as a result of livestock grazing. Several cold springs also emanate from the pasture. All eventually flow into the nearby Big Wood River.

Minimum Elevation: 6837 feet Size: 2 +- AC

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: Source spring W of the highway has been dug out into a large pool and the vicinity has been heavily trampled. This is a well-used spring. The lower springs are in a Forest Service horse pasture that is lightly grazed. Wildlife use of the area is heavy.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 082

Site Name: PIERSON SPRING

County: Custer

USGS quadrangle: ALTURAS LAKE

Latitude: 435924N Longitude: 1144800W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
008N014E	27	BO	NE4SE4

Location:
Sawtooth Valley, S side of Warm Creek, below (W of) Valley Road. Ca 6 miles S of Obsidian.

Survey Date: 1995-08-25 Last Observed: 1995-08-25 First Observed: 1970

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

Aquatic Data:
Ross (1970) reports discharge 0.7 cfs and temperature 49 degrees C. Parliman and Young (1992) from a 1979 sample report temperature 42 degrees C, conductivity 243 umhos, pH 9.3, and total alkalinity 74 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.04 cfs. 1995: Cursory visit by Bob Moseley, Idaho CDC.

Habitat Description:
Bedrock geology: alluvium or granite. Surrounding vegetation is graminoid wetland and shrub-steppe upland. Occurs on a gentle, W-facing, valley-bottom slope in the middle of a cattle pasture surrounded by graminoid vegetation.

Minimum Elevation: 6900 feet
Maximum Elevation: feet
Size:

Ownership Comments: Private land.

Protection Comments:
The surrounding area is grazed. A pool has been developed for soaking (per John Shelly, Sawtooth NF, Fairfield RD).

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 083
Site Name: ROCKY MOUNTAIN RANCH
County: Custer
USGS quadrangle: OBSIDIAN
Latitude: 440605N Longitude: 1145155W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
009N014E	18	BO	SW4SW4SE4, E2E2SW4
009N014E	19	BO	center N2N2

Location:
Low river terrace on the W side of the Salmon River, across from the Idaho Rocky Mountain Ranch, Sawtooth Valley.
Survey Date: 1995-08-25 Last Observed: 1995-08-25 First Observed: 1970
EORANK: AD
EORANK Comments: Upper spring is undisturbed (A) except for some light grazing. The lower spring is developed (D).

Aquatic Data: Ross (1970) reports temperature 41 degrees C. Parliman and Young (1992) from a 1979 sample report temperature 47 degrees C, conductivity 277 umhos, pH 9.4, and total alkalinity 75 mg/l as CaCO3. Idaho Department of Water Resources reports lower spring diversion rate of 0.080 cfs and temperature 110-112 degrees F at the point of diversion. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 source springs, temperature 47 degrees C at the hottest source but most are cooler, conductivity 361 umhos, pH 8.7, and total alkalinity 81 mg/l as CaCO3.

Habitat Description:Bedrock geology: alluvium. Surrounding vegetation: graminoid wetland; sagebrush-steppe and Pinus contorta forest on adjacent slope. Upper spring emanates from alluvium on terrace and flows at very low gradient N to the Salmon River. The thermal influence diminishes rapidly because the spring is not very hot, has a low discharge, and mixes with cold water that subirrigates adjacent wetlands. Eleocharis pauciflora is the dominant vegetation adjacent to thermal channels. There is a considerable amount of green and yellow-brown algae in the channels. Some vegetation is underlain by quaking peat, but this is probably more from being subirrigated by cold water.

Minimum Elevation: 6600 feet Size: 1 AC

Ownership Comments:Sawtooth NF, Sawtooth NRA, and private land.

Protection Comments:Upper spring is undisturbed except for some light grazing. The lower spring is captured at the source and piped across the river to heat the swimming pool at the ranch. Use by both wildlife and domestic livestock (horses) is light, mostly occurring in the summer.

Management Comments: Site of plot 95RM031.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 084
Site Name: STANLEY
County: Custer
USGS quadrangle: STANLEY
Latitude: 441325N Longitude: 1145542W
TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
010N013E 03 BO NE4SW4

Location: On both sides of State Route 75, along the W side of the Salmon River immediately upstream from its confluence with Valley Creek. Near the turnoff to the Salmon River Lodge, Stanley.

