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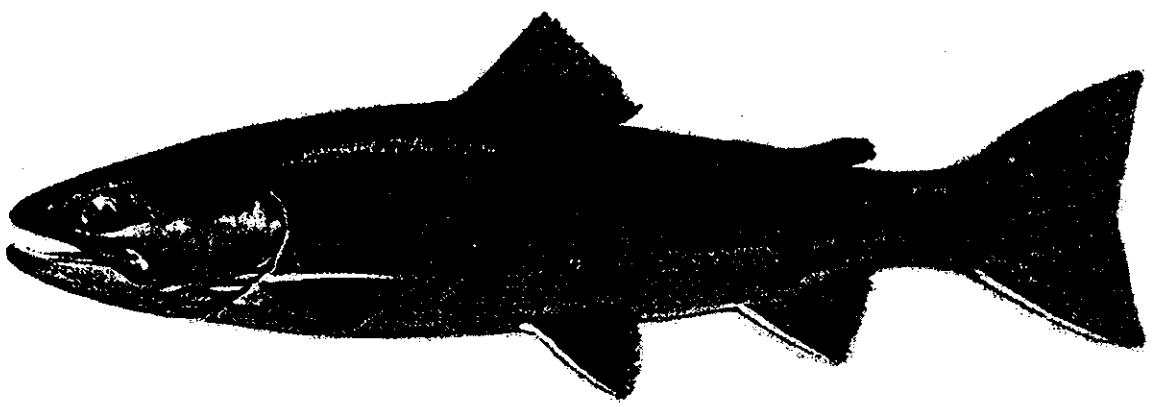
Jarbidge KeyWatershed Bull Trout Problem Assessment

December 1998



Prepared for
State of Idaho

by
Southwest Basin Native Fish Technical Group

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I. Participants

This document has been prepared by the Southwest Basin Native Fish Watershed Advisory Group (SBNFWAG) according to Governor Philip E. Batt's State of Idaho Bull Trout Conservation Plan (1996).

The SBNFWAG is made up of a ten-person executive committee, and general membership. The executive committee is appointed following recommendations of individuals by the Southwest Basin Advisory Group (BAG). The SBNFWAG executive members for the Jarbidge Key Watershedsare:

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4. Introduction

The bull trout (*Salvelinus confluentus*) is listed, as of the date on this document, by the U.S. Fish and Wildlife Service as an "endangered" species as per the Endangered Species Act. In mid-1996, Governor Batt and the State of Idaho issued an official conservation plan for bull trout and is now executing this strategy across the state. The State of Idaho intends to restore this species by developing and implementing the necessary conservation measures.

This document is a problem assessment for the Jarbidge and follows the guidelines provided in the Bull Trout Conservation Plan.

This document represents the first phase, problem assessment. The next step is to develop a watershed conservation plan. The watershed conservation plan, as outlined in the Bull Trout Conservation Plan, will be developed within Governor Batt's time line on a schedule recommended by the Southwest BAG and SBNFWAG.

Conclusions based upon this assessment lead to short term action items that can and should be done in the interim to protect the existing resource. This assessment also serves to develop the background information supporting future actions and begin implementation of long term programs to restore part of Idaho's rich natural heritage.

5. Mission and Goals

This document completes the problem assessment phase for the Jarbidge key watershed. The following section includes the mission statement and goals developed in Governor Batt's Bull Trout Conservation Plan. In the second phase of the Governor's plan, development of a conservation plan, specific key watershed goals will be established and evaluated. The mission is to:

Maintain and/or restore complex interacting bull trout populations throughout their native range in Idaho. Recommendations are focused only on the key watershed - the East and West Forks of the Jarbidge River from the Idaho-Nevada boundary to their confluence at Murphy Hot Springs, Idaho.

To accomplish this mission, the goals include:

- Maintain the condition of those areas presently supporting critical bull trout habitat;
- Institute recovery strategies that produce measurable improvement in the status, abundance, and habitats of bull trout. Concentrate resources and recovery efforts in areas which will produce maximum cost-effective, short-term returns and which will also contribute to long-term recovery;
- Establish a secure, well-distributed set of sub-watersheds within key watersheds to achieve a stable or increasing population and to maintain options for future recovery; and
- Achieve the above goals while continuing to provide for economic viability of Idaho's industries.

6. Study Area

6.1. General

The Jarbidge River heads high atop the peaks of the Jarbidge Wilderness Area within northern Nevada. Descending from the wilderness area in two separate rivers, East Fork and West Fork of the Jarbidge River, they join approximately five miles into Idaho (Figure 1). It eventually flows into the Snake River near Bruneau, Idaho, some 102 miles to the northwest. The elevation of the Jarbidge River ranges from 10,839 feet in Nevada to roughly 5,200 feet at the confluence of the east and west forks of the Jarbidge near Murphy Hot Springs in Owyhee County, Idaho. The river continues its descend 29 miles to the confluence with the Bruneau River (approximately 0.5 miles upstream of Indian Hot Springs); an elevation of 3,695 feet. The combined rivers are then referred to as the Bruneau River which continues 48 miles to the confluence with the Snake River at elevation 2,455 feet. The watershed encompasses nearly 425,012 acres between the two states. The Jarbidge-Bruneau River system was studied and found eligible for inclusion in the federal Wild and Scenic Rivers System (Robertson 1994).

