3 Environmental Conditions

3.1 Characterization of Aquatic Habitat Conditions

3.1.1 Subbasin Scale

At the subbasin scale, high quality, coldwater habitat is restricted to headwater tributaries and portions of the Jarbidge watershed. Less complex, cool-warm water habitat exists throughout the remainder of the subbasin, but is variable due to climatic conditions. In general, tributary habitat is used for salmonid spawning and rearing, while some mainstem reaches provide migratory and overwintering habitat. Unique habitat conditions exist in the subbasin, affording habitat for specialized, nonsalmonid species.

Habitat of a quality sufficient to support all life history phases of redband trout and bull trout exists, but is limited in extent. Approximately 28% of stream channels in the subbasin are perennial. Drought conditions occur several times each decade, reducing the percentage of perennial streams and reducing habitat quality, especially in the lower portions of the subbasin.

To determine current stream health relative to potential natural conditions found on a particular stream segment, protocols developed by BLM were used (see BLM 1997, 2000; NRCS 2000 for specific methods), which define the ecological condition of streams into five categories: proper functioning condition (PFC), functioning at risk with an upward trend (FAR u), functioning at risk with a static trend (FAR na), functioning at risk with a downward trend (FAR d), and nonfunctioning condition (NF). Of the 131 stream segments surveyed in the subbasin between 1995 and 1999, 46% were considered to be in PFC while 3% were NF (Figure 38). Stream segments considered as NF occurred in the Clover Creek (East Fork Bruneau) subwatershed and include Cedar, Cherry, House, Pole, Shack, and Three creeks. Upward and downward trends of streams classified as FAR were similar, as were those FAR segments that showed little or no change.

3.1.2 Watershed Scale

The same BLM protocols were applied to assess riparian conditions in the Jarbidge Resource Area (JRA) for the 1998, 1999, and 2002 fiscal years (Figure 39). Although the “FAR u” classifications have increased over the assessment period, the percentages of riparian areas classified as “NF” have decreased.

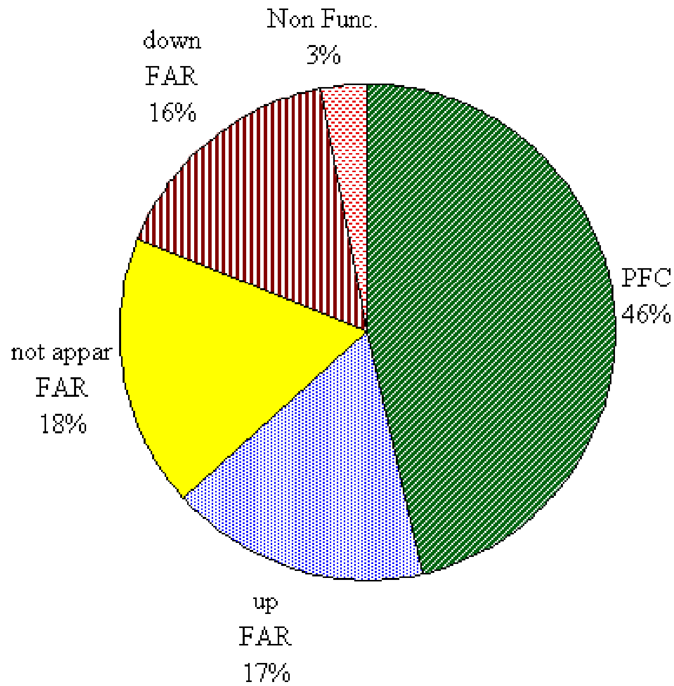

Figure 38. Known conditions of streams in the Bruneau subbasin (BLM unpublished data). PFC = properly functioning condition, FAR = functioning at risk, and NF = not functioning

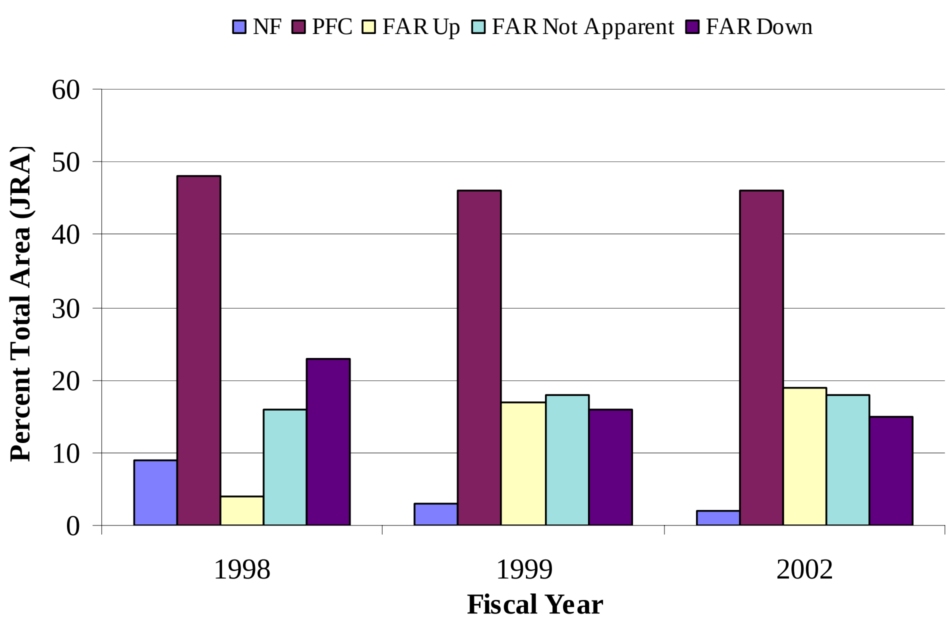

Figure 39. Riparian condition in the Jarbidge Resource Area for fiscal years 1998, 1999, and 2002 (BLM unpublished data).

3.1.2.1 Aquatic Habitat Condition of the Jarbidge Subwatershed

The majority of high quality coldwater aquatic habitat in the subbasin occurs in the Jarbidge watershed. This watershed has a sufficient quantity of suitable habitat to support bull trout. Spawning occurs only in the Nevada portion of the watershed (Parrish 1998).

The entire Jarbidge River within Idaho is considered a migratory corridor or wintering habitat for bull trout, with no perennial tributaries suitable for spawning or juvenile rearing purposes.

In the Idaho portion of the Jarbidge River system, Warren and Partridge (1993) found the substrates to be in excellent condition, to be dominated with gravel or rubble, with the highest percentages of silt or sand being 17%. The fish habitat was extremely variable with pools, runs, pocket water, and riffles and no backwater habitat. Although riparian vegetation was in good condition, few large trees existed to provide large woody debris or cover. Despite the survey taking place during a multi-year drought (starting in 1996), the streambed remained watered and the habitat diverse. Temperature in the Idaho portion of the East and West Forks and mainstem Jarbidge River limits bull trout use during much of the year, and during drought years, impacts redband and other species as well (Warren and Partridge 1993).

The geology of the Jarbidge contributes to a nutrient “poor” condition in the river system (Parrish 1998), which has been compounded following the loss of anadromy. Macroinvertebrate sampling found more than three times the productivity in the West Fork of the Jarbidge River as in the East Fork. The higher prevalence of large woody debris (LWD) in the West Fork could explain these differences in productivity (Parrish 1998).

Large woody debris in the Jarbidge system is sparse and concentrated in logjams. Most LWD is recruited from the forests in Nevada rather than the high deserts of Idaho (Parrish 1998). Large rocky structures provide most cover in the system, although some over-hanging banks and willows exist below the confluence of the East and West Fork in Idaho.

Most of the Jarbidge system has confined channels with little channel erosion. In 1979, the West Fork Jarbidge River in Nevada was channelized. Quality pools developed within 6 years of the project (Parrish 1998). No known barriers to fish exist in the Jarbidge system other than seasonal high water temperatures in the lower portion of the system. Protecting the Jarbidge Canyon Road from annual high water events has often included pre-flood treatment and channel work (USFS 1998). Flood control in the past has included blasting boulders, removal of large wood from the stream channel, heavy machinery work and an extensive channelization project (USFS 1998). Habitat conditions reflect the channel modifications. A 1985 GAWS survey found that 35% of quality pools in the Jarbidge River fell between RM 16.8 and RM 18.75, the upper 10% of the river. The East Fork Jarbidge River has nearly two times the number of pools as the Jarbidge River, even though the Jarbidge River has a narrower profile and higher volume of large wood (USFS 1998). A survey for LWD 1996 (USFS 1998) found that the upper 10% of the river above Snowslide Wilderness Portal (which has not been treated for flood control since at least 1974) exceeded Riparian Management Objectives for large wood. The reach below Snowslide Wilderness Portal, which had been treated for flood control, had only 25% of the Riparian Management Objective for large wood (USFS 1998).

Dave Creek (NV), a headwater tributary to the East Fork Jarbidge, is unique from other Jarbidge tributaries in that it is a lower gradient system and is less confined and therefore contains comparatively higher amounts of spawning gravels (Burton et al. 2001). Because of its lower gradient, Dave Creek contains, making it some of the most critical habitat for bull trout spawning and rearing (G. Johnson, NDOW, personal communication, April, 2004). Dave Creek has been impacted by roading, grazing, and other land use activities, which has resulted in elevated amounts of fine sediment, excessive width:depth ratios, and limited riparian coverage (Burton et al. 2001).

The Nevada Department of Wildlife has expressed interest in assuming management responsibilities in Dave Creek, either through land acquisition or through conservation easements. There are currently discussions between NDOW and the Rocky Mountain Elk Foundation to acquire a 4-mile reach of privately owned land to further bull trout protection and restoration objectives (B. Zoellick, BLM, personal communication, April, 2004). If outright purchase does not occur, NDOW and Rocky Mountain Elk Foundation would consider the acquisition of a conservation easement for a 1000 acre private grazing allotment on Dave Creek (for a period of 4 years or less depending on how long it will take BLM to work out a land exchange with the landowner), and fencing 4 miles along the creek, placing large woody debris into the stream channel, and restoring of bull trout habitat at one road crossing.

Water temperatures in the headwater areas of the Jarbidge River meet coldwater biota requirements in most years. The lower 60% of the river, however, may sustain afternoon water temperatures exceeding 18 °C from mid-July through mid-August, and water temperatures may fluctuate as much as 9 °C within a 12-hour period (McNeill et al. 1997). These temperatures affect bull trout. Zoellick et al. (1996) did not find bull trout in the Jarbidge River when water temperatures exceeded 14 °C. As water temperatures increase to unfavorable levels in July and August, bull trout are forced upstream and into tributaries that have lower water temperatures. Studies conducted by Warren and Partridge (1993) documented quality salmonid spawning and rearing habitat in 14 of 19 sites sampled on Idaho reaches of the Jarbidge. In general, sampled sites had low percentages of sand and silt and high percentages of gravel, cobble or rubble. These conditions were typical of high gradient sample sites. Jarbidge River habitat information collected in Nevada was consistent with Idaho surveys (McNeill et al. 1997). Due to the confined nature of the channel, sand, silt, and gravel are commonly deposited on the floodplain during high water events (McNeill et al. 1997).

The West Fork of the Jarbidge River has six perennial fish-bearing tributaries: Buck, Jack, Bear, Pine, and Fox creeks. Moore, Bonanza, Bourne, and Dry gulches are intermittent or ephemeral, contributing flow to the Jarbidge River on a seasonal basis. Total miles in the perennial tributaries and mainstem Jarbidge exceed 42 miles (McNeill et al. 1997).

Strong sculpin populations in the West Fork of the Jarbidge River below Snowslide Creek, indicate that embeddedness is low. Sculpins are benthic feeders that rely on cobble-boulder substrate for cover (McNeill et al. 1997).

Woody debris, which lends to channel complexity, is scarce in the unforested portions of the subbasin. Parrish (1998) found the amount of woody debris in the Idaho portion of the Jarbidge to be sparse and primarily concentrated in aggregates. Parrish (1998) proposes that the majority of LWD occurring in reaches bordered by the high desert plateaus of Idaho has been recruited from upriver forested areas of Nevada. Thirty-five percent of all pools in the Jarbidge River above the confluence with the East Fork are in the upper 10% of the river. Over 50% of the pools in this section are large wood-related pools, compared to only 7% of pools below this area (McNeill et al. 1997).

McNeill et al. (1997) considered the Jarbidge River watershed to be a system in recovery from intense land-use impacts that occurred between 1885 through 1945. They emphasized that current channel morphology and habitat is a product of 90 years of channel and riparian area modification from human activities and that low bull trout numbers are also a product of this modification (McNeill et al. 1997). Salmonid habitat in Clover Creek was identified as unstable.

3.1.2.2 Aquatic Habitat Condition of Other Salmonid-Bearing Subwatersheds

Habitat quality, as judged by the strength of salmonid populations, should also be considered adequate in redband stronghold areas. A study conducted by the Bruneau Resource Area BLM (BLM 1999) documented changes in stream habitat conditions in Little Jacks Creek over a fifteen-year period, and related accordant changes in redband population densities. Trout densities in Little Jacks Creek remained unchanged from 1980 to 1995, even with drought-like conditions from 1990-1994. High quality habitat exists in Little Jacks Creek, Big Jacks Creek, Duncan Creek and Cottonwood Creek. Lesser quality, but still valuable habitat exists in Wickahoney Creek. Wickahoney Creek habitat is impacted by periodic drought effects, which limit populations (Lay and IDEQ 2000). Redband strongholds also occur in the central portion of the West Fork of the Bruneau River, the Jarbidge watershed and headwater portions of Clover Creek (see Figure 26).