Survey Date: 1995-08-25 Last Observed: 1995-08-25 First Observed: 1970
EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.
Aquatic Data: Ross (1970) reports discharge 0.9 cfs, temperature 49 degrees C, and conductivity 300 umhos. Parliman and Young (1992) from a 1979 sample report temperature 41 degrees C, conductivity 273 umhos, pH 8.8, and total alkalinity 71 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.130 cfs. 1995: Area surveyed by Bob Moseley, Idaho CDC. 6 source springs, one main spring and five seeps; temperature 34 degrees C, conductivity 347 umhos, pH 9.3, and total alkalinity 77 mg/l as $CaCO_3$.

Habitat Description: Bedrock geology: alluvium. Surrounding vegetation is sagebrush-steppe and riparian along the Salmon River and Valley Creek. Source springs discharge on flat to gentle slopes in alluvium. Most of the thermally influenced area is dominated by Eleocharis pauciflora, with small areas of Scirpus americanus. These types grade into other wetland communities associated with the riparian zone of the river and creek.

Minimum Elevation: 6220 feet Size: 1 AC

Ownership Comments: Sawtooth NF, Sawtooth NRA, and private land.

Protection Comments: A cement pool was constructed at the largest spring source, which was filled with gravel, then partially reexcavated. It is no longer used for bathing. State Route 75 bisects the thermally influenced area and certainly destroyed some of the area with roadbed fill. 3 source areas on the E side of the road are largely undisturbed. Source springs on the W side of the road are in a Forest Service horse pasture. The surrounding land use is residential, pasture, and recreation.
Management Comments: Plot 95RM030 established at this site.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 085

Site Name: UPPER ELKHORN HOT SPRING

County: Custer

USGS quadrangle: STANLEY

Latitude: 441440N Longitude: 1145306W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N013E	36	BO	E2NE4NW4

Location:
N side of the Salmon River, below State Route 75. Just above river mile 376. Ca 2 miles ENE of Lower Stanley. Also known as First Bend Hot Spring.

Survey Date: 1995-09-08 Last Observed: 1995-09-08 First Observed: 1979-09-14

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data:
Parliman and Young (1992) from a 1979 sample report temperature 59 degrees C, conductivity 326 umhos, pH 9.4, and total alkalinity 86 mg/l as $CaCO_3$. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 source springs, temperature 56 degrees C, conductivity 421 umhos, pH 9.2, and total alkalinity 112 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granitic. Surrounding vegetation is shrub-steppe and Pseudotsuga menziesii forest. No vegetation. Water runs from road fill into river. Considerable trampling by bathers. There is also a small seep that comes out of river gravels below high water ca 700 feet downstream on the same side of the river.

Minimum Elevation: 6160 feet Size: 300 SQ FT

Ownership Comments: Sawtooth NF, Sawtooth NRA. State land is south of the river.

Protection Comments:
State Route 75 was built over the source spring. Water exits road fill in a pipe, runs down to fill a bathing tub, then into a primitive pool constructed at river level.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 086

Site Name: LOWER ELKHORN HOT SPRING

County: Custer

USGS quadrangle: STANLEY

Latitude: 441451N Longitude: 1145257W

TOWNRANGE: SECTION: MERIDIAN: TRSNOTE:
011N013E 25 BO S2SW4SE4

Location:
S side of the Salmon River, opposite and slightly upstream of the mouth of Elkhorn Creek. Ca river mile 376.75. Ca 3 miles downstream from Stanley.

Survey Date: 1995-08-25 Last Observed: 1995-08-28 First Observed: 1970

EORANK: B
EORANK Comments: Site little disturbed, largely natural; minor recreational development and/or concentrated animal use.

Aquatic Data: Ross (1970) reports temperature 57 degrees C and conductivity 328 umhos. Parliman and Young (1992) from a 1979 sample report temperature 55 degrees C. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 1 source spring, temperature 55 degrees C, conductivity 430 umhos, pH 9.1, and total alkalinity 104 mg/l as $CaCO_3$.