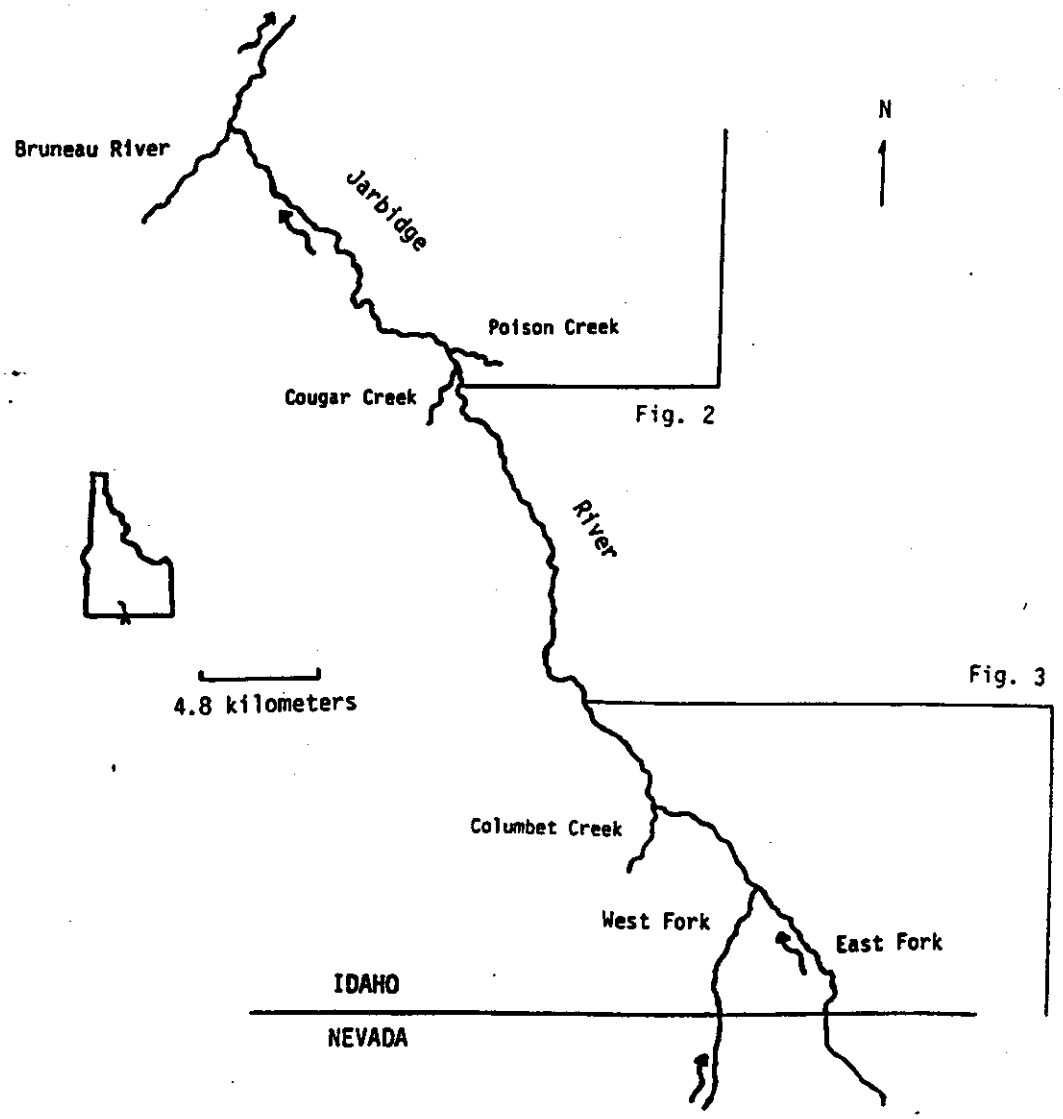

Figure 1. Jarbidge River in south central Idaho with areas investigated for the presence of bull trout.

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Figure 1. Jarbidge River, Location. (Warren and Partridge 1993)

Bull trout in the Jarbidge River watershed are a relic from the Pleistocene era. They are isolated from all other bull trout populations in the Snake River system. Existing data is not sufficient to make a valid projection of population viability. It must be emphasized that current morphology of the Jarbidge River is a product of 90 years of channel, watershed, and riparian area modification from human activities. It is likely that low bull trout numbers in the Jarbidge River are also a product of these alterations (McNeill et al. 1997).

6.2. Climate

The climate is best described as moderate. Average temperatures range from below 32 degrees in January to 80 degrees in July. Temperatures well below zero and over 100 degrees are not uncommon. the mean annual precipitation along the river system varies from a high of about 35 inches in the Jarbidge Mountain headwaters to a low of eight inches near the confluence with the Snake River (Vinson 1990).

6.3. Hydrology

Most of the river flow is derived from winter snowpack in the high mountain watershed, with annual peak flows corresponding with spring snow melt, typically in May and June. Low flow generally occurs from November through January. The river is perennial in the main channel though flow may become very low (less than 5 cfs) during years of extended drought.