Sheep Creek and Marys Creek contain aquatic habitat of sufficient quality to support redband trout in most years. These creeks have been know to completely dry up under drought conditions (BLM 1989; Allen et al. 1995, 1996)

In the Humboldt-Toiyabe National Forest stream surveys conducted between 1988 and 1992 documented a total of 16.9 miles of stream habitat (11.3%) in good condition, 118.1 miles (79%) in fair condition and 14.5 miles (9.7%) in poor condition (USFS 1995). Limiting factors identified by these surveys were water flow, streambank cover, pool quality, stream bottom embeddedness, and pool-riffle ratios. Stream widths of many of the higher order streams, especially the Bruneau River itself, were deemed excessive, which indicates a shortage of quality pools. These exposed reaches of stream are less hospitable to fish populations due to temperature extremes both in the summer and winter. The streambanks in the system (with some exceptions) exhibit good stability, which is characteristic of the geomorphology of the area (USFS 1995). The surveys and analysis concluded the primary limiting influence on aquatic habitats and fish population densities was livestock grazing, which removed and trampled streambank vegetation.

Water diversions have resulted in making many miles of streams unsuitable to support aquatic species. Large portions of several streams are dewatered annually including Deadwood Creek, Cherry Creek, Flat Creek, Deer Creek, Jim Bob Creek, House Creek, Antelope Creek, and Three Creek (Klott 1996). This has resulted in fisheries habitat becoming more fragmented and populations becoming isolated.

Dams have resulted in salmon and steelhead being eliminated from the Bruneau subbasin. Bull trout in the Jarbidge River are now isolated from all other bull trout populations.

3.1.2.3 Aquatic Habitat Condition of Hot Springs and Seeps

A USFWS survey conducted in 1996 located Bruneau hot springsnail in 116of 204 (54 %) seeps and hot springs along the Bruneau River (Table 30) (Mladenka and Minshall 1996). Wood (2000) reduced this estimate of occupied habitat to 89 of 155 based on 1998 habitat surveys. This habitat has been considerably reduced in quantity and quality by groundwater pumping for agricultural uses (Varricchione and Minshall 1995b).

Table 30. Total number of springs and total number of springs occupied by Bruneau hot springsnail and the water levels of two wells near Indian Bathtub spring (table from Wood 2000).

Date	Total Number of Springs	Number of Occupied Springs	October Elevation (ft) of Well 03BDC1	October Elevation (ft) of Well 03BDC2
1991	211	131	2672.74	2672.56
1993	201	128	2671.65	2671.45
1996	204	116	2671.65	2671.39
1998	155	89	2671.57	2671.23

Habitat near the Indian Bathtub area was dramatically impacted by a high runoff event in 1991, which reduced habitat in the area to less than half the previous amount (Varricchione et al. 1998). Habitat in Hot Creek has been impacted by sediment inputs from an ephemeral channel. Habitat assessments carried out between 1995 and 1997 rated riparian vegetation communities to be intermediate to high in quality and substrate to be low. Particle size distribution data showed that ≥65% of Hot Creek's substrate was less than 1 cm in diameter and ≥29% was less than 0.1 cm in diameter (Varricchione et al. 1998). They concluded that overall habitat conditions in Hot Creek are "very poor and appear to be the result of poor land management practices on the watershed upstream" (Varricchione et al. 1998). Wood (2000) indicates that portions of the Indian Bathtub are currently under 3 meters of sediment and points towards reduced spring flow as limiting the ability of the spring to flush itself clean from the sediments.

3.1.2.4 Geomorphologic Conditions of Stream Channels

The morphology of the mainstem Jarbidge is largely influenced by debris inputs from low frequency, high magnitude flood and landslide events. Cobble and gravel bars, which are often located at the mouths of steep, ephemeral or perennial tributaries, are often transient and shift in location depending upon runoff flows and/or deposition from source streams (Parrish 1998, USFS 1998). Because the majority of these high gradient tributaries enter the mainstem Jarbidge from the west, the deposition of alluvium commonly forces the mainstem channel to the eastern side of the valley (USFS 1998). This lateral movement however, is constrained by bridges, dikes, and road prisms, which force the channel into a narrow profile and potentially increase its velocity and/or capacity for flooding (USFS 1998).

3.2 Terrestrial

The Northwest Habitat Institute (2003) modeled current (Figure 31) and historic (Figure 40) wildlife habitat types of the Bruneau subbasin. Although this is a course analysis, it provides some insight into the magnitude of habitat changes (Table 31) encountered by terrestrial species over time in the subbasin. Although shrub-steppe has undergone a relatively small decrease in quantity (-3%), the degradation of habitat condition by altered fire regime, invasive exotics, and grazing are the currently threaten this environment. The most extensive loss of habitat is interior riparian wetlands which have decreased by 1,965% from historic estimates. Aspen (76%) and desert playa (43%) have increased while focal habitats that have undergone a decrease include western juniper and mountain mahogany (-474%) and dwarf shrub-steppe (-39%).

Terrestrial environmental conditions are discussed in further detail in section 1.5.7 (about vegetation and land cover), section 2.4.1 (about terrestrial focal habitats), and section 5.1.2 (with the interpretation and synthesis of terrestrial conditions).

Table 31. Current and historic projected quantities of wildlife habitats (WHTs) in the Bruneau subbasin (NHI 2003).

Habitat	Current # Acres	Historic # Acres	%change
Montane Mixed Conifer Forest	15,051	0	100
Interior Mixed Conifer Forest	455	1,894	-316
Lodgepole Pine Forest and Woodlands	0	1,483	100
Ponderosa Pine & Interior White Oak Forest and Woodlands	0	34,068	100
Upland Aspen Forest	56,974	13,647	76
Alpine Grasslands and Shrublands	3,480	8,936	-157
Western Juniper and Mountain Mahogany Woodlands	7,670	44,005	-474
Interior Grasslands	1,052	96,058	-9031
Shrub-steppe	1,515,534	1,553,829	-3
Dwarf Shrub-steppe	198,082	274,938	-39
Desert Playa and Salt Scrub Shrublands	78,940	44,637	43
Agriculture, Pastures, and Mixed Environs	227,770	0	100
Urban and Mixed Environs	121	0	100
Open Water–Lakes, Rivers, and Streams	2,658	1,652	38
Herbaceous Wetlands	6,287	0	100
Montane Coniferous Wetlands	318	0	100
Interior Riparian-Wetlands	1,997	41,245	-1965

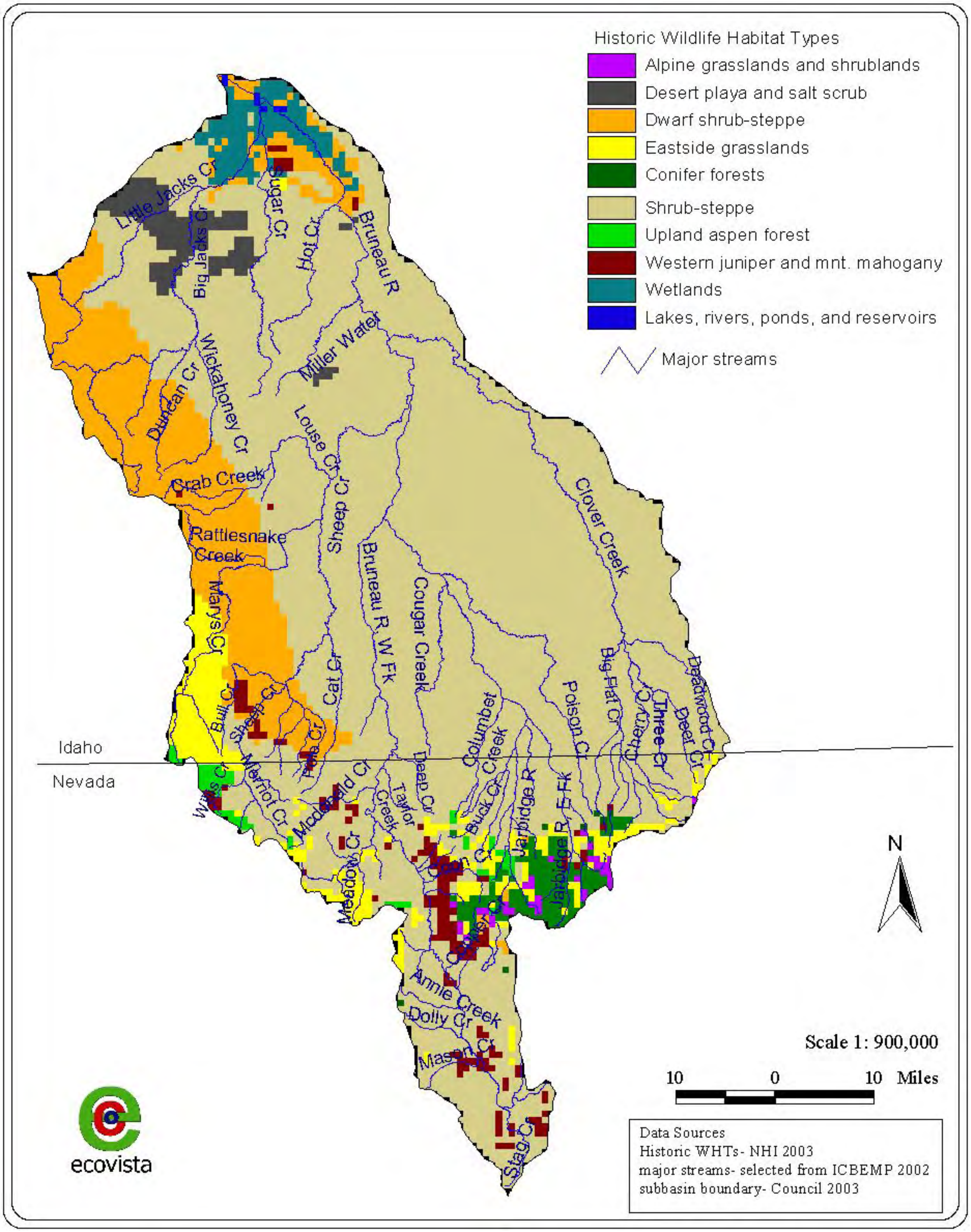

Figure 40. Projected historic wildlife habitat types of the Bruneau subbasin.

3.3 Out-of-Subbasin Effects

3.3.1 Effects on Aquatic Focal Species

Historic out of subbasin activities significantly affected the current aquatic fauna of the Bruneau subbasin. Anadromous fish were first blocked from entering the Bruneau subbasin in 1860 following construction of an irrigation storage reservoir on the lower 1.5 miles of the Bruneau. Although it is unknown whether the structure blocked all anadromous salmonids, the construction of Swan Falls Dam on the Snake River in 1901 soon became the terminus for all Snake River Salmon, and, to a large extent, the dam was a barrier to steelhead (Chandler 2001). Although a fish ladder was installed at Swan Falls Dam during the initial construction, it was not functional for salmon and was probably not functional for steelhead (Chandler 2001). Any hope of anadromous fish passage into the Bruneau subbasin was eliminated in 1952 following construction of C.J. Strike Dam, which posed a complete migration barrier.

The loss of anadromous fish in the Bruneau subbasin was significant. Chandler (2001) estimates that during the pre-development era (pre-1860), the area above Hells Canyon Dam produced between 1 and 1.7 million adult Pacific salmon (*Oncorhynchus* spp.) and steelhead (*Oncoryhynchus mykiss*). This estimate includes an estimated 0.76 to 1.19 million spring/summer chinook salmon, 135,000 to 214,000 fall chinook salmon, 117,000 to 225,700 steelhead, and 14,400 to 57,400 sockeye salmon (*O. nerka*).

The loss of anadromy into the Bruneau subbasin has likely had profound effects on at least two of the extant focal species. Although their influence on redband populations is unknown, it is probable that the elimination of steelhead from the Bruneau subbasin represented an impact to redband population connectivity, genetic diversity, and/or refounding capacity (*e.g.,* Vigg and Company 2000). Similarly, the loss of anadromous carcasses and juvenile fish has affected current nutrient cycling and prey availability (respectively) for extant focal species, most notably for bull trout and redband trout.

The construction of impoundments outside of the subbasin has significantly affected connectivity of bull and redband trout populations to other migratory populations. Historic interactions between Bruneau bull and redband trout populations and those residing in other Snake River tributaries (*e.g.,* Boise, Weiser, Malheur, Payette, and Powder subbasins) is unknown, however, it is reasonable to assume that all historic migratory trout populations periodically interacted with other populations in the Snake River basin. Currently, interaction is difficult or impossible as most populations are isolated by fish barriers, primarily dams.

3.3.2 Effects on Terrestrial Focal Species

A number of the terrestrial focal species spend a portion of their life cycle outside the Bruneau River subbasin's designated boundaries. Although most are nongame avian species, at least one upland game species and several big game species potentially migrate between State jurisdictions. Depending on the extent, location, and timing of seasonal movements, out of subbasin effects may range from limited to potentially substantial. Potentially limiting factors encountered outside the subbasin, including hunting, environmental toxins, and habitat degradation, may influence species occurrence, annual survival, reproductive success, and ultimately population growth within the subbasin.

Several of the Bruneau subbasin focal bird species display varying degrees of seasonal movements. Yellow warbler, willow flycatcher, white-faced ibis, and yellow-billed cuckoos are primarily long-distant migrants; wintering south from Mexico to South America (Ryder and Manry 1994, Hughes 1999, Lowther et al. 1999, Sedgwick 2000). In contrast, sage grouse and northern goshawk populations may move relatively short distances or remain resident (Squires and Reynolds 1997, Connelly et al. 2000): although seasonal movement likely includes locations outside the subbasin boundaries. Migration is considered energetically expensive, loss of habitat along migratory paths and exposure to potential collisions with stationary or moving objects may increase this cost (Hughes 1999, Sedgwick 2000). Furthermore, loss or degradation of winter habitat due to pesticides, herbicides, fragmentation, and decline in extent has been suggested as a potential cause of declining populations of North American bird species (Ryder and Manry 1994, Hughes 1999, Connelly et al 2000, Sedgwick 2000). In general, insectivorous birds, birds in western North America, and birds migrating to Mexico and Central and South America are still contaminated with relatively high levels of organochlorines (primarily DDE; DeWeese et al. 1986). Seasonal movements, however, may not be limited to winter, as big game and sage grouse may move outside the subbasin during alternative seasons (Connelly 2000). However, independent of the timing of seasonal movements, the condition of habitats sought likely influences within subbasin population dynamics. For example, reduced sagebrush cover due to herbicide application, fire, and mechanical removal has been shown to be an important predictor of sage grouse occurrence and recruitment (Connelly et al. 2000). Isolating the causes of population declines requires a full understanding of species ecology in combination with long-term population monitoring data.