Habitat Description: Bedrock geology: granite and/or alluvium. Surrounding vegetation: Pinus contorta and Pseudotsuga menziesii forest upslope. Hot stream flows for ca 30 m down a ca 5% slope to the Salmon River. Orange algae in stream. Narrow band of thermally influenced wetland vegetation on either side of the creek, largely consisting of Eleocharis pauciflora. Green algae in source pool. High diversity of vascular flora for a relatively small area.

Minimum Elevation: 6160 feet Size: 150 SQ M

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: 1 small primitive pool was constructed at the source. An active, large primitive pool has been constructed just above high water. The intervening area is undisturbed. The area is isolated from heavier use since it's on the S side of the river. Light use of the area by wildlife in the summer.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 087

Site Name: MORMON BEND

County: Custer

USGS quadrangle: EAST BASIN CREEK

Latitude: 441537N Longitude: 1145010W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N014E	29	BO	N2NE4NE4

Location:
S side of the Salmon River, immediately downstream from Mormon Bend Campground. Ca 6.5 miles downstream from Stanley.

Survey Date: 1995-09-08 Last Observed: 1995-09-08 First Observed: UNKNOWN

EORANK: C
EORANK Comments: Site disturbed by pool development, channel alteration, animal use and/or nearby development; some natural portions remain intact.

Aquatic Data:
1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 3 source springs, 1 major spring upstream and two smaller hot seeps downstream. Temperature 55 degrees C, conductivity 382 umhos, pH 9.2, and total alkalinity 98 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granitic. Surrounding vegetation is Pseudotsuga menziesii forest. Upstream spring pops out of the river bank just above high water and flows a few feet downslope into the river. No communities and a few species in the thermally influenced zone.

Minimum Elevation: 6120 feet
Maximum Elevation: feet
Size: 0.1 AC OR LESS

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments:
2 primitive pools constructed below high water along the river.
Light wildlife use of the area.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 088
Site Name: BASIN CREEK CAMPGROUND COMPLEX
County: Custer
USGS quadrangle: EAST BASIN CREEK
Latitude: 441545N Longitude: 1144907W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N014E	21	BO	S2SE4, SW4NE4SE4
011N014E	22	BO	NW4SW4SW4

Location: Across Basin Creek from Basin Creek Campground, ca 200 m upstream from its confluence with the Salmon River. Includes 2 hot seeps along the Salmon River 0.2 mile upstream and downstream from the mouth of Basin Creek.

Survey Date: 1995-08-25 Last Observed: 1995-08-25 First Observed: 1954-09-09
EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.
Aquatic Data: Ross (1970) reports temperature 59 degrees C and conductivity 345 umhos. Parliman and Young (1992) from a 1972 sample report temperature 38 degrees C (a 1954 sample reports 59 degrees C), conductivity 304 umhos, pH 8.8, and total alkalinity 77 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.290 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 3 source springs, 1 main spring near the campground and 2 small sources along the Salmon River. temperature 58 degrees C, conductivity 425 umhos, pH 9.1, and total alkalinity 105 mg/l as $CaCO_3$.

Habitat Description: Bedrock geology: granite. Surrounding vegetation: sagebrush-steppe on slopes, riparian willow along the creek. A single spring discharges into Basin Creek near the normal, low-water level. Essentially no vegetation associated with the thermally influenced area. Site is flooded annually by Basin Creek. 2 other small hot water sources discharge in river gravels along the Salmon River near the confluence with Basin Creek. The upstream source is on the S side of the river and the downstream source is on the N side of the river. Both are below high water and have minimal flow.

Minimum Elevation: 6070 feet Size: 0.1 AC OR LESS

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: Main spring discharges into a series of primitive pools built along the creek. The campground is just across the creek.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 089

Site Name: ROBINSON BAR

County: Custer

USGS quadrangle: ROBINSON BAR

Latitude: 441448N Longitude: 1144036W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N015E	27	BO	SE4SE4; unsurveyed
011N015E	34	BO	NE4NE4; unsurveyed

Location:
Near the mouth of Warm Springs Creek on Robinson Bar, along the S side of the Salmon River.

Survey Date:
Last Observed: 1979-09-13
First Observed: 1954-09-09

EORANK: D?
EORANK Comments: Site developed with nothing natural at source; little/no restoration potential.