Gauging data for the Jarbidge River system can best be described as limited. The Jarbidge River was gauged for 23 years until high water destroyed the gauge site in 1971. During the time of operation, the gauge showed a close correlation to approximately 66% of flows recorded downstream at the Bruneau River U.S.G.S. Hot Springs gauge station. Using this hypothesis, average median flows for the Jarbidge River are:

Table A. Average Median Flows For Jarbidge River.

Month	Flow	Month	Flow
October	67 cfs	April	530 cfs
November	81 cfs	May	845 cfs
December	84 cfs	June	658 cfs
January	92 cfs	July	176 cfs
February	117 cfs	August	65 cfs
March	238 cfs	September	56 cfs

(Vinson 1990)

6.4. Geology/Landform

Geology of the Jarbidge River watershed is dominated by the Jarbidge rhyolite formation, occupying

76% of the surface acres within the watershed. This rhyolite is a light-colored, fine-grained volcanic rock with a very high silica content. As lava, rhyolite tends to be very viscous because of its high silica content, and upon eruption it generally formes steep-sided domes and plugs. Gas-rich rhyolite, however, erupts violently to form welded tuffs, or ignimbrites, and may spread out over great distances.

The Jarbidge River watershed geology includes sediments of dust, ash, volcanic glass, and rock fragments of various sizes spread by the force of volcanic explosion. Pyroclastic rocks, fragments of igneous material shot out of volcanoes and deposited as sediments, are considered to be sedimentary rock. Tuff is one of two major pyroclastic rocks. Tuff contains the smaller fragments which form when ejected liquid lava solidifies in flight, and blocks, which are ejected from a volcano as solids. Pyroclastic rocks are chemically unstable, and the minerals within are subject to rapid alteration. One kind of tuff that carries a special name is ignimbritye, or welded tuff, a nonsorted rock deposited from a hot glowing ash flow that moved very rapidly down the volcano, while the particles were still in plastic condition. As ash flows cool, the plastic condition material welds these particles together. Ignimbrites are a geologic feature found on approximately 7% of the watershed.

Alluvium, glacial moraines, landslide deposits and colluvium occupy the remaining 17% of the watershed.

One potentially significant difference in geology between the two watersheds is in those geologic types which could be considered as disturbance prone. The East Fork has a landscape occurrence of 11% for catastrophic type events while the West Fork has a higher factor of stability at an occurrence of 4% over the landscape.

As a general rule, soils in the watershed are very coarse but have moderately high productivity. Inherent permeability is mostly slow and primarily moderate to well drained. Many soils in the watershed have duripan, claypan, or shallow depth to bedrock which increases potential for slumping on a localized basis.

The geology of the area contributes to the nutrient "poor" condition of the aquatic river system. Macroinvertebrate sampling showed more than three times greater level of productivity (0.4 g/m2 versus 1.4 g/m2) in the West Fork of the Jarbidge River. This level of productivity is still low and can only support a moderate fishery. The difference in productivity between the two watersheds could be due to a greater prevalence of LWD in the West Fork relative to the East Fork Jarbidge in Nevada (Johnson personal comm.).

6.5. Bull Trout Life History

Only nodal habitat exists in the Jarbidge River, within Idaho, for bull trout. All spawning and juvenile rearing habitat within the watershed is found upstream in Nevada.

During August of 1998, the *Salvelinus confluentus* Curiosity Society attempted to conduct a comprehensive sampling effort of remaining bull trout populations within the watershed. Rudimentary data collected included: species of fish, lengths and weights for all native salmonids,

recorded map coordinates of sample sites, and fin clips from bull trout for genetic analysis. Preliminary results from mDNA testing conducted at the University of Montana indicates three separate resident populations remain within the upper Jarbidge River watershed, in Nevada, with very little evidence of genetic mixing (Spruell personal comm.).

6.6. Other Native Fishes and Amphibians

In the fall of 1997, weirs were setup near the confluence of the East and West Forks within Idaho, in an attempt to document downstream migration of post spawning fluvial adult bull trout. Efforts documented a range of native fish including redband rainbow trout (*Oncorhynchus mykiss gardenarii)*, mountain white fish (*Prosopium williamsoni*), bridgelip suckers (*Catostomus columbianus*), mountain sucker (*C. platyrhynchus*), shorthead sculpin (*Cottus confusus*), redside shiner (*Richardsonius balteatus*), longnose dace (*Rhinichthys cataractae*), speckled dace (*R. osculus*), and leopard dace (*R. falcatus*) along with one bull trout trapped in the West Fork.

6.7. Land Management

The Jarbidge River watershed, within Idaho, is primarily federally owned land managed by the Bureau of Land Management Jarbidge Resource Area, headquartered in Twin Falls, Idaho. Within the BLM Resource Area boundaries, 81% of the lands are federally owned, 5% are state owned, and 14% are privately managed. Present land management activities within the Resource Area primarily revolve around livestock management (U.S.D.I., 1987).

Federal lands within the Jarbidge River watershed of northern Nevada are managed by the U. S. Forest Service as part of the Toiyabe-Humbolt National Forest.

7. Conditions Data Table

Not available for this problem assessment.