Five terrestrial focal species identified for the Bruneau subbasin are managed by both Idaho and Nevada as game animals. Depending on seasonal movements exhibited by populations, State agencies may be managing the same animals from opposite sides of the fence. Pronghorn antelope, mule deer, and sage grouse occurring in the subbasin are hunted in both Idaho and Nevada, although hunting seasons, limits, and pressure are variable among years and locations. Although seasons primarily overlap, in all three instances there is the potential for individuals from populations moving across State boundaries to be exposed to a longer hunting season. In the case of mule deer for example, the season has been “extended” approximately 2 weeks on either side. Coordination between these two State agencies, including an understanding of the migratory ecology of potentially shared populations, is essential for proper management (Connelly et al. 2000).

4 Identification and analysis of Limiting Factors

4.1 Aquatic Limiting Factors

Insufficient habitat quantity and quality, and the loss of connectivity between populations appear to be the primary factors limiting production of aquatic focal species in the Bruneau subbasin. However, the degree to which coldwater species are limited is unknown since no historic baseline data exists. Nevertheless, studies have documented declines in salmonid populations and habitat and related them to natural and anthropogenic influences.

4.1.1 Natural Influences on Habitat Quantity and Quality

The semiarid climate of the Bruneau subbasin significantly affects the amount and quality of coldwater fish habitat. The highest quantity of suitable trout habitat occurs in the higher elevation portions of the subbasin, which are areas that receive the highest amount of precipitation. Even in these areas, fish habitat may be annually and/or seasonally restricted by inadequate streamflows. The most important mechanism driving these conditions, especially when considering inland redband trout populations, appears to be periodic drought cycles and their accordant effects on streamflow and water temperatures (*e.g.*, Allen et al. 1995, 1996; Parrish 1998). During nondrought years, salmonid populations in the Bruneau subbasin have been shown to react favorably to the increased amount of habitat offered by lower water temperatures and higher flows (*e.g.*, BLM 1999). During drought years, salmonids are restricted to small habitat patches (*e.g.*, BLM 1999). Extended periods of drought (such as that which occurred from 1988-1994) can cause the isolation of small numbers of individuals into short perennial reaches. Population stability may be compromised when critical habitat for salmonid cohorts is reduced. Allen et al. (1996) documented the absence of age 0 and 1 redband trout in the West Fork Bruneau River and suggested that previous drought conditions may have prohibited spawning or rearing success.

Flooding is another hydrologically related factor that poses limitations to focal species. For example, in 1995, a debris torrent occurred on the West Fork of the Jarbidge River, and washed out a 1.5 mile section of the South Canyon Road. The effects from the washout, and those associated with the attempted repair of the road (*see* Section 4.1.2.3 below) posed a significant threat to the bull trout in the area, and could have resulted in the loss of 27 percent of the known occupied bull trout habitat in the West Fork of the Jarbidge River (USFWS unpublished data, http://nevada.fws.gov/public/jarbidge.htm). Mollusk species, such as the Bruneau hotsprings snail, are also susceptible to the effects of flooding, due to scouring of critical spawning substrate. For example, the Hot Creek population was reduced to approximately zero individuals following a flood event in 1991 and remained absent from the site until 1999. Although a natural phenomenon, flood effects are commonly exacerbated by human land use activities, including removal of upland vegetation, channel straightening, bridge construction, and reductions in riparian vegetation/floodplain interaction.

Coldwater habitat quantity and quality in the Little Jacks and Sugar watersheds and the Bruneau Valley is limited by the natural discharge of geothermal springs. The contribution of these flows to cooler water bodies is significant in areas, and has shaped current salmonid distribution patterns in affected watersheds.

4.1.2 Anthropogenic Influences on Habitat Quantity and Quality

Grazing, irrigated agriculture, and road construction and maintenance are among the most notable land-use practices influencing salmonid habitat in the subbasin. These factors, when coupled with the natural severity of the environment, may potentially limit the persistence of coldwater species in the subbasin. Streamflow reduction, removal or destruction of riparian vegetation, habitat simplification, and impairment of water quality often result from these land-use activities and may directly or indirectly affect the amount and/or condition of salmonid habitat.

4.1.2.1 Streamflow Reduction

In the Nevada portion of the subbasin, diversion of streamflows via instream structures and channelization has allowed arid ground to be converted to irrigated pasture (USFS 1995). These practices have reduced the amount of instream habitat by removing a significant portion of annual flow from streams and disrupting normal channel processes (USFS 1995). Lay and IDEQ (2000) determined that flow reductions resulting from irrigation, aquaculture, and small dam construction, have contributed to the listing of the mainstem Bruneau, Jacks Creek, Wickahoney Creek, and Hot Creek to the §303(d) list (Table 32). Other streams or stream segments annually dewatered include Cedar Creek, Deadwood Creek, Cherry Creek, Devil Creek, Flat Creek, Deer Creek, Jim Bob Creek, House Creek, Antelope Creek, and Three Creek (Klott 1996).

Groundwater mining for irrigation purposes represents a considerable limitation to surface water volume. As mentioned previously (see section 1.5.8.5), increasing well withdrawals from the aquifer have led to declining groundwater levels (Wood 2000) and have in turn affected surface flows. Wood (2000) considers agricultural-related groundwater withdrawal and pumping to be the most important threat to the persistence of the Bruneau hot springsnail.

Table 32. Water quality limited stream segments in the Bruneau subbasin (Lay and IDEQ 2000).

Water Body	Source Agency: BLM				Source Agency: IDEQ		
	Pollutant Source	Pollutant[a]			Pollutant Source	Pollutant[a]	
Bruneau River	irrigated crop	SED			irrigated crop	NUT	SED
	pasture	SED	Q		pasture	NUT	SED
	range	SED			aquaculture	NUT	SED
	aquaculture	NUT	TM	Q			
	flow regulation	Q					
	riparian habitat removal	H					
	streambank destabilization	H					
	small dam construction	Q					
	natural	TM					

Water Body	Source Agency: BLM				Source Agency: IDEQ		
	Pollutant Source	Pollutant[a]			Pollutant Source	Pollutant[a]	
Jacks Creek	irrigated crop	SED			irrigated crop	NUT	SED
	pasture	SED	Q		pasture	NUT	SED
	range	SED			aquaculture	NUT	SED
	aquaculture	NUT	TM	Q	feed lots	O	
	flow regulation	Q					
	riparian habitat removal	H					
	streambank destabilization	H					
Sugar Creek					irrigated crop	SED	
					pasture	SED	
					aquaculture	SED	
WickahoneyCreek	range	SED	Q				
	riparian habitat removal	H					
	streambank destabilization	SED					
Hot Creek	range	SED			range	SED	
	flow regulation	Q	H				
	riparian habitat removal	H					
	streambank destabilization	SED	H				
	recreation	BACT					
Clover Creek					range	SED	
Three Creek					range	SED	
Cougar Creek					range	SED	
Poison Creek					range	SED	

[a] Pollutants and/or stressors: NUT = nutrients, SED = sediment, Q = flow alteration, TM = temperature, BACT = pathogens, O = organic enrichment, H = habitat alteration

4.1.2.2 Removal or Destruction of Riparian Vegetation

In a system that inherently suffers from high water temperatures and low flows, the additive effects of widespread and prolonged grazing on aquatic resources are magnified. One of the most notable effects of grazing has been the reduction or removal of riparian vegetation. The general effects of grazing on riparian areas, as they relate to salmonid habitat, are well documented (*e.g.,* Kauffman and Krueger 1984; Platts 1985, 1991; Chaney et al. 1993; Reid 1993). In the Bruneau subbasin however, grazing has most notably affected the insolation and water storage capacity offered by riparian vegetation, as demonstrated by surveys conducted by Klott (BLM, personal communication, September 7, 2001), the BLM (1999a) and Allen et al. (1995, 1996).

Changes in channel morphology have been documented in streams within grazing allotments and include: increases in width/depth ratios, reductions in pool quality and/or frequency, increased frequency of unstable banks, and a higher incidence of stream incision in low gradient areas (USFS 1995, USDA 2000). The relative magnitude of these habitat alterations extends to other aquatic species such as gastropods and amphibians.

4.1.2.3 Habitat Simplification

Reductions in habitat complexity through land-use activities such as road construction and maintenance, grazing, and possibly agriculture, have resulted in a net decrease in habitat for salmonid species.

Although road density in the Bruneau subbasin is not as extensive as in other subbasins (see Figure 17), road construction and maintenance still represents one of the more notable land-use practices that have contributed to a reduction in habitat complexity, and ultimately habitat quantity and quality. Many roads have been constructed in floodplain areas and/or along stream channels. Road placement influences the hydrological function of the stream, reduces or eliminates habitat areas, and contributes fine sediment to stream channels. The concentration of traffic onto the limited road network also represents a potential limiting factor to aquatic species since the probability for spills of hazardous materials into streams is heightened. In the Nevada portion of the Jarbidge, approximately 300 yards of bull trout habitat were modified by road construction activities, which subsequently led to an “Emergency Listing” by the USFWS in August of 1998 (Trout Unlimited 2001).

Other road construction and channel straightening activities have been documented throughout the Jarbidge portion of the subbasin. One of these problems is that of undersized bridges. Several of the bridges in the West Fork Jarbidge watershed represent a limiting factor to natural river hydraulics, as they were undersized at the time of their construction (USFS 1998). Because of the narrowness of the bridge structures, it has been necessary to dike the stream channel above the bridge in order for it to fit under the bridge (USFS 1998; McNeill et al. 1997). These activities have functionally disconnected the channel from its floodplain, which has in turn contributed to increased stream power, scouring of spawning gravels, and elimination of overwintering and rearing habitat. Another problem is the access that roads provide to large wood in the rivers. In the West Fork Jarbidge River, large woody debris has been removed for flood control and firewood (Parrish 1998).

In July 1998, with the Jarbidge River bull trout already proposed for listing, Elko County began reconstructing the South Canyon Road in the midst of known bull trout habitat. Potential direct and indirect impacts in the West Fork of the Jarbidge River included the harm and harassment of juvenile and adult bull trout; disruption or prevention of bull trout migration and spawning; alteration of stream flow and temperature; loss of riparian vegetation; and increased sediment transport. This combination of activities had the potential to affect the future survival and recovery of the Jarbidge River population. For these reasons, the Service temporarily emergency listed the Jarbidge River population as endangered on August 11, 1998 (63 Federal Register 42757). The emergency listing lasted for 240 days.

Grazing has contributed to a net loss in habitat complexity throughout various portions of the subbasin. The removal or reduction of riparian vegetation through herbivory and/or trampling is considered to be a primary limiting factor on aquatic habitats and fish population densities in portions of the Bruneau subbasins in Nevada, as measured by poor streambank cover, pool quality, width/depth ratios, and stream bottom embeddedness (USFS 1995). The effects of agriculture on habitat complexity are largely unknown in the subbasin. In 1990, approximately 45,000 acres of croplands were irrigated in the Idaho portion of the subbasin (Berenbrock 1993). The majority of these areas (most notably pasture and hay land cover types) occur proximal to stream channels. Although speculative, it may be assumed that a proportionate amount of the riparian vegetation in these areas has been converted to irrigated crops, thus decreasing the potential contribution of habitat-forming woody debris to stream channels. Assessment of agriculture as it relates to habitat complexity currently represents a data gap.

Threats to springsnail populations include loss of habitat due to agriculture-related groundwater mining (Varricchione and Minshall 1995b), and degradation of habitat due to trampling of streambanks and springs. Direct mortality from trampling by livestock has been documented for both mature and juvenile springsnails (Mladenka 1992 cited in Klott 1996).

4.1.2.4 Water Quality

Unsuitable water quality is a key factor limiting the quantity and quality of aquatic habitat in the Bruneau subbasin. Water quality parameters of concern include excessive temperatures, nutrients, and sediment. Legacy effects from mining activities are also cited as contributing to reductions in water quality.

As mentioned previously, elevated stream temperatures in the subbasin exceed coldwater biota standards. Although this problem is considered by some to be a natural phenomenon exacerbated by geothermal discharge (*e.g.,* Lay and IDEQ 2000), it has been shown by others (*e.g.,* USFS 1995, Zoellick et al. 1996; McNeill et al. 1997, BLM 1999a) to be a much more pervasive and widespread issue. One of the most commonly cited sources for thermal pollution in stream segments is the lack of riparian shading caused by grazing. In 1994-96, the BLM (1999a) found that Idaho State criteria for coldwater biota was not met in the portions of Little Jacks Creek that had no restrictions on grazing, and was met in restricted portions. Other sources for thermal pollution include mines in the upper subbasin that discharge thermally heated water to coldwater stream segments (Parrish 1998). Their influence on habitat quantity and quality is unknown.

Irrigated pastures, crops, and aquaculture have all been cited by Lay and IDEQ (2000) as causing elevated nutrient levels in some stream segments within the Bruneau subbasin (see Table 32). Total phosphorus (TP) concentrations in Jacks Creek are related to nonsediment sources (such as animal concentrations) rather than from fertilizer applications and runoff from agriculture fields.