Aquatic Data:
Ross (1970) reports discharge 0.1 cfs, temperature 53 degrees C, and conductivity 359 umhos. Parliman and Young (1992) from a 1979 sample report temperature 56 degrees C, conductivity 351 umhos, pH 9.4, and total alkalinity 98 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate ranging from 0.02 to 0.15 cfs.

Habitat Description:
Bedrock geology: alluvium. Surrounding vegetation is Pseudotsuga menziesii forest. Developed springs.

Minimum Elevation: 5923 feet
Maximum Elevation: feet
Size:

Ownership Comments: Private land.

Protection Comments:
Loam (1980) notes that the springs are diverted into developed soaking and swimming pools.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 090

Site Name: SLATE CREEK HOT SPRING

County: Custer

USGS quadrangle: LIVINGSTON CREEK

Latitude: 441015N Longitude: 1143727W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
010N016E	30	BO	SE4NW4; unsurveyed

Location:
Slate Creek Hot Spring. Ca 6.5 miles S on Slate Creek Road (FS Road 666) from the Salmon River. Below the Hoodoo Mine. Ca 15 air miles ESE of Stanley.

Survey Date: 1995-09-08 Last Observed: 1995-09-08 First Observed: 1954-09-09

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.
Aquatic Data: Ross (1970) reports discharge 0.4 cfs, temperature 51 degrees C, and conductivity 448 umhos. Parliman and Young (1992) from a 1979 sample report temperature 50 degrees C, conductivity 443 umhos, pH 8.6, and total alkalinity 110 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.430 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 3+ source springs, temperature 50 degrees C, conductivity 578 umhos, pH 8.2, and total alkalinity 138 mg/l as $CaCO_3$.

Habitat Description: Bedrock geology: metamorphic. Surrounding vegetation: Pseudotsuga menziesii forest. Springs emanate from hillside on the W side of Slate Creek and flow for up to 20 m down the valley bottom into Slate Creek. The full extent of the thermal area has been disturbed to some degree in the past. Vegetation consists of disturbance species. Overall, species diversity is low.

Minimum Elevation: 7040 feet Size: 0.5 AC

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: The full extent of the thermally influenced area has been disturbed to some degree via channelization, diversion, damming, and pool/tub construction. Most source springs were covered by construction of the road to the mine and now discharge from the fill slope.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 091

Site Name: SULLIVAN HOT SPRINGS

County: Custer

USGS quadrangle: CLAYTON

Latitude: 441515N Longitude: 1142634W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
011N017E	27	BO	center of section

Location:
Sullivan Hot Springs, S side of the Salmon River at the mouth of Sullivan Creek. Ca 2 miles upstream from Clayton.

Survey Date:
Last Observed: 1983-11-02
First Observed: 1954-09-09

EORANK: D?
EORANK Comments: Springs apparently developed.

Aquatic Data:
Ross (1970) reports discharge 0.4 cfs, temperature 41 degrees C, and conductivity 1120 umhos. Parliman and Young (1992) from a 1983 sample report temperature 40 degrees C, conductivity 1030 umhos, pH 6.9, and total alkalinity 454 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: pre-Tertiary. Springs apparently developed.

Minimum Elevation: 5536 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land.

Protection Comments:
Springs are apparently developed.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 092
Site Name: WEST PASS CREEK

County: Custer
USGS quadrangle: RYAN PEAK
Latitude: 435853N Longitude: 1142905W

TOWNRANGE:	SECTION:		MERIDIAN:	TRSNOTE:
008N017E	32	BO	NW4	

Location:
Along the S side of West Pass Creek near its confluence with the East Fork Salmon River. Ca 24 air miles SE of Stanley.

Survey Date: 1995-09-08 Last Observed: 1995-09-08 First Observed: 1970

EORANK: B
EORANK Comments: Site little disturbed, largely natural; minor recreational development and/or concentrated animal use.
Aquatic Data: Ross (1970) reports discharge 1.0 cfs and temperature range 21-49 degrees C. Parliman and Young (1992) from a 1980 sample report temperature 52.5 degrees C, conductivity 643 umhos, pH 8.5, and total alkalinity 217 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.020 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 2 main source areas, temperature 50 degrees C, conductivity 759 umhos, and pH 7.3.