8. Bull trout distribution and abundance

The only native char in Idaho and Nevada is the bull trout (*Salvelinus confluentus*). Bull trout were found solely in anadromous waters of Idaho and Nevada. Historical, and mostly antidotal evidence suggests an annual migration of bull trout coincided with movement of anadromous fish from the Snake River into the Jarbidge River system. Both resident and fluvial populations existed within the Jarbidge River system, however, only fluvial bull trout are found within Idaho. Because both fluvial and adfluvial bull trout populations in other watersheds have demonstrated a propensity for lengthy migration, it is plausible that bull trout may have used the Jarbidge River as a migratory corridor between the Snake River and headwater spawning and juvenile rearing streams in Nevada. Currently, the Jarbidge River in Idaho is known to provide winter habitat for the fluvial form of bull trout.

8.1. Distribution

Although, elevational criteria for spawning purposes are met in Idaho, as described in Reiman et al. 1993, for the Boise River watershed, no perennial tributaries to the Jarbidge River, within Idaho, contain suitable spawning habitat or water temperatures (Partridge, personnel comm.). Distribution within Idaho can best be described as nodal with utilization of habitats within Idaho being seasonal.

8.1.1. Historic

Historical accounts made by early settlers and native Americans who visited the Jarbidge and Bruneau River watersheds provide antidotal referenced to salmon, steelhead, and bull trout within the river system. Distribution of anadromous fish and fluvial bull trout appeared widespread with the spawning occurring in the headwater streams of what is now known as Nevada. There is ample evidence that human activities have influenced, fragmented, and altered terrestrial and aquatic resources in the watershed to the point that only remnant populations of the native fish communities exist (Fredrick 1998).

8.1.2. Current

In Idaho, extensive surveys were conducted on the Jarbidge River in 1992 and 1997 by IDFG and 1994 by the BLM. The 1992 survey sampled 19 randomly selected transects on both the East and West Forks of the Jarbidge along with the main river below the confluence. 1992 was the close of an extended period of below normal precipitation and above normal temperatures throughout southern Idaho. Water temperatures documented in the main river were in excess of 25o C.; well beyond lethal limits described in literature for bull trout (Boise River Key Watershed Problem Assessment). No bull trout were sampled at any of the sites, although, one bull trout was documented by IDFG, as being caught by an angler near Murphy Hot Springs during 1992 sampling efforts (Partridge personal comm.).

Accidental/incidental sampling in the Jarbidge River within Idaho has lead to other recent documented observations of bull trout. Interagency sampling in 1994 yielded sighting of one adult approximately 1.5 miles downstream of the Idaho-Nevada boarder (Johnson 1997; Zoellick et al. 1996) while sampling in conjunction with the 1998 *Salvelinus confluentus* Curiosity Society meetings, also yielded one subadult bull trout within a sample reach on the East Fork Jarbidge River within Idaho.

Antidotal reports of bull trout caught by anglers continue to be recited to local IDFG conservation officers and Regional Office in Jerome.

8.2. Abundance

Because of the low numbers of bull trout and limited access to the river, determining abundance is problematic, at best. In the Jarbidge River, approximately 19 bull trout have been collected in 13 sampling efforts since 1954 which suggests that bull trout are represented in extremely low numbers. Using very limited sample information, the population of bull trout in the Jarbidge River was estimated at 292 fish in 1994 (McNeill et al. 1997).

9. Habitat Conditions and Trends

Habitat condition and trend information is needed to assess factors limiting bull trout productivity in key watersheds (Bull Trout Conservation Plan, pg 16). Habitat variables mentioned in the Conservation Plan include: a) channel and hydrologic stability, b) substrate size and relative composition, c) cover complexity, d) temperature and related variables, and e) barriers to migration. Analysis of habitat data will give an overall picture of the health of the watershed and its suitability to recover or sustain viable bull trout populations.

Extensive habitat data is available for the East Fork, West Fork, and Jarbidge River below the confluence. Historic data and habitat descriptions also provide a clear picture of habitat trends, as well.

9.1. Channel and Hydrologic Stability

At the lower elevations in Idaho, the stream gradient lessens and channel type begins to transition from an "A2" headwater stream in Nevada to a "B3" type stream in Idaho, as characterized by the Rosgen method of classification (Rosgen, 1994). "B3" type streams are the result of the integrated influence of structural contact zones, faults, joints, colluvial-alluvial deposits, and structurally controlled valley side-slopes which tend to result in narrow valleys that limit the development of a wide floodplain. Streambank erosion rates are normally low as are the channel aggradation /degradation process rates (Rosgen 1996).

9.2. Substrate Size and Relative Composition

The most comprehensive data collected on substrate in the Jarbidge River watershed of Idaho comes from Warren and Partridge 1993. Data were collected from 19 randomly selected sites in both forks of the Jarbidge River and the mainstem between Murphy Hot Springs and the Bruneau River. These sites are shown on maps (figure 2. and 3.), and are described in Appendix A. The data collected at these sites is summarized in Appendix B.

In general, a low percentage of the substrate was composed of silt or sand. In all but four of the sites, the substrate was dominated by gravel, cobble, or rubble. In those four exceptions, the highest percentage of silt or sand at any one site was 17%. The low percentage of fine material is typical for a high-gradient, confined, channel. Water column velocities during hydrologic events transport smaller sized materials downstream or deposit them within riparian dominated areas of the flood plain.