All stream segments identified as water quality limited by Lay and IDEQ (2000) had sediment cited as a pollutant (see Table 32) (Lay and IDEQ 2000). High embeddedness levels recorded between 1988-1990 in a Humboldt-Toiyabe National Forest watershed study were considered the principle factor limiting habitat quality (USFS 1995). Excessive sedimentation is common in areas of the subbasin that have been heavily grazed. The mean percent of fine sediment (sand and smaller sized particles) in streams within the Battle Creek Allotment (i.e., Little Jacks and Big Jacks creeks) differed significantly ($P = 0.02$) among streams with different levels of livestock access (BLM 1999a). Fine sediment percentages were greatest in livestock-accessible stream segments grazed in the spring (BLM 1999a). Excessive sedimentation is also a problem in Hot Creek springsnail. Fine silts and sands have covered high quality substrate utilized by the gastropod, and have eliminated a majority of its habitat. Potential sediment sources upstream need to be stabilized and restoration of cobbles needs to be initiated to allow recolonization of previously utilized habitat.

Historically, mining strongly influenced water quality in the Jarbidge River. The West Fork Jarbidge River, in the vicinity of Jarbidge, was placer mined in the 1880s (Zoellick et al. 1996). At the onset of operations, fish were reported to be plentiful. By 1935, the river was described as "polluted by mine tailings, starting 2 miles upstream of the town of Jarbidge, and unfit for fish" (Parrish 1998).

Mine shafts were pumped to allow continued ore extraction, contributing acidic and thermally heated water to the river system. The overall quantity of pumped water is unknown. Thermally heated water was still flowing from the Pavlak adit at 42 gallons per minute (gpm) in 1996 (USFS 1997). The Greyrock shaft at the Elkoro mill began filling with thermally heated water in the mid 1930s. Dewatering operations were initiated between 1937 and 1941, during which over 7 billion gallons of warm water were dumped into the Jarbidge River at a continuous rate of 31 cfs. This volume exceeded the base flow of the Jarbidge River by six times for a period equivalent to 696 days (Parrish 1998). It is estimated that the thermal plume from this discharge would have persisted in the river from August through April, raising base temperatures well above tolerance limits for bull trout, macroinvertebrates, and other coldwater biota (Parrish 1998).

Water quality was tested at the Elkoro adit in 1977 and at the Pavlak adit in 1996 (McNeill et al. 1997). Water from the Elkoro adit had a pH of 6.27; the Pavlak adit, a pH of 8.18 (McNeill et al. 1997). Arsenic, copper, and iron have also been found in the lower Jarbidge River at levels that may be affecting aquatic fauna (McNeill et al. 1997).
One other notable pollution source that may be directly related to salmonid persistence is noise pollution. The effects of sound and shock waves associated with jets from the Air Force training range in Idaho (see section 1.5.8.11 for a description of the training range) represent a potentially limiting factor to bull trout in the Idaho portion of the Jarbidge. Potential effects from sonic booms include disruption of normal behavior, physiological stress responses, and increased mortality of eggs due to noise-related vibrations during critical periods of development (USAF 1998). Little research exists to judge the significance of this threat to bull trout in the subbasin (Parrish 1998).

4.1.2.5 Exotic Species Introductions

Eastern brook trout (*Salvelinus* fontinalis) occur in portions of the subbasin and represent a threat to native species. Brook trout occur in Emerald Lake near the headwaters of the East Fork of the Jarbidge River and in Bear Creek, a tributary to the West Fork of the Jarbidge River. Although interactions have not been documented, this exotic speices represents a possible hybridization threat to proximal bull trout populations due to the potential for future illegal transplants elsewhere in the subbasin. Brook trout populations have also established in Merritt Crek, and in the Idaho tributaries of Three, Big Flat, Deer, and Deadwood Creeks. These populations are known to be impacting redband trout deliteriously through increased competition (G. Johnson, NDOW, personal communication, April, 2004).

Non-native game species (*e.g.*, smallmouth bass) occur in the subbasin although their influence upon focal species is unknown (K. Meyer, IDFG, personal communication, May, 2004). The influence of this species, and the native northern pikeminnow, on redband trout currently represents a data gap.

Wild mosquito fish and tilapia were suspected of limiting springsnail recovery in Hot Creek, but gut content analysis indicated that tilapia were not preying on springsnails (Varricchione and Minshall 1995a). Follow-up research by Myler and Minshall (1999) indicated that tilapia recognized springsnails as prey, both when the fish were starved and when they were fed generously. The study concluded that tilapia negatively impact springsnail populations in Hot Creek (Myler and Minshall 2001).

4.1.3 QHA-Based Limiting Factors Analysis and Prioritization

Qualitative Habitat Assessment (QHA; Mobrand Biometrics 2003b) was used to evaluate habitat conditions and limiting factors within and between sixth field HUCs in the Bruneau subbasin for redband trout, bull trout, mountain whitefish, the Idaho springsnail, and the Bruneau springsnail. Analyses were run based on the habitat occupied[1] for each species (Table 33 and Figure 41).

Raw data used in, and outputs from the QHA model are included in Appendix G. Information included in this section (with the exception of the two snail species) is not a direct reflection of those results. Adjustment was made to QHA restoration scores/ranks to account for relevant factors not considered within the QHA model itself (e.g., amount of available habitat). No adjustment was made to original QHA protection scores/ranks.

To account for the differing amount of habitat between HUCs (e.g., total stream miles in a sixth field HUC used by a given species), QHA restoration scores were standardized based on the average usable length of stream in the subbasin (Table 33). The estimated length utilized within each individual HUC was divided by the subbasin average; the result was then multiplied by the original QHA restoration score for that reach. The streams were re-ranked according to the resultant scores.

[1] Habitat occupation included consideration of four life history stages, as defined by Mobrand Biometrics (2004b). These were spawning and incubation, summer rearing, winter rearing, and migration.

Table 33. Average stream miles per sixth field HUC occupied by focal species in the Bruneau subbasin. Averages were used to standardize restoration scores derived from QHA modeling efforts.

Focal Species	Total # of HUCs Occupied	Average Miles Occupied per HUC	Range (Miles)		Standard Deviation
			Minimum	Maximum	
Redband Trout	56	12.9	0.05	29.8	5.9
Bull Trout	8	12.0	7.7	31.5	8.0
Mountain Whitefish	9	11.7	8.2	16.5	2.7
Bruneau springsnail	2	N/A	N/A	N/A	N/A
Idaho springsnail	1	N/A	N/A	N/A	N/A

No adjustment was made to original QHA protection scores/ranks. Protection of both larger and smaller habitat areas used by the focal species will be critical to maintaining population/habitat diversity, irregardless of reach length. This concept is consistent with the guiding principles of the accompanying subbasin management plan and with the scientific principles of the Council's Fish and Wildlife Program (NPPC 2000).

Species-specific comparisons of protection versus (adjusted) restoration ranks for each sixth-field HUC are shown in Table 34, Table 37, and Table 40. A graphical representation of restoration *vs.* protection areas for each species follows the respective tables (Figure 42, Figure 43, and Figure 44).

Reaches prioritized for restoration activities are presented in rank order in Table 34, Table 38, and Table 41; those prioritized for protection are presented in rank order in Table 36, Table 39, and Table 42. In each of these tables, habitat priority factors in need of restoration or protection (respectively) are highlighted using rankings drawn directly from the QHA model outputs[2] (see Appendix G).

[2] Within QHA a maximum of eleven ranks are possible within each reach (one for each habitat variable). Due to tie rankings, the number of unique ranks observed in any reach considered in this assessment did not exceed 6. To extract only priority information from the QHA matrix, the following rules were applied in creating Table 2 and Table 3: If 2-3 unique ranks existed for a given reach, the single most important issue is highlighted in summary tables; If 4-6 unique ranks existed for a reach, the two most important issues are highlighted in summary tables. Ranks are taken directly from the QHA model output and are comparable within but not between rows/reaches.

Figure 41. Bruneau subbasin sixth-field HUCs used in the QHA modeling process.

4.1.3.1 Redband Trout

Comparisons of where to focus restoration efforts and where to focus protection efforts, as they relate to redband trout are shown in Table 34 and in Figure 42. At the subbasin scale, restoration efforts are generally identified throughout the majority of the Clover Creek (a.k.a. East Fork Bruneau) watershed, in the Big Jacks Creek and Wickahoney and Crab Creek drainages, and in headwater tributaries to the West Fork Bruneau (primarily those occurring in the westernmost portion of Nevada). Eight HUCs, primarily in the West Fork Bruneau, fall into the "middle ground" with respect to both priorities, and are thus prioritized for both protection and restoration activities in subsequent tables. Priority areas for protection include the lower mainstem Bruneau, the majority of the Jarbidge watershed (East and West Forks inclusive), headwater reaches of the West Fork Bruneau, the Little Jacks Creek drainage, and the Rattlesnake and Mary's Creek drainages.

Table 34. Comparative restoration versus protection value for redband trout sixth field HUCs (shown in parenthesis) within the Bruneau subbasin based on (modified) QHA ranks for each activity.

Protection Rank / **Restoration Rank**	**High**	**Moderate**	**Low**
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore Bruneau 14 (2202) Meadow (2501)	Priority = Restore Deer (1003) Telephone (2502) McDonalds (2602) Big Jacks 1 (4201) Seventysix (2203) Willow Creek/Tribs. (2302) Cat (2901) Sheep 4 (2903)	Priority = Restore Louse 1 (3601) Lower Three (1002) Willis (4402) Clover 3 (0801) Upper Three (1004) Louse 2 (3602) Clover 1 (0502) Merrit (4401)
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect EF Jarbidge 1 (1601) Jarbidge 4 (1701) Coon (2102) Jarbidge 2 (1801) Bruneau 12 (2201)	Priority = Protect & Restore Jarbidge 5 (1702) Bruneau 7 (2803) Sheep 1 (3401) Bruneau 6 (3501) Flat and Coudle (1202) Sheep 3 (2904) Bruneau 8 (2701) Jarbidge 1 (2801)	Priority = Restore Big Flat Cr. (1101) Clover 2 (0503) Deadwood (1001) Wickahoney 2 (3802) Sheep (3101) Clover 4 (0802)
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect Bruneau 13 (2103) Bruneau 11 (2101) Jarbidge 3 (1501) EF Jarbidge 2 (1602) Cottonwood (3901) Little Jacks 2 (4101) Pole (2902) Duncan (3803) Marys 2 (3303) Little Jacks 1 (4202)	Priority = Protect Big Jacks 2 (3902) Little Jacks 3 (4102) Bruneau 4 (0402)	Priority = Protect Bruneau 5 (0501) Wickahoney 1 (3801) Bruneau 3 (0401) Marys 1 (3301) Bruneau 2 (0102)

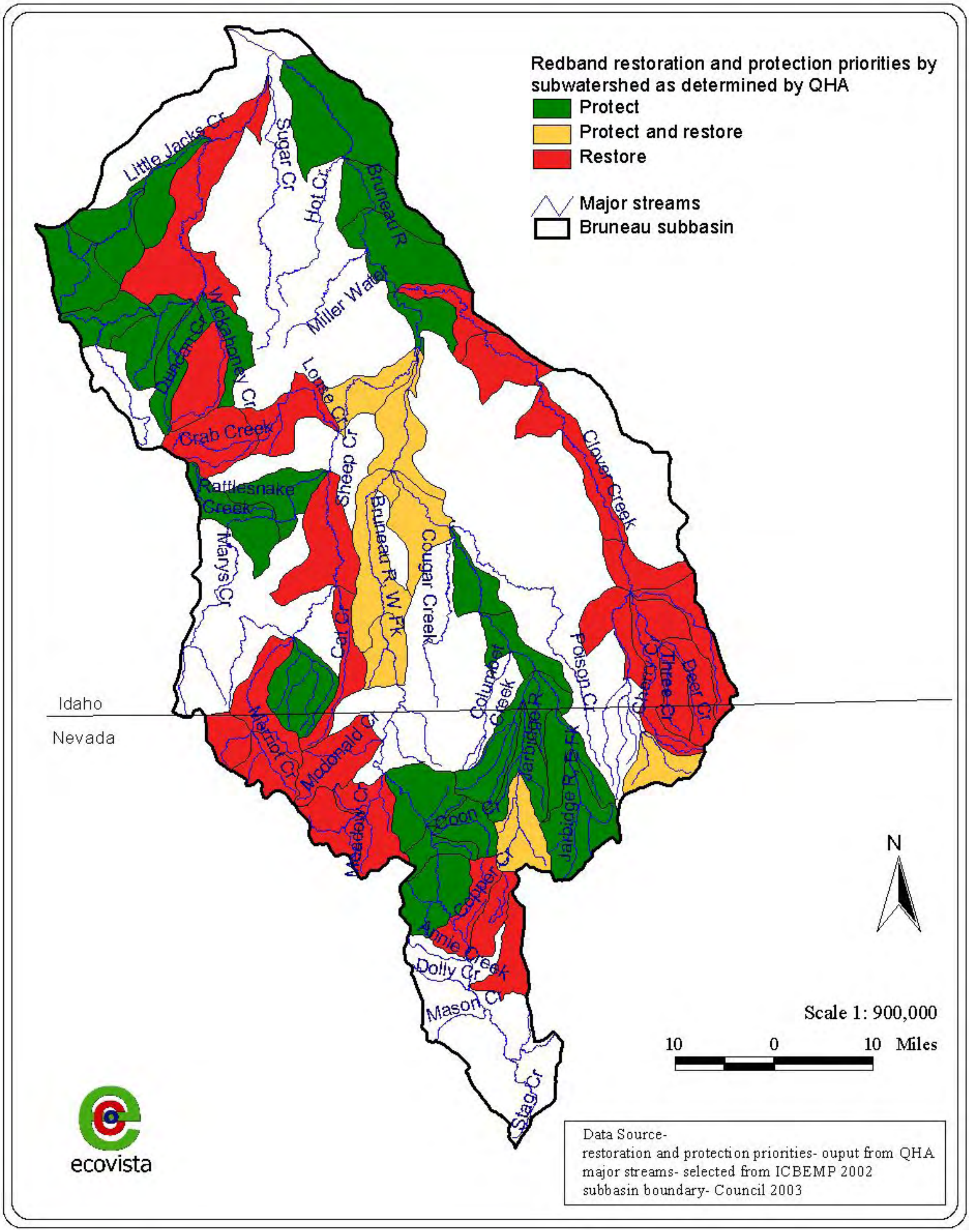

Figure 42. QHA-based restoration and protection areas for redband trout in the Bruneau subbasin.