Habitat Description: Bedrock geology: volcanics. Surrounding vegetation is sagebrush-steppe and Pseudotsuga menziesii forest. 2 main source areas. The higher one emanates from a high bench and flows down a steep slope into the creek. The lower one has several small springs along the base of a bench and the thermally influenced area is quite wide as it flows across the stream terrace and eventually into the East Fork Salmon River. Extensive unvegetated areas near the source with surface water and yellow-brown algae. Eleocharis rostellata is a predominant community with small areas of Scirpus americanus.

Minimum Elevation: 6780 feet Size: 2 AC

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: Cattle graze throughout the site. Some hot water from the lower spring is diverted to a nearby cow camp. Bathing tubs have been constructed at the upper spring. Subjective estimate of ungulate use is (on a 1-4 scale, little to heavy) 3 for domestic livestock and 2 for wildlife with most use occurring during the summer. The surrounding land use is recreation, grazing, and mining.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 093

Site Name: BOWERY HOT SPRINGS

County: Custer

USGS quadrangle: RYAN PEAK

Latitude: 435827N Longitude: 1142958W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
008N017E	31	BO	center S2

Location: Along the East Fork Salmon River near Bowery Guard Station. Ca 0.5 mile beyond the end of the road.

Survey Date: 1995-09-08 Last Observed: 1995-09-08 First Observed: 1970

EORANK: A
EORANK Comments: Site largely undisturbed, except possibly a small pool away from source.
Aquatic Data: Ross (1970) reports discharge 0.7 cfs and temperature range 24-43 degrees C. Parliman and Young (1992) from a 1980 sample report temperature 52.5 degrees C, conductivity 562 umhos, pH 8.5, and total alkalinity 159 mg/l as $CaCO_3$. Idaho Department of Water Resources reports a diversion rate of 0.110 cfs. 1995: Area thoroughly surveyed by Bob Moseley, Idaho CDC. 5+ source springs, temperature 47 degrees C, conductivity 664 umhos, and pH 7.2.

Habitat Description: Bedrock geology: volcanics. Surrounding vegetation is aspen and sagebrush-steppe. Several springs emanate from a bench above the river and flow across the bench, down slopes and eventually into the East Fork Salmon River. Eleocharis rostellata is the most common community on the flats and on moderate to steep slopes. Other communities include Eleocharis pauciflora and Scirpus americanus. Quaky, organic substrates are common on the flats. There is also an extensive unvegetated area with a thin layer of surface water and yellow-brown algae near the source springs.

Minimum Elevation: 6800 feet

Ownership Comments: Sawtooth NF, Sawtooth NRA.

Protection Comments: A tub has been placed next to the river with minimal impacts on the site. Little use by livestock and wildlife occurring mostly during the summer.

Management Comments:Site of plots 95RM032 and 95RM033.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 094

Site Name: ELK CREEK HOT SPRINGS

County: Camas

USGS quadrangle: CANNONBALL MOUNTAIN

Latitude: 432523N Longitude: 1143739W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001N015E	14	BO	NE4SE4NE4

Location:
Elk Creek Hot Springs. Foothills of the Soldier Mountains, N edge of the Camas Prairie. Ca 10 air miles NE of Fairfield.

Survey Date:
Last Observed: 1989-05-03
First Observed: 1924-07-13

EORANK:
EORANK Comments:

Aquatic Data:
Parliman and Young (1992) from a 1989 sample report temperature 54 degrees C, conductivity 424 umhos, pH 9.0, and total alkalinity 86 mg/l as $CaCO_3$.

Habitat Description:
Bedrock geology: granite - volcanic contact. Surrounding vegetation is sagebrush-grass.

Minimum Elevation: 5680 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 095

Site Name: BARRON HOT SPRINGS

County: Camas

USGS quadrangle: CORRAL

Latitude: 431734N Longitude: 1145431W

TOWNRANGE:	SECTION:		MERIDIAN:	TRSNOTE:
001S013E	34	BO	SW4NW4	

Location:
S side of the Camas Prairie along Camas Creek. NE side of Johnson Hill. Ca 7 air miles SW of Fairfield and 1.5 miles S of Punkin Corner.