Findings from data collected within Idaho were consistent with habitat information collected upstream in Nevada where the most dominant substrate size was cobble and the river appeared to be sediment and gravel "poor" within the active channel. Sands and gravels were mostly deposited on the flood plain by high water events (McNeill et al. 1997).

Water column fish habitat is extremely variable with pools, runs, pocket water, and riffles all represented. Pool depth, which can be the limiting factor for wintering fish populations averaged between 24 and 36" (Zoellick et al. 1996).

A subjective barometer of pool quality does exist, however, physical measurement were not taken by IDFG to judge suitability for fish habitat. It should be noted that quality pools (adequate depth, cover, and substrate size) are probably the last habitat element to re-establish in a disturbed stream system.

In 1979, the West Fork Jarbidge River in Nevada was channelized. Quality pools developed within 6 years following destabilization of the reach. The reason for such a long time frame for re-development of the pools is due to the characteristics of a "B" type channel. Extreme high water velocities and confined channels tend to readily scour down to control surfaces (bedrock or large boulders) and do not trap debris (Rosgen 1996).

9.3. Cover Complexity

Because of the confined nature of the channel and the lack of LWD in the riparian community, LWD is sparse, widely scattered, and mostly concentrated in log jams. Most LWD in the Jarbidge River is recruited from forested areas of Nevada rather than the high desert plateaus of Idaho.

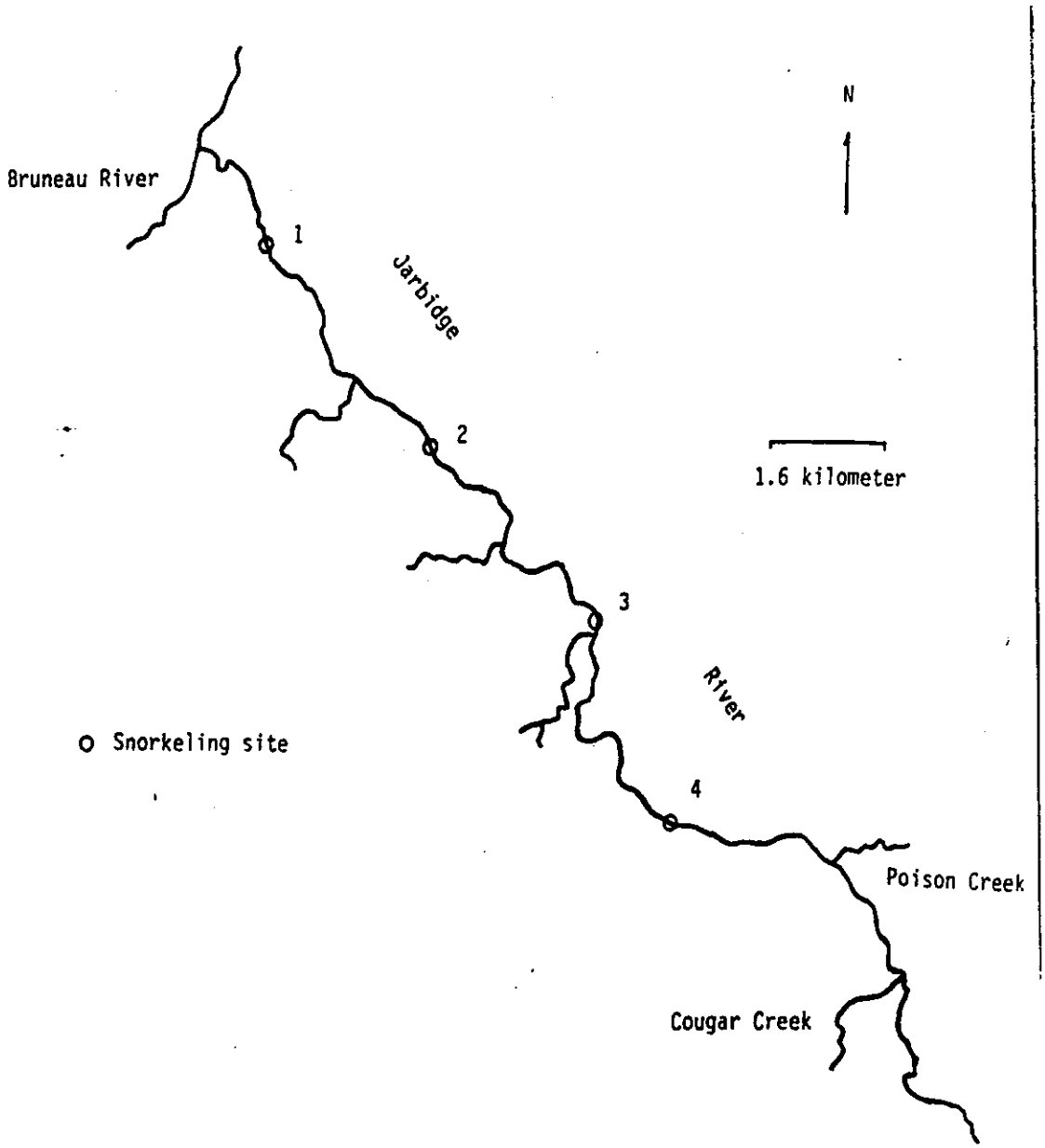

Figure 2. Locations of fish population and habitat sites on the lower Jarbidge River, Idaho.