Redband HUCs prioritized for restoration are shown in Table 35. Habitat metrics most frequently cited as being in need of restoration include low flows, high temperatures and oxygen, sediment, channel form, and obstructions to migration.

Table 35. Restoration ranks[1] for redband sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for restoration within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Restoration Rank	Reach Name[2]	Length (Miles)[3]	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	DEER	21.8	1003						1	3		2		
2	Telephone	16.8	2502	5	3		3						1	1
2	McDonalds	20.5	2602		2				3	3		3	3	1
4	Louse 1	16.1	3601						2	3				1
5	Lower Three	29.9	1002						3	2		1		
5	Big Jacks 1	26.2	4201	3		2							1	
7	Willis	12.1	4402		3		3		1			1		
8	Clover 3	22.5	801				3		1			2		
9	Upper Three	15.6	1004						1	3		2		
10	Bruneau 14	18.1	2202						1			3		2
11	Seventysix	11.1	2203					5	3	3			1	1
11	Meadow	19.9	2501		6		6		1	1		1	1	1
13	Louse 2	13.8	3602				3		2					1
14	Willow Creek/tribs	20.2	2302		1				2	2		2		
15	Clover 1	15.6	0502						1	3		2		
16	Merritt	16.0	4401	2					3					1
17	Cat	11.6	2901		2	3			1					
18	Sheep 4	23.9	2903		4		4		1	1				1
19	Big Flat Cr.	10.9	1101						1	3		2		
20	Clover 2	9.4	0503				3		1			2		
20	Deadwood	21.8	1001				2		1			3		
22	Jarbidge 5*	12.7	1702		1	2			3				3	
23	Bruneau 7*	16.5	2803				2		1	3		3		
24	Sheep 1*	17.7	3401				1		2	2		2		
24	Wickahoney 2	7.1	3802	3		3	2							1
26	Flat and Coudle*	13.8	1202	2	1		3					3		3
26	Bruneau 6*	13.6	3501				1		2	2		2		
28	Sheep	15.9	3101		2	2			1	4				4
29	Sheep 3*	9.5	2904		2	3			1					
30	Clover 4	6.6	0802				3		1			2		
31	Bruneau 8*	8.0	2701	4		4	3		1			1		
31	Jarbidge 1*	9.6	2801		4		4		1	1		1		

[1]/ Uses "adjusted" reach ranks (previously described) to give weight to amount of usable habitat (length)
[2]/ HUCs prioritized as "Protect and Restore" in Table 34 occur in Table 35 and Table 36; (asterisk (*))
[3]/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which redband trout are either known present or unknown but potentially present (IDFG data).

Redband HUCs prioritized for protection are shown in Table 36. Habitat metrics most frequently cited as being in need of protection (i.e. those that are functioning adequately) include pollutants, obstructions, and oxygen.

Table 36. Protection ranks for redband sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for protection within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows. Cells with values indicate the respective variable is functioning adequately and deserves protection.

Protection Rank	Reach Name[1]	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	Bruneau 13	2103				6		1	1		5	1	1
2	Coon	2102				5		1	1		6	1	1
3	Jarbidge 3	1501			4			1	1		5	5	1
3	Bruneau 11	2101				6		1	1		5	1	1
5	Jarbidge 4	1701			4			1	1		5	5	1
6	E. Frk Jarbidge 1	1601		5				4	1			1	1
7	E.Frk Jarbidge 2	1602		6		6		1	1		1	1	1
8	Bruneau 12	2201		6		6		1	1		5	1	1
9	Cottonwood	3901		4		3			1			1	
10	Little Jacks 2	4101	6		6	1			1		1	1	1
11	Pole	2902				6		2	2		2	1	2
12	Jarbidge 2	1801		5				4	1			1	1
13	Duncan	3803				4			2			2	1
14	Marys 2	3303							1		4	1	3
15	Little Jacks 1	4202	5			1			2		2	2	
16	Jarbidge 5*	1702				5		3	1			3	1
17	Big Jacks 2	3902		3		3			1		3	1	
18	Little Jacks 3	4102		2		2			2		2	1	2
19	Jarbidge 1*	2801		5		5		3	3			1	1
20	Bruneau 6*	3501		5				3	3			1	1
21	Flat and Coudle*	1202			7	4		1	1		4	1	4
22	Sheep 1*	3401		4					3			1	1
23	Bruneau 8*	2701						5	3		5	1	1
24	Bruneau 7*	2803					5		3			1	1
25	Sheep 3*	2904							2		4	1	2
26	Bruneau 4	0402		4					2			2	1
26	Bruneau 5	0501		4					2			2	1
28	Wickahoney 1	3801		4		4			3			1	1
29	Bruneau 3	0401		3				2					1
30	Marys 1	3301		4		4			2			1	2
31	Bruneau 2	0102		1					2		2	2	2

1/ HUCs prioritized as “Protect and Restore” in Table 34 occur in Table 35 and Table 36; (asterisk (*)).

4.1.3.2 Bull Trout

Comparisons of where to focus restoration efforts and where to focus protection efforts, as they relate to bull trout are shown in Table 37 and in Figure 43. Based on QHA output, high priority restoration efforts are primarily associated with headwater habitats in the Jarbidge watershed (Table 38). Habitat components most commonly identified as in need of restoration include channel form (habitat diversity), channel stability, and excessive stream temperatures.

Important bull trout protection areas include the lower reaches of the East Fork Jarbidge mainstem, and the mainstem reaches of the Jarbidge which provide critical connectivity between tributary reaches (Table 39). Habitat components that are considered to be functioning appropriately include water quality (pollutants) and streamflow.

Table 37. Comparative restoration versus protection value for bull trout sixth field HUCs (shown in parenthesis) within the Bruneau subbasin based on (modified) QHA ranks for each activity.

Protection Rank / **Restoration Rank**	**High**	**Moderate**	**Low**
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore EF Jarbidge 2 (1602) Jarbidge 5 (1702)	Priority = Restore	Priority = Restore Jarbidge 4 (1701)
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect EF Jarbidge 1 (1601)	Priority = Protect & Restore	Priority = Restore Jarbidge 3 (1501)
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect	Priority = Protect Jarbidge 2 (1801) Jarbidge 3 (1802)	Priority = Protect Jarbidge 1 (2801)

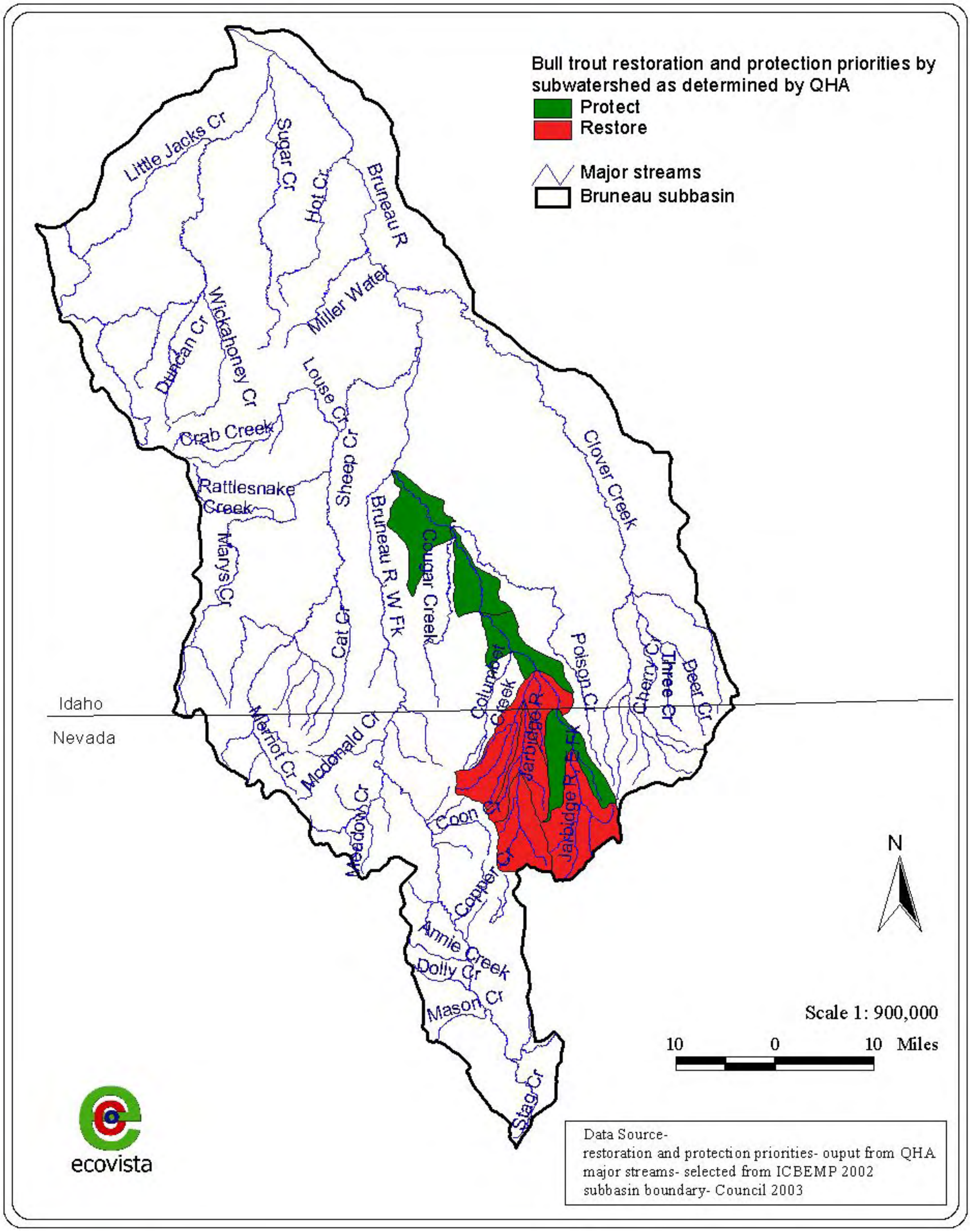

Figure 43. QHA-based restoration and protection areas for bull trout in the Bruneau subbasin

Table 38. Restoration ranks[1] for bull trout sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for restoration within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Restoration Rank	Reach Name	Length (Miles)[2]	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	E.Frk Jarbidge 2	31.5	1602		4	4	4		1			1	1	
2	Jarbidge 5	9.6	1702	4	1	1	1							
3	Jarbidge 4	7.7	1701		1	1	4					3		
4	Jarbidge 3	8.1	1501	3	1	1						4	4	

[1]/ Uses "adjusted" reach ranks (previously described) to give weight to amount of usable habitat (stream length)
[2]/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which bull trout are either known present or unknown but potentially present (IDFG data; USFWS data; NDOW data)

Table 39. Protection ranks for bull trout sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for protection within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows. Cells with values indicate the respective variable is functioning adequately and deserves protection.

Protection Rank	Reach Name	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	E. Frk Jarbidge 1	1601		3	3	3		1				1	
2	Jarbidge 2	1801		3		3		1				1	5
2	Jarbidge 3	1802		3		3		1				1	5
2	Jarbidge 1	2801		3		3		1				1	5

4.1.3.3 Mountain Whitefish

Based on QHA output (Table 41), high priority restoration efforts are primarily associated with headwater portions of the Jarbidge, in lower portions of the mainstem Jarbidge, and in the confluence reach of the West Fork Jarbidge. Habitat components most commonly identified as in need of restoration include excessive temperatures, fine sediment, and low streamflow.

Mountain whitefish habitat in the East Fork Jarbidge, mainstem reaches of the Bruneau, and mainstem reaches of the Jarbidge River are functioning appropriately and warrant protection consideration (Table 42). Specific habitat components that should be protected include water quality (pollutants) and channel form.

Table 40. Comparative restoration versus protection value for mountain whitefish sixth field HUCs (shown in parenthesis) within the Bruneau subbasin based on (modified) QHA ranks for each activity.