Survey Date:
Last Observed: 1989-05-03
First Observed: 1924-07-26

EORANK: D?
EORANK Comments: Springs developed.

Aquatic Data:
Parliman and Young (1992) from a 1989 sample report temperature 69 degrees C, conductivity 468 umhos, pH 8.0, and total alkalinity 183 mg/l as CaCO3. Idaho Department of Water Resources reports a diversion rate of 0.230 cfs.

Habitat Description:
Bedrock geology: alluvium near volcanics. Springs are apparently developed for domestic and stockwater use.

Minimum Elevation: 5050 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land.

Protection Comments:
Developed springs. Surrounding land use is agriculture.

THERMAL SPRINGS AQUATIC COMMUNITY
Occurrence Number: 096

Site Name: COW CREEK

County: Camas

USGS quadrangle: HILL CITY

Latitude: 432014N Longitude: 1150235W

TOWNRANGE:	SECTION:	MERIDIAN:	TRSNOTE:
001S012E	16	BO	SW4NW4

Location:
E of the county road that heads N from Hill City past the cemetery. Ca 2.5 miles N of Hill City.

Survey Date:
Last Observed: 1995
First Observed: 1995

EORANK: D
EORANK Comments: Site totally disturbed, but still somewhat seminative; good restoration potential.

Aquatic Data:
1995: Cursory visit by John Shelly, Sawtooth NF, Fairfield RD. No water data available.

Habitat Description:
Bedrock geology: alluvium. Shallow muddy spring in the middle of a cultivated field.

Minimum Elevation: 5120 feet
Maximum Elevation: feet
Size:

Ownership Comments:
Private land.

Comments:
Ross (1970) says the spring is in section 15, but Shelly says it's in section 16.

Protection Comments:
Spring is in the middle of a cultivated field.

APPENDIX 2

Conservation Data Center occurrence records for populations of
Epipactis gigantea, *Epilobium palustre*, and *Primula incana* in the study area.

NOTE: To save paper, this appendix is not included in all copies distributed.

EPIPACTIS GIGANTEA
GIANT HELLEBORINE
Occurrence Number: 022

Site Name: BAUMGARTNER HOT SPRINGS

County: Camas

USGS quadrangle: JUMBO MTN.

Location: Baumgartner Hot Springs on the South Fork Boise River, about 11 mi E of Featherville; populations scattered at three hot spring/seep outlets.

Survey Date: 1995-07-25
Last Observed: 1995-07-25
First Observed: 1989-08-09

EORANK: C
EORANK Comments: Small population, trampling impacts.

Population Data: 1989: 51-100 normal genets, 100% in immature fruit. Area surveyed by Bob Moseley, Idaho CDC. 1995: No change. Observation by Moseley.

Habitat Description: Saturated (wet-mesic), bottom, N aspect & flat, 0-35% slope; open and partial light.

Elevation: 4960 feet

Size: 20 SQ M

Land Owner/Manager: Sawtooth NF, Fairfield RD.

Protection Comments: Much disturbance associated with nature trail and hot spring development.

Management Comments: Continued trampling around nature trail threatens--restrict access to certain areas.

Specimens:

EPIPACTIS GIGANTEA
GIANT HELLEBORINE
Occurrence Number: 053

Site Name: SKILLERN HOT SPRINGS

County: Camas

USGS quadrangle: PARADISE PEAK

Location: Skillern Hot Springs along Big Smoky Creek. Ca 2.5 miles up FS Trail 072 from the trailhead at Canyon Campground.

Survey Date: 1995-07-26
Last Observed: 1995-07-26
First Observed: 1995-07-26

EORANK: A
EORANK Comments:

Population Data: 1995: Zillions of ramets, 5% vegetative and 95% in flower. Population age class structure is unknown. Population vigor assessed as very good - very dense and extensive. Area thoroughly surveyed by Bob Moseley, Idaho CDC.

Habitat Description: Hot seeps on steep to near vertical SE-facing slopes of granite outcrop above creek. *Oenothera hookeri, Carex cusickii,* and *Aster chilensis* are common associates.

Minimum Elevation: 5800 feet
Maximum Elevation: 6000 feet
Size: 1 AC

Land Owner/Manager: Sawtooth NF, Fairfield RD.