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Figure 2. Locations of fish population and habitat sites on the lower Jarbidge River, Idaho. (Warren and Partridge 1993)

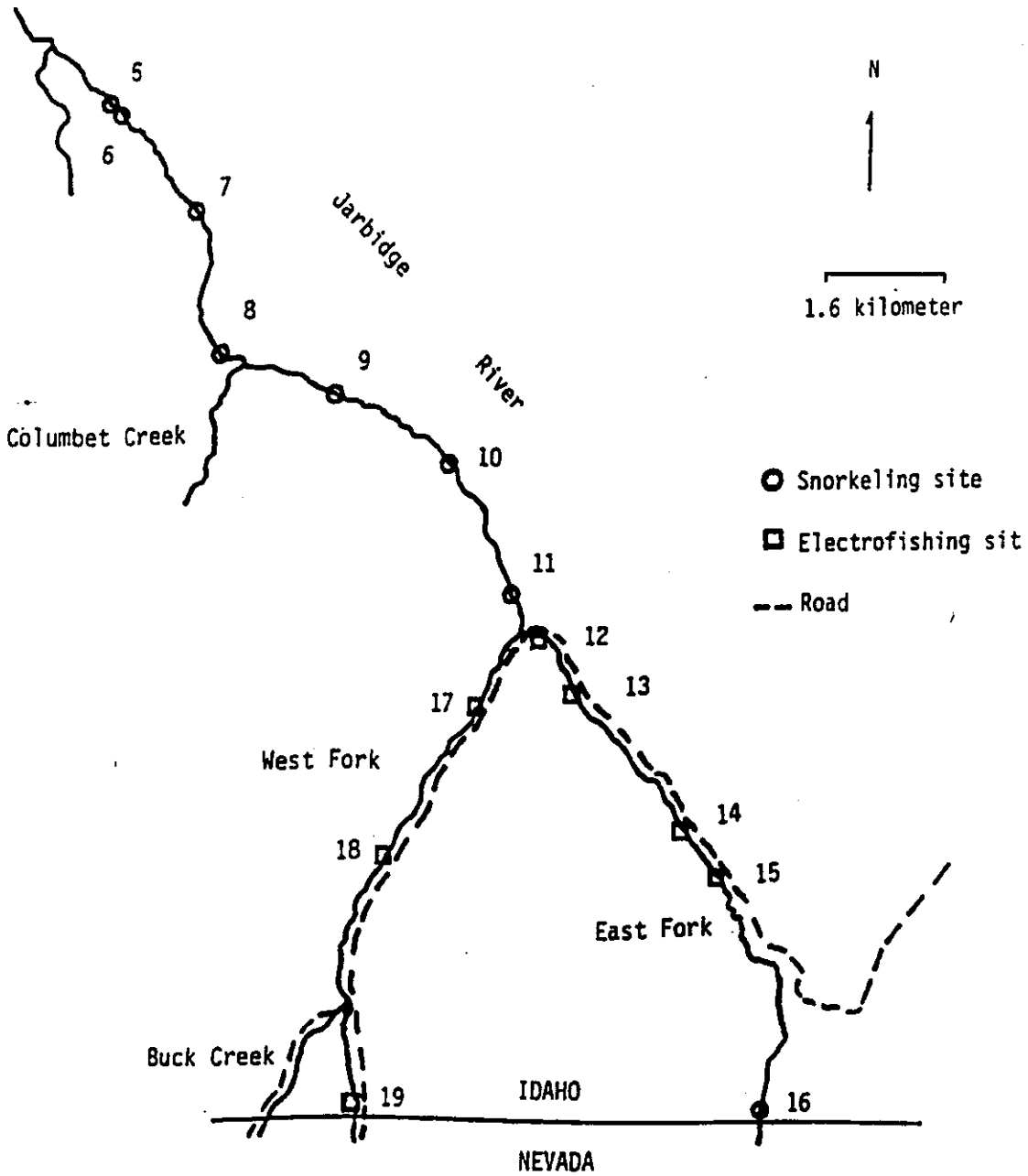

Figure 3. Locations of fish population and habitat sites on the East and West forks and upper Jarbidge River, Idaho.

Figure 3. Locations of fish population and habitat sites on the East and West forks and upper Jarbidge River, Idaho. (Warren and Partridge 1993)

The predominant cover utilized by the fishery and other aquatic biota is habitat provided by large rocky structures. Some over-hanging banks and willow cover exists as the Jarbidge River moves downstream and transitions towards a "C" type channel below the confluence of the East and West Fork in Idaho.

Review of settlement history suggests that most LWD within the confined river channel was removed for construction or fuel wood purposes. Steep terrain and harsh conditions made LWD carried by the river the easiest to transport to their destination of use. In more recent times, LWD has been removed along roadways for flood control reasons (McNeill et al. 1997).

9.4. Temperature and Related Variables

Spawning and rearing of bull trout is not documented to occur within Idaho, therefore, temperature criteria to support reproduction should not apply. Adult bull trout have not been observed in sampling within Idaho when temperatures exceed 14 degrees C. (Zoellick et al. 1996). During the summer of 1992, Warren et al. recorded temperatures well in excess of 14° C. (Appendix C.) Temperatures recorded by Partridge et al. in 1997, are more within tolerance limits for bull trout outside of reproductive habitats, however, some daily maximums were recorded in excess of the 14° threshold (Appendix D.)