Protection Rank / **Restoration Rank**	**High**	**Moderate**	**Low**
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore Bruneau 6 (3501) E. Frk Jarbidge 1 (1601)	Priority = Restore Bruneau 7 (2803)	Priority = Restore Jarbidge 4 (1701)
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect	Priority = Protect & Restore Jarbidge 5 (1702) Jarbidge 3 (1802)	Priority = Restore Jarbidge 1 (2801) Jarbidge 2 (1801)
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect E.Frk Jarbidge 2 (1602) Bruneau 11 (2101)	Priority = Protect Bruneau 4 (0402)	Priority = Protect Jarbidge 3 (1501)

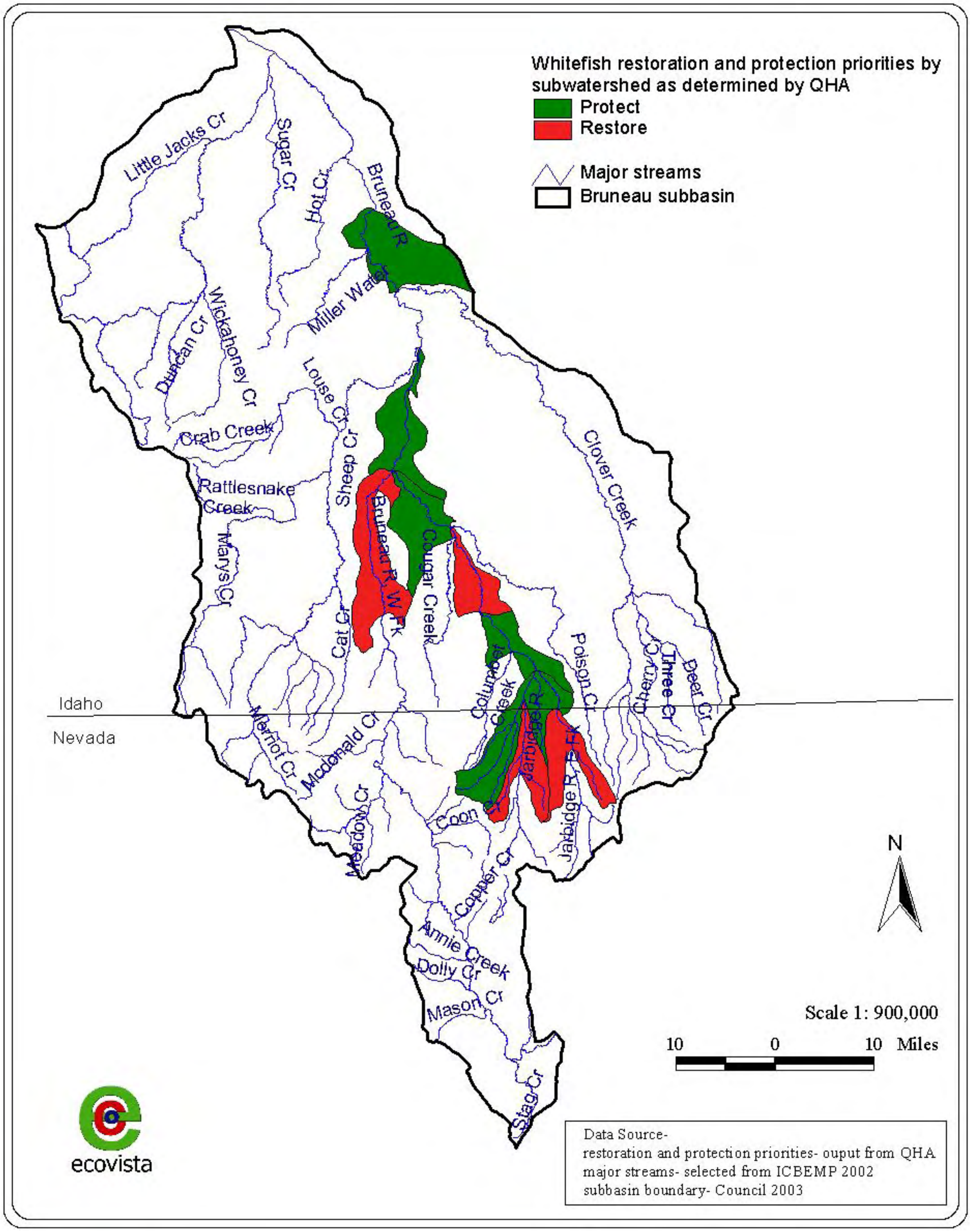

Figure 44. QHA-based restoration and protection areas for mountain whitefish in the Bruneau subbasin.

Table 41. Restoration ranks[1] for mountain whitefish sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for restoration within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name[2]	Length (Miles)[3]	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	Jarbidge 4	13.2	1701		2		2					1		
2	Bruneau 7	16.5	2803				2		1			3		
3	E. Frk Jarbidge 1	13.2	1601	3			2					1		
4	Bruneau 6	13.6	3501				1		2			2		
5	Jarbidge 5*	12.0	1702		1	2			3				3	
6	Jarbidge 3*	8.7	1802				1		2			2		
7	Jarbidge 2	13.6	1801	2	2	2	1		2			2		
8	Jarbidge 1	9.6	2801	1	1	1	1		1			1		

[1]/ Uses "adjusted" reach ranks (previously described) to give weight to amount of usable habitat (stream length)
[2]/ HUCs prioritized as "Protect and Restore" in Table 40 are included in both Table 41 and Table 42 and are marked with an asterisk (*)
[3]/ Measurement is based on estimates of the total length of stream channels within a sixth field HUC for which redband trout are either known present or unknown but potentially present (IDFG data)

Table 42. Protection ranks for mountain whitefish sixth code HUCs and habitat variables within each, for HUCs prioritized primarily for protection within the Bruneau subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows. Cells with values indicate the respective variable is functioning adequately and deserves protection.

Protection Rank	Reach Name[1]	HUC_6	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	E.Frk Jarbidge 2	1602		4		4		1			1	1	
2	Bruneau 11	2101						1			3	1	
3	Bruneau 4	0402										1	
4	Jarbidge 5 *	1702				3		1				1	
5	Jarbidge 3*	1501	1	1		1						1	
6	Bruneau 4	0402										1	
7	Jarbidge 3	1802		4		1		2			2		

[1]/ HUCs prioritized as "Protect and Restore" in Table 40 are included in both Table 41 and Table 42 and are marked with an asterisk (*).

4.2 Terrestrial Limiting Factors

The primary limiting factors for terrestrial species and habitats in the Bruneau subbasin were selected by the Bruneau Technical Team and were based on a comparison of threats identified for focal and concern species, with changes in habitat conditions identified at the scale of the WHT. Addressing limiting factors at the habitat scale will provide the greatest benefit to the greatest number of species.

4.2.1 Grazing and/or Browsing

In western North America, livestock grazing is the most prevalent land management practice (Fleischner 1994). Habitats may be limited by grazing because livestock can serve as vectors for the spread of invasive plant species (Knick et al. 2003), change habitat features by reducing plant species diversity and biomass (Reynolds and Trost 1981), disrupt ecosystem function, or alter ecosystem structure (Fleischner 1994). In addition to plant communities, deleterious effects of grazing have been observed in all vertebrate classes. Many observers have noted that cattle prefer and select riparian zones because they provide shade, cooler temperatures, water, and an abundance of food (Fleischner 1994). Habitat disturbance of most western riparian communities has been attributed to livestock grazing (Mosconi and Hutto 1982, Fleischner 1994, Dobkin et al. 1998). Species richness and relative abundance of avian species decline in response to cattle grazing but restoration of riparian meadows and avifauna may be possible through exclosure management practices (Dobkin et al. 1998). The longer the time since an area was last grazed has significantly correlated with increases in avian abundance, shrub volume, and shrub heights (Taylor 1986).

All allotment evaluations and watershed assessments on portions of the subbasin rank grazing as a leading cause of degraded riparian area (BLM 1989, 1997, 2000b; USFS 1995, 1998; Klott 1996; McNeill et al. 1997; Parrish 1998; Schnitzspahn et al. [2000]; JSGWG 2001; Jim Klott, BLM, personal communication, August 26, 2001). Grazing has led to a loss of more succulent forbs and other plants favored by sage grouse, elk, mule deer and other wildlife. Grazing effects in aquatic habitat include raised stream temperatures, contribution of sediment through collapsing stream banks, reduction of bank storage and altered stream hydrologic processes.

The Riparian Recovery Initive program of the BLM (http://www.blm.gov/riparian) implemented four exclosure treatments within the Bruneau subbasin (Table 43).

Table 43. Areas identified for restoration through the Riparian Recovery Initiative within the Bruneau subbasin.

Project Area	Type of Treatment	Date Began	Pre-treatment Condition
Battle Creek	Fencing	1995	Fisheries depleted
Big Jacks Creek Reservoir	Fencing	1997	Livestock on shores reduced habitat for other wildlife species
Duncan Creek	Electric fencing	1996	Riparian degradation from livestock grazing
Pasture 16	Divided pasture and reduced season of use	1997	Riparian degradation from livestock grazing

4.2.2 Invasive Exotics

Noxious weeds pose significant long-term threats to ecosystem health. These species reduce plant biodiversity, habitat quality and quantity and generally lower the ecological quality of the habitat. Shrub-steppe communities are particularly threatened by the expansion of cheatgrass, which has contributed to an increased fire frequency and conversion of sagebrush-steppe habitat to annual grasslands (Keane et al. 2002). Cheatgrass cures early in the season and forms a continuous, fine fuel source that ignites easily and allows fire to spread rapidly (USAF 1998). In years with above average spring precipitation, larger fires often develop due to increased grass production (BLM 1998). As a consequence of an altered fire regime, much of the subbasin east of the Bruneau River is now dominated by exotic annual and perennial grasses.

4.2.3 Altered Fire Regime

Many Rocky Mountain ecosystems are in declining health because of the exclusion of fire. Fire exclusion is accomplished through policy that aims to eliminate fires from the landscape using fire suppression techniques. In addition to firefighting efforts, livestock grazing has played a critical role in the decline of wildland fire through the removal of fine fuels from the landscape. Fire may be considered a “keystone” disturbance because it regulates succession, maintains biological diversity, reduces biomass, controls insect and disease populations, maintains biological and biogeochemical processes, and recycles nutrients. A “fire regime” is defined as “a description of the long-term, cumulative fire characteristics of a landscape and is often described by frequency, extent, pattern, severity, and seasonality”. A comparison of current and historical fire regimes for the Interior Columbia River basin revealed that recent fires tended to be less frequent and more severe than those that occurred prior to 1900 (Keane et al. 2002).

Sagebrush and native bunchgrass communities evolved with fire. Sagebrush-steppe ecosystems cover approximately 45 million ha in the Western United States and typically burned at 60- to 110-year intervals prior to European settlement (Keane et al. 2002). Mountain big sagebrush communities burned every 20 to 30 years while Wyoming big sagebrush communities burned every 50 to 100 years (BLM 1998). In many cases, fire suppression has led to unnaturally high densities of big sagebrush (USAF 1998) which reduces or eliminates perennial grasses and forbs depended upon by wildlife. An increase in density, biomass, and number of woody species, or increased fuel loads amplfy the likelihood of stand-replacing fires (Keane et al. 2002).

The historical role of large wildfires was habitat fragmentation and maintenance of mosaics of differing successional stages of sagebrush beneficial to sage grouse and other shrub obligate species (Knick and Rotenberry 1995). Fire exclusion can influence multiple terrestrial species. For example, bighorn sheep can benefit from fire by reduced lungworm infections, improved forage, and reduced tree cover. The absence of fire has prevented the expansion of aspen forests, therefore reducing this valuable forage base for ungulates (Keane et al. 2002). Within the Bruneau subbasin, mule deer and pronghorn winter range and fawning habitat have declined as a result of an altered fire regime (IDFG 2000c). The prey base for raptors and mammalian predators has also been reduced (Jim Klott, BLM, personal communication, September 7, 2001).

4.2.4 Crested Wheatgrass

Conversion of rangelands to areas producing livestock forage has occurred through prescribed fire, mechanical removal treatments, biological agents, and herbicides. These treatments are followed by reseeding with non-native grasses, primarily crested wheatgrass (*Agropyron cristatum*) (Knick et al. 2003). Grassland vegetation communities in the Bruneau subbasin are dominated by exotic perennial seedlings (intermediate wheatgrass, crested wheatgrass), nonnative weedy annuals (cheatgrass, tumble mustard, peppergrass), and to a lesser extent by native perennials (bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, needle-and-thread) (USAF 1998). During the past decade, over 90% of the Jarbidge Resource Area has burned. In an attempt to prevent establishment of cheatgrass, large areas were seed-drilled with crested wheatgrass, a nonnative species. Crested wheatgrass out competes cheatgrass, is more resistant to fire, and helps control erosion. However, the species provides little habitat value to sage grouse and other native wildlife species (Parrish 1998).

4.2.5 Noise and Other Military Activities

Environmental impacts of military training activities in the Bruneau subbasin include noise pollution from aircraft operations. Flight guidelines are outlined which specify minimum altitudes and restrict flight along the Bruneau canyon. Range operations entail periodic use of emitter sites and ongoing site maintenance for all locations (CH2M HILL 2003). In addition to aircraft noise and emitter site activity, construction of houses and additional facilities to accommodate the Air Force mission are potential future actions that may impact the local environment and biological communities.

The Air Force defines mission impacts as “problem areas that have the greatest impact on ecosystems functioning and those impacts that may occur on a landscape scale” (CH2MHILL 2003). Environmental impacts of military training activities in the Bruneau subbasin include air pollution, noise pollution, water pollution, hazardous materials and hazardous waste management, groundwater depletion, and implementation of ground safety requirements for fire prevention. Construction of houses and additional facilities to accommodate the Air Force mission are potential future actions that may impact the local environment and biological communities. Biological resources may be further affected by an increased use of roads and public thoroughfares. Range operations entail periodic use of emitter sites and ongoing site maintenance for all locations (CH2M HILL 2003). Natural resource management issues and concerns for the Juniper Butte Range (Table 44) and avoidance actions for sage grouse (Table 45) are outlined in the Integrated RMP (CH2M HILL 2003).

Table 44. Natural resource management issues and concerns of the Juniper Butte Range (CH2M HILL 2003).

Resource	Issues and Concerns
Vegetation	impacts to slickspot peppergrass habitat and populations
	loss of sagebrush habitats
	exotic/noxious weed invasion
Wetlands	delineation of wetlands
Watershed protection	Erosion
Fish and wildlife management	exotic/noxious weed invasion
	disturbance to special status species and their habitats
Grounds maintenance/pest control	exotic/noxious weed invasion
	impacts to slickspot peppergrass
Outdoor recreation	No impacts identified
Grazing outleasing	integrating grazing with training requirements, fire prevention, and slickspot peppergrass habitat management

Table 45. Emitter site sage grouse avoidance actions of Mountain Home Air Force Base (CH2M Hill 2003).