Protection Comments: Primitive hot pool construction has occurred in the area, but does not appear to affect Epipactis.

Specimens:

EPILOBIUM PALUSTRE
SWAMP WILLOW-WEED
Occurrence Number: 005

Site Name: BOWERY HOT SPRINGS

County: Custer

USGS quadrangle: RYAN PEAK

Location: Bowery Hot Springs, on bench (SE of) the East Fork Salmon River; ca 0.2 mile upstream and across the river from BoweryGuard Station.

Survey Date: 1990-08-15
Last Observed: 1995-09-08
First Observed: 1990-08-15

EORANK: BC
EORANK Comments:

Population Data:
1990: 11-50 normal genets in flower; restricted to a small patch of *Carex nebrascensis* within *Eleocharis rostellata* dominated fen; age structure appears to be well distributed. Area surveyed by Bob Moseley, Idaho CDC. 1994: Thomas Haberle, Sawtooth NRA, was unable to relocate the population. Bob Moseley relocated population in 1995. Included in ecological plot 95RM003.

Habitat Description: Saturated (wet-mesic); bottom; flat aspect; 0-3% slope; open light; Carex nebrascensis community; organic substrate near hot seeps; associated with *Eleocharis rostellata, Primula incana, Epilobium watsonii.*

Minimum Elevation: 6780 feet
Size: 1 - 5 SQ YD

Land Owner/Manager: Sawtooth NF, Sawtooth NRA.
Protection Comments: Threatened by cattle grazing.
Management Comments: Occurs with (near) Primula incana - wetland should be fenced.
Specimens: Moseley 2150 (ID).

PRIMULA INCANA
JONES' PRIMROSE
Occurrence Number: 002

Site Name: BOWERY HOT SPRINGS
County: Custer
USGS quadrangle: RYAN PEAK

Location: Bowery Hot Springs, on Bench above (SE of) the East Fork Salmon River; ca 0.2 mile upstream and across the river from Bowery Guard Station. And just NE of Bowery GS, along (west of) FS Road 120.

Survey Date: 1990-08-15 Last Observed: 1995-09-08 First Observed: 1983-08-05

Population Data: 1983: Occasional, flowers pale lilac with yellow eye, some plants with farinose leaf undersurface. Observation by Brunsfeld and Johnson. (Subpopulation NE of Bowery GS). 1990: 45 normal genets,15 in flower, 30 vegetative rosettes; age structure probably well distributed. Subpopulation SW of Bowery GS surveyed by Bob Moseley, Idaho CDC. 1994: SW subpopulation had ca 60 plants in flower on 6/29. Population appears vigorous. By 8/17, plants no longer locatable except for a few still carrying seedheads. NE subpopulation had ca 100-500 genets on 6/30, 10% vegetative, 90% in flower. Population age class structure is 10%? immature and 90%? in flower. Population vigor assessed as excellent. Observations on thorough surveys by Thomas Haberle, Sawtooth NRA. Bob Moseley relocated population in 1995. Included in ecological plot 95RM003.

Habitat Description: Saturated (wet-mesic); hummocky fen; bottom; flat aspect; 0-3% slope; open light; Eleocharis rostellata community; organic deposits around hot seeps; associated with *Aster eatonii, Agrostis, Parnassia palustris, Deschampsia cespitosa, Potentilla fruticosa, Viola palustris, Salix* spp., *Erigeron lonchophyllus, Carex nebrascensis, Senecio* sp., *Penstemon* sp., *Castilleja,Cerastium, Pedicularis,* and *Trifolium.*

Minimum Elevation: 6800 feet m Size: 5 - 10 SQ YD

Land Owner/Manager: Sawtooth NF, Sawtooth NRA.

Protection Comments: NE subpopulation is subject to grazing, although it doesn't seem to adversely effect the population. Road work that might result in debris being dumped to the west of FS Road 120 and any activity resulting in draining of the meadow are potential threats (TH).

Specimens: S. Brunsfeld 2126 (ID).

APPENDIX 3

Ecological plot forms from thermally-influenced wetlands in south-central Idaho.

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APPENDIX 4

Thermal Spring Community Observation Report.