Several factors influence late summer water temperatures of the Jarbidge River within Idaho. One factor is the unique north-south alignment of this watershed resulting in a lack of natural shading. Additional influences include a lack of a well developed riparian canopy due to substrate and lack of soils, the vertical canyon topography, and the dark colored basalt which acts as a radiator to warm water temperatures during periods of solar input.

9.5. Barriers to Migration

Within Idaho, crossings of the Jarbidge River are either bridges or fords. Physical barriers (e.g. culverts, irrigation diversions, etc.) are not documented to disrupt migration of bull trout. Antidotal evidence suggests that thermal spring discharges from developed sources may act as a barrier to fish migration during low flow conditions.

10. Watershed Characteristics Influencing Bull Trout

The charteristics of the geology of the watershed provide for commercially marketable minerals. The extraction/development has had a significant influence on bull trout habitat in the Jarbidge River system. Historic and present extraction and use of resources continues to influence habitat availability and quality for native fish throughout the drainage. Commercial development and the role its played in shaping the watershed characteristics and bull trout populations also demonstrates the resilience and persistence of native salmonids within the Jarbidge River.

10.1. Geologic Processes

The upper Jarbidge River watershed, within Nevada, is very active erosionally with mass-wasting being the dominant erosional process. Several types of mass wasting have been identified, including

debris avalanches, debris torrents, and earth slumps. Review of historic aerial photos indicate that recent (since 1984) side channel debris torrents and debris avalanches have occurred on the side slopes and in side drainages with a west, southwest aspect. Colluvial and alluvial material has accumulated in the narrow Jarbidge River valley bottom forming wide cobble and gravel bars and influencing hydrologic flow regimes. On a more chronic basis, shallow soils on moderate to steep valley slopes allow for continual downslope dry ravel, sheet erosion and minor gullying. Periodic spring rain-on-snow events contribute to the downslope movement of rock debris (McNeill et al. 1997).

Geologic process influencing channel formation in Idaho are assumed to be the same as those described above.

10.2. Stream Flow Regime

No man-made controls exist on the Jarbidge River within Idaho which will directly influence hydrologic events. Stream flows are dominated by snow melt and atypical weather phoneme such as rain on snow events or summer thunder storms.

10.3. Land Uses and Practices

Roughly 1.2% of the watershed has visible surface disturbance in the form of towns, roads, trails, mining activity, campgrounds, and miscellaneous associated support facilities. Steep terrain within the watershed limits the opportunity for development of homes and industry, though livestock grazing,, timber harvest and hardrock mining have occurred extensively throughout the watershed. Further development is limited by restrictions imposed by the dominance of public land within the watershed (McNeill et al. 1997).

Historically, the country surrounding the Jarbidge River was heavily disturbed by resource development. The discovery of gold in the early 1900's within the Jarbidge River watershed caused the towns of Jarbidge, Nevada and Murphy Hot Spring, Idaho to flourish. In 1911, the area population soared to 1,200 individuals packed into the narrow stream bottom of the Jarbidge River. The number of residents then began a fluctuating decline until the last commercial mine closed in 1932 (Nevada History 1998). Today, full-time residents number less than 50.

Timber was cut and LWD removed from the river to shore mine tunnels and build towns, rivers were fished to supply fresh food to mining camps, and livestock were grazed on the limited suitable and unsuitable lands, also to provide food and other goods to support the mining towns. With the exception of still visible mine adits and placer waste deposits, natural reclamation of the area has restored ecologic integrity to the watershed. However, acidic and thermally heated waste water, intercepted and brought to the surface by mining activities continues to impact the watershed. Documented pH values and temperature beyond tolerance limits for salmonid species continues to plage tributaries to the Jarbidge River system within Nevada (McNeill et al. 1997).

10.3.1. Roads

Roads within Idaho do contribute fine surface sediments to the Jarbidge watershed. The confined

canyon topography places most roads within the flood plain of the East and West Fork Jarbidge Rivers from Murphy Hot Springs to the Nevada-Idaho line. There are no roads downstream of Murphy Hot Spring until the Jarbidge River meets the Bruneau. Road placement has two significant impacts on the watershed: 1) they restrict the flood plain which concentrates high flows resulting in exacerbation of bank erosion; and 2) contribute vast quantities of fine sediments when they fail during hydrologic events.

Additionally, fine-grained native materials have been used to surface roads and provide visible sediment contributions to the river during minor precipitation events. Options to address this problem will likely be limited due to the restricted access and economics of road surfacing alternatives.

Annual problems with beaver damming the Jarbidge River in Idaho during low flow periods and backing the river onto the road bed also exacerbates sediment yield from the road system. IDFG continues to work with the Three-Creeks Highway District to remove problematic beavers and dams.

An additional threat associated with the narrow, unimproved roads along the Jarbidge River, is from vehicle accidents. In 1991, a tank truck transporting petroleum products to Murphy Hot Springs and Jarbidge, Nevada rolled into the East Fork Jarbidge River within Idaho (Partridge personal comm.). Impacts to native fish populations and macroinvertebrate populations were documented. Although, no morbid bull trout were recovered, it is plausible they were negatively influenced downstream of the spill site.