	Dates	Time	Sites*
Wintering	December 15 to February 15	24 hours a day	AV/ND-4
Breeding	March 15 to May 1	4 a.m. to 9:30 a.m.	AF, AI, AU, BD
Nesting	April 15 to June 7	24 hours a day	AI, AV/ND-4
	No restrictions	No restrictions	AA, AB, AC, AD, AE, AF, AG, AH, AJ, AK, AL, AM, AN, AO, AP, AQ, AT, AU, BA, BB, BC, BD, BE, BG, BK, BJ, BI, BF, ND-1, ND-5, ND-7, ND-9

*see Figure 19 for site locations

4.2.6 Land-Use Conversion

Human activities have been the primary cause of the loss of sagebrush across its historical range. Land uses that have converted native range include agriculture, mining, powerline and natural-gas corridors, urbanization, and expansion of road networks which fragment landscapes or eliminate sagebrush from expansive tracts of land (Knick et al. 2003). Increased fragmentation of shrub-steppe negatively influences the presence of shrub-obligate species (Knick and Rotenberry 1995).

4.2.7 Water Use

Wells on private lands in the subbasin withdraw and pump groundwater for personal and agricultural uses. In the Bruneau/Grandview area, well withdrawals increased from zero to approximately 49,900 acre-feet of water per year from 1890 to 1978 (Berenbrock 1993). Withdrawals have been increasing since 1992, and data from monitoring in 2001 indicate a return to declining groundwater levels surpassing 1994 levels, which were previously the lowest monitored levels since 1991 (USFWS 2002). In addition to water use, several surface and subsurface leaking wells were identified in an artesian well inventory conducted by the Idaho Department of Water Resources (IDWR 1992) for which a majority have not been addressed.

Although the Conservation Reserve Program is a conservation measure that temporarily removes private land from agricultural production, there has been no continuation of the Program in Owyhee County since 1999 because of a dramatic decline in monetary compensation. Aquatic and terrestrial species and communities are not afforded any protection or conservation through the allocation of surface or groundwater in the Bruneau/Grandview area (USFWS 2002). Some conservation measures have been implemented, but levels of groundwater and associated springflows continue to decline (USFWS 2002). Continuation of extensive groundwater withdrawals and land irrigation affects terrestrial species and habitats by degrading, reducing and eliminating habitat.

4.2.8 Roads

There are seven general effects that roads may have on aquatic and terrestrial ecosystems: 1) increased mortality from road construction, 2) increased mortality from collision with vehicles, 3) modification of animal behavior, 4) alteration of the physical environment, 5) alteration of the chemical environment, 6) spread of exotic species, and 7) increased alteration and use of habitats by humans (Trombulak and Frissell 2000). Terrestrial species in the Bruneau subbasin could be affected by a number of these factors, although specific research on road effects have not been conducted within the subbasin.

The life history of amphibians (e.g., Columbia spotted frog) entails migratory movements between wetland and upland habitats. Because they are inconspicuous and slow moving, they may be especially vulnerable to roadkill which can result in population fragmentation (Joly and Morand 1997). Roads may also serve to act as barriers to gene flow in amphibians, leading to significant genetic differentiation among populations (Reh and Seitz 1990). Mule deer in Colorado exhibited preference for areas >200 m from roads during the winter (Rost and Bailey 1979). Physiological responses of roads have been recorded in female bighorn sheep where heart rate increased near a road independent of the level of use (MacArthur et al. 1979). They inferred the increase in heart rate would lead to an increased metabolic rate and energy expenditure. In addition to species effects, roads may affect terrestrial habitats through the disruption of the physical environment (e.g. redirection of water, sediment, and nutrients between streams and wetlands), alteration of the chemical environment (e.g. contamination of soils and plants), and through the spread of exotic species (e.g. providing habitat by alteration of conditions) (Trombulak and Frissell 2000). Although the Bruneau subbasin is not a densely populated area, roads likely influence aquatic and terrestrial species and habitats.

Thirteen road-associated factors and their potential effects on terrestrial species are noted in Table 46 (Wisdom et al. 2000).

Table 46. Thirteen road-associated factors with deleterious impacts on wildlife (Wisdom et al. 2000).

Road-Associated Factor	Effect of Factor in Relation to Roads
Snag reduction	Reduction in density of snags due to their removal near roads, as facilitated by road access
Down log reduction	Reduction in density of large logs due to their removal near roads, as facilitated by road access
Habitat loss and fragmentation	Loss and resulting fragmentation of habitat due to establishment and maintenance of roads and road rights-of-way
Negative edge effects	Specific case of fragmentation for species that respond negatively to openings or linear edges created by roads
Overhunting	Nonsustainable or nondesired legal harvest by hunting as facilitated by road access
Overtrapping	Nonsustainable or nondesired legal harvest by trapping, as facilitated by road access
Poaching	Increased illegal take (shooting or trapping) of animals, as facilitated by road access
Collection	Collection of live animals for human uses (*e.g.*, amphibians and reptiles collected for use as pets), as facilitated by the physical characteristics of roads or by road access
Harassment or disturbance at specific use sites	Direct interference of life functions at specific use sites due to human or motorized activities, as facilitated by road access (*e.g.*, increased disturbance of nest sites, breeding leks, or communal roost sites)
Collisions	Death or injury resulting from motorized vehicles running over or hitting animals on roads
Movement barriers	Preclusion of dispersal, migration, or other movements as posed by a road itself or by human activities on or near a road or road network
Displacement or avoidance	Spatial shifts in populations or individual animals away from a road or road network in relation to human activities on or near a road or road network
Chronic negative interaction with humans	Increased mortality of animals due to increased contact with humans, as facilitated by road access

Interpretation and Synthesis

5.1 Subbasinwide Problem Statement

5.1.1 Aquatic

A final synthesis component is presented in Table 47, Table 48 and in Figure 45. The multi-species prioritization is based on the previous, species-specific QHA information, but identifies priority areas only in HUCs where species overlap occurs, and where there are common management prescriptions (*e.g.*, restoration *vs.* protection *vs.* protection/restoration actions). HUCs are ranked using the QHA-derived weighting assigned to the importance of each species' life history stage.

An inherent problem associated with this type of prioritization is the different distributions of the focal species. For example, redband trout are distributed throughout the subbasin (occurring in 56 sixth field HUCs) and overlap most areas where other focal species occur. Conversely, the two snail species have a very narrow distribution, and either dont occur with any of the other focal species (*e.g.,* Idaho springsnail) or only overlap redband migratory habitat (*e.g.,* Bruneau springsnail). Mountain whitefish represent a species distributed throughout middle-elevation portions of the subbasin, occurring with bull and redband trout, whereas bull trout represent a headwater species distributed only in eight sixth field HUCs. Therefore, the differences in species occurrence insert spatial bias when it comes to prioritization, which limits the utility of using the multi-species matrix to derive subbasin scale problem statements.

Based on the previous limiting factors analysis and the multi-species matrix, several common denominators emerge. First, when considering where and which management actions would prove most beneficial to multiple focal species, the Jarbidge watershed (East Fork and mainstem Jarbidge) represents the area with the greatest focal species overlap, within which habitat and population protection appears to be the dominant management theme (Table 47).

The occurrence of multiple species in this portion of the subbasin should not be surprising, as it represents an area characterized by comparatively cooler water temperatures, sufficient flows (due to higher mean annual precipitation), and a moderate degree of protection from land use influences (Jarbidge Wilderness occurs in headwater portions of HUCs 1602 and 1702). The management prescription of "protection" is similarly logical, as the Jarbidge watershed contains core populations of bull trout, stronghold redband populations, and well distributed mountain whitefish populations. Protection of mainstem Jarbidge habitats (*e.g.*, sixth field HUCs 1802 and 1801) is also important for the maintenance of connectivity between other portions of the subbasin, and is consistent with underlying themes of conservation biology (*e.g.*, Doppelt et al. 1993) and metapopulation theory (*e.g.,* Rieman and Dunham 1999).

Table 47. Sixth-field HUCs within which redband trout (RB), bull trout (BT), mountain whitefish (MW), and Bruneau springsnail (BS) co-occur and within which common restoration, protection, or protection/restoration activities have been defined. HUCs shown are not ranked in order of management action (*e.g.*, Restoration, Protection, Restore/Protect) priority. The Idaho springsnail does not occur with any other focal species, hence its exclusion.

	RB, BT, MW	**RB, MW**	**RB, BS**	**BT, MW**
Priority: Restoration	Jarbidge 4 (1701) [2]			Jarbidge 5 (1702)
Priority: Protection	Jarbidge 3 (1501)[2] EF Jarbidge 1 (1601) [2] EF Jarbidge 2 (1602) Jarbidge 2 (1801) [2] Jarbidge 3 (1802) [2]	Bruneau 4 (0402) Bruneau 11 (2101)		
Priority: Protection/Restoration			Bruneau 2 (0102)[1] Bruneau 3 (0401)[1]	Jarbidge 1 (2801)

[1]/ Rule 1: If two species occur in the same HUC yet one has a "restore" action and the other has a "protect" action, then a "protect/restore" action is prescribed.
[2]/ Rule 2: If three species occur in the same HUC, the dominant management action dictates the final action prescription.

Table 48. Multi-species prioritization of restoration, protection, and protection/restoration activities in the Imnaha subbasin. HUC rankings are based on the revised QHA restoration values and QHA protection scores (presented above), and are further stratified based on the relative importance of life history stages[1] defined in the HUC. HUCs are prioritized based on the highest rank assigned. This prioritization effort should be used in combination with individual species prioritization (presented above).

	Name	HUC_ 6	Redband Trout				Bull Trout				Mtn. Whitefish				Bruneau Springsnail				Lifestage Score	Rank
			S/I	SR	WR	M	S/I	SR	WR	M	S/I	SR	WR	M	S/I	SR	WR	M		
Priority: Restoration																				
	Jarbidge 5	1702	1.3	1.3	1.3	1	1	1.5	1.5	1.7	1	1	1	1	0	0	0	0	14.8	1
	Jarbidge 4	1701	2	2	2	1	0	1	1	1	1	1	1	1	0	0	0	0	14.0	2
Priority: Protection	E.Frk Jarbidge 2	1602	1.3	1.3	1.3	1.0	1.2	1.2	1.2	2.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	14.6	1
	E. Frk Jarbidge 1	1601	2.0	2.0	2.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	14.0	2
	Jarbidge 3	1501	2.0	2.0	2.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	12.0	3
	Jarbidge 3	1802	1.3	1.3	1.3	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	12.0	3
	Bruneau 11	2101	1.5	2.0	2.0	2.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	11.5	5
	Jarbidge 2	1801	1.3	1.3	1.3	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	10.0	6
	Bruneau 4	0402	0.0	1.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.3	0.0	0.0	0.0	0.0	7.3	7
Priority: Protect/Restore																				
	Jarbidge 1	2801	1.0	1.2	1.2	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	9.3	1
	Bruneau 2	0102	0.0	0.8	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	0.0	8.5	2
	Bruneau 3	0401	0.0	1.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	3

[1]/ Life history stages include spawning/incubation (S/I), summer rearing (SR), winter rearing (WR), and migration (M)

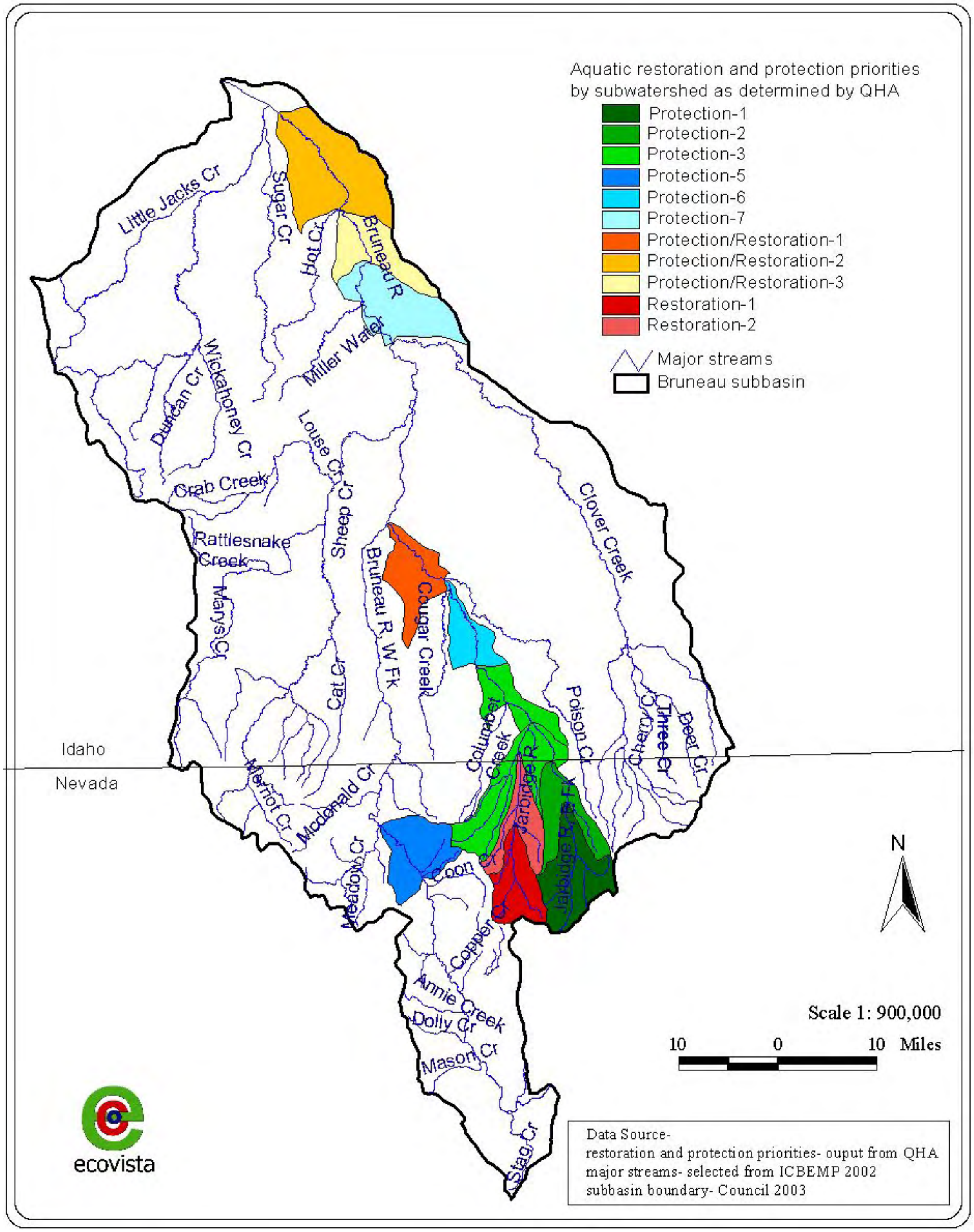

Figure 45. Multi-species representation of restoration, protection, and protection/restoration areas in the Bruneau subbasin.