Culverts have not been extensively used within Idaho due to the high gradient and confined nature of the stream and its propensity for widely fluctuating flows. Consequently, migration barriers are not considered a threat within the Jarbidge watershed within Idaho.

10.3.2. Mining

There are strong indications that the quality of water in the Jarbidge River has been impacted by historical mining. One of the early discoverers of the Jarbidge claims, Dave Bourne, noted that fish were plentiful in the Jarbidge River 1909 (Mathias and Berry, in press 1997). Twenty-six years later, Biologist S.D. Durrant of the Dept. of Commerce noted that the Jarbidge River was ". . . greatly polluted by mine tailings. . ." starting two miles upstream from Jarbidge town. Mining pollution rendered ". . . the entire lower stretches of the Jarbidge River unfit for fish". The lowest recorded pH value on the river was taken by Durrant in 1934 when he documented a value of 5.0 and noted that the observation was associated with mining pollution.

The use of cyanide in the milling and separation operations conducted at the Bluster, Pavlak, and Elkoro mill sites in Nevada is documented by Schrader and others in 1923. Volume of cynaide actually used in the drainage or its disposal is unknown. An antidotal measure of the quantity of cyanide can be gauged by observation of existing redwood remaining within the Jarbidge River corridor. Disassembly of the redwood cyanide vats and re-use of the materials for home construction can be documented by visiting the existing homes in the area (McNeill et al. 1997).

De-watering of mine shafts within Nevada also influenced base water temperatures and flows in the headwaters and main Jarbidge River. As early as 1923 the Pavlak adit was documented to be discharging water in excess of 51.8°F (11° C). The mine was pumped for the life of operations to allow continued ore extraction, so, the total volume of water contributed to the river is unknown, however, the shaft measured discharge to the river was still over 0.1 cfs of water in 1996.

The Greyrock shaft at the Elkoro mill site was sunk 1,300 feet (396 m) in the mid 1930's and immediately filled with thermally elevated water. Dewatering operations from 1937 to 1941 reportedly dumped over 7 billion gallons of warm water into the Jarbidge River. Back calculation of the discharge indicates flow from the shaft at a continuous 31 cfs -over six times the base flow of the Jarbidge River for a period equivalent to 696 days. This flow would have dominated the river from August through April, substantially raising the base temperature. It is also suspected that it would have raised the temperature of the Jarbidge River well above tolerance limits for bull trout, macroinvertebrates, and other cold water salmonids. Samples taken in 1977, where the water continues to flow from the shaft of a rate of over 0.1 cfs, measured temperature in excess of 75.2°F (24° C). (McNeill et al. 1997).

10.3.3. Forestry

Historically, logging activities potentially impacted bull trout habitat in both Idaho and Nevada. Since large-scale mining and the market it created for lumber products left the Jarbidge River watershed, timber harvest has only occurred on a local level with no commercial harvest. Impacts from historical logging are, for the most part, no longer a threat to bull trout or their habitat.

The majority of merchantable timber, both historically and presently remaining within the watershed, resides in Nevada.

10.3.4. Agriculture/Livestock

As previously stated, livestock use has historically been extensive within the Jarbidge watershed. Earliest documented livestock use was in 1885 by "tramp" or "rogue" sheep outfits. In 1906, outcries from resident sheep ranchers regarding the over-grazed conditions prompted inclusion of the Jarbidge River Canyon to the Forest Reserve system. Even with inclusion of the area in the Forest Reserve, 392,350 head of sheep were recorded to have used the area all summer long for a period of five to eight years. Rates of 95% utilization were common on all uplands and accessible riparian areas. Antidotal references are even made to grazing influencing water yield back in the early 1900's. By 1948, carrying capacity of the Reserve was reduced to only 2,000 head of sheep. In 1960, sheep grazing was eliminated on the Forest Reserve portion of the watershed (McNeill et al. 1997).

Currently, grazing activity is dominated by cattle. Very little grazing of the riparian corridor takes place in Idaho due to the steep nature of the canyon walls and minimal forage availability for sustained grazing. Riparian areas within the Jarbidge River canyon have shown to be resilient with most impacts from historic grazing no longer detectable. Impacts on riparian vegetation are minor and localized in nature and could have impacts on bull trout within the drainage (Klott 1996).

There is speculation that intense grazing has modified the plant community of the watershed and

channel morphological features. The lack of small sized particles within the stream substrate and downcutting of the present channel, no doubt, was exacerbated by intense livestock use.

No agricultural activity takes place within the Jarbidge River watershed within Idaho and no surface water rights have been issued by the Idaho Dept. of Water Resources for beneficial water use other than for domestic purposes (Stanton personal comm.).

10.3.5. Fire

Fire and fire suppression/reclamation have modified a large portion of the Jarbidge Resource Area. Over the past decade, 90% of the Resource Area has burned as a result of lightening or man-causes fires (Klott personal comm.). Historically, native plant communities in the high desert environment of the Jarbidge River watershed were fire resistant. Native grasses and forbs along with the sagebrush community were either sparse enough or experienced a great enough difference in canopy height to prevent carrying fire over great distances. With the invasion of dense growing non-native cheatgrass (*bromus