Despite its apparent "Properly Functioning Condition," portions of the Jarbidge watershed are in need of restoration. As shown in Figure 45, sixth field HUCs 1701 and 1702 were determined (based on QHA analyses) to be areas in the subbasin where restoration efforts would most benefit multiple focal species. Although it is somewhat surprising that HUC 1702 surfaced as one in need of restoration (based on its partial wilderness designation), it's proximity to core bull trout habitat supports the theory of "building out from areas of strength," which is one of the key considerations in conservation biology (Doppelt et al 1993). It is also logical to have restoration activities occurring in headwater reaches, as the benefits will most likely extend to downriver reaches.

Protection of core bull and redband trout habitat is defined a high priority in the upper reaches of the EF Jarbidge (*e.g.*, HUCs 1501, 1601 and 1602), as well as throughout the middle portions of the Jarbidge migratory corridor. Protection of these areas would provide a degree of connectivity between the core habitat portion of the subbasin and the less stable habitat occurring elsewhere. HUC 2801 is defined as a "protect and restore" HUC, which is appropriate since it contains the confluence reach of the Jarbidge River, a segment of stream that could stand improvement while equally warrant protection from further degradation.

Protection/restoration designations are also shown in Bruneau 3 and Bruneau 2 (HUCs 0102 and 0401), two HUCs occurring just upstream from the confluence of the Bruneau and Snake Rivers. The designations are due to co-occurrence of the Bruneau hot springsnail and redband trout. Because of the reservoir, certain restoration activities commonly applied in lotic systems would obviously not be applicable, however protection of unique resources (*e.g.*, groundwater discharge) found in these areas is critical for the continued persistence of the Bruneau hot springsnail.

5.1.2 Terrestrial

Following the development of focal habitats, species, and their limiting factors by the Bruneau Terrestrial Technical Team, expert field biologists performed a qualitative spatial analysis of terrestrial limiting factors of the Bruneau subbasin (Jerry Deal and Mike McDonald, Idaho Fish and Game; Jeff Beck, University of Idaho). For the analysis, thirteen terrestrial regions (Figure 46) were delineated within the Bruneau subbasin by merging 5th field HUCs that contained similar vegetation types. Vegetation types are based on satellite imagery derived maps of Wildlife Habitat Types developed by the Northwest Habitat Institute (NHI) for use in the subbasin planning process (Figure 31). Riparian and wetland habitats were under represented in NHI's mapping results, but they were added to each of the terrestrial regions because of their importance.

The eight limiting factors (see section 4.2) the Bruneau Terrestrial Technical Team identified to be most prominent in focal habitats were qualitatively ranked (Table 49) by focal habitat type in each terrestrial region.

Table 49. Description of ranks used in the qualitative spatial analysis of limiting factors in the Bruneau subbasin.

Rank	Influence
1	Slight to none
2	Intermediate
3	Moderate
4	Moderate to severe
5	Severe and/or extensive

A resulting rank of limiting factors identified as most influential within the Bruneau subbasin (Table 50) was provided to serve in the development of the Bruneau Management Plan. In addition to the limiting factors ranking, a spatial summary of the influence of individual limiting factors within terrestrial groups (Table 51) and an overall average influence of limiting factors by group (Table 52) were provided by this qualitative spatial analysis.

Grazing, invasive exotic plant species, and increased fire frequency and intensity were identified as the top three factors limiting focal habitats and species of the Bruneau subbasin. This analysis is not statistical which precludes interpretation of significant differences between limiting factors or terrestrial regions. No monitoring data were available that would allow such an analysis. These results are corroborated by local experts and peer reviewed literature on these limiting factors in other regions and are intended to guide the development of the objectives and strategies of the Bruneau Management Plan. Because this is an iterative process, the relative ranks of the limiting factors and terrestrial groups should be reevaluated and updated through the adaptive management process.

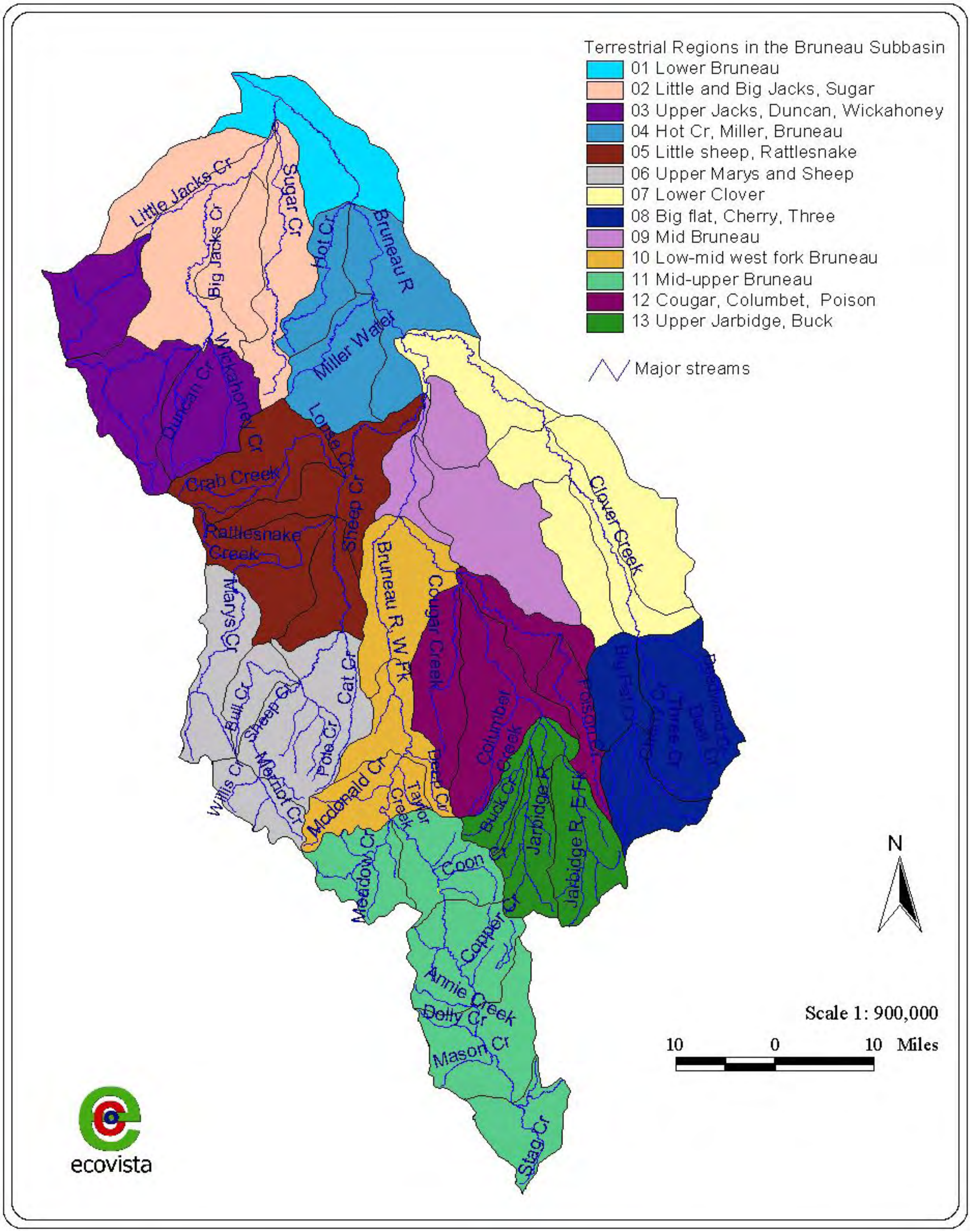

Figure 46. Terrestrial regions of the Bruneau subbasin

Table 50. Qualitative assessment of limiting factors by focal habitat type in the Bruneau subbasin. Limiting factors were ranked on a scale of 1 to 5, with 5 representing the most extensive prevalence of a limiting factor in a focal habitat.

Focal Habitat Type	**Influence of Limiting Factor →**								
	Grazing	**Invasive Exotics**	**Increased Fire**	**Crested Wheatgrass**	**Noise**	**Land-Use Conversion**	**Water Use**	**Decreased Fire**	**Roads**
Upland aspen	3.1	2.1	2.4	1.9	1.7	1.0	1.0	4.0	1.3
Shrub steppe	3.9	3.9	3.8	3.9	2.7	1.4	1.0	-	1.4
Dwarf shrub steppe	3.7	3.8	3.8	3.6	2.5	1.3	1.0	-	1.4
Riparian, wetland, spring	4.3	2.6	1.7	0.9	2.3	2.6	4.6	-	1.0
Western juniper	2.5	2.7	1.0	0.5	1.0	1.0	1.0	1.5	1.0
Desert playa	3.7	4.3	3.3	3.0	3.0	2.3	1.0	-	1.2
Montane Conifer Forest	2.0	1.0	-	0.5	1.0	1.0	1.0	3.5	1.0

Table 51. Summary of limiting factors by terrestrial groups in the Bruneau subbasin. Limiting factors were ranked on a scale of 1 to 5, with 5 representing the most extensive prevalence of a limiting factor in a terrestrial group. Blank cell values indicate the limiting factor is not currently a threat within that terrestrial region.

Terrestrial Group	Major Streams in Terrestrial Group	Grazing	Invasive Exotics	Increased Fire	Crested Wheatgrass	Noise	Land Use Conversion	Water Use	Decreased Fire	Roads
1	lower Bruneau	3.7	3.7	3.7	3.0	-	3.0	-	-	1.0
2	lower Little Jacks, lower Big Jacks, Sugar	3.5	5.0	3.5	3.0	-	3.5	-	-	1.0
3	upper Little Jacks, upper Big Jacks, Duncan, Wickahoney	3.5	3.0	3.0	3.0	-	1.0	-	-	1.0
4	lower Sheep, Louse, Crab, Rattlesnake, lower Mary's	3.7	3.0	4.0	-	-	1.0	-	-	1.0
5	upper Mary's, Bull Creek, upper Sheep Creek, Pole Creek, Cat Creek	3.0	3.0	3.0	-	-	1.0	-	-	1.0
6	Hot Creek, Miller Water, Bruneau	5.0	4.4	3.5	2.8	3.0	1.0	2.0	-	1.4
7	lower Clover and tributaries	4.7	3.7	3.3	3.3	3.7	1.7	2.3	-	1.7
8	Big Flat, Cherry, Three, Deadwood	4.5	2.3	3.8	2.5	1.0	2.0	2.0	-	1.8

Terrestrial Group	Major Streams in Terrestrial Group	Grazing	Invasive Exotics	Increased Fire	Crested Wheatgrass	Noise	Land Use Conversion	Water Use	Decreased Fire	Roads
9	middle Bruneau and tributaries	-	-	-	-	-	-	-	-	-
10	West Fork Bruneau, Taylor Deep, McDonald	-	-	-	-	-	-	-	-	-
11	upper West Fork Bruneau, Annie, Coon, Copper, Meadow	3.0	3.0	1.0	5.0	-	1.0	-	-	1.0
12	Cougar, Columbet, Poison	3.9	3.1	2.1	2.8	3.0	1.5	2.0	-	1.4
13	upper Jarbidge, Buck, East Fork Jarbidge	2.8	1.6	2.5	1.0	1.2	1.8	1.4	3.0	1.3

Table 52. Qualitative assessment of limiting factors in the Bruneau subbasin. Ratings were pooled across limiting factors within each area to rank overall influence of human impacts by watershed group. No ratings were obtained for watershed groups 9 and 10.

Overall influence of limiting factors (highest → least)	**Watershed Group**	**Major Streams**	**Average Rating**
1	2	lower Little Jacks, lower Big Jacks, Sugar	3.3
2	7	lower Clover and tributaries	3.0
3	1	lower Bruneau	3.0
4	6	Hot Creek, Miller Water, Bruneau	2.9
5	8	Big Flat, Cherry, Three, Deadwood	2.5
6	12	Cougar, Columbet, Poison	2.5
7	4	lower Sheep, Louse, Crab, Rattlesnake, lower Mary's	2.4
8	3	upper Little Jacks, upper Big Jacks, Duncan, Wickahoney	2.3
9	5	upper Mary's, Bull Creek, upper Sheep Creek, Pole Creek, Cat Creek	2.1
10	11	upper West Fork Bruneau, Annie, Coon, Copper, Meadow	2.0
11	13	upper Jarbidge, Buck, East Fork Jarbidge	1.8
?	9	middle Bruneau and tributaries	N/A
?	10	West Fork Bruneau, Taylor Deep, McDonald	N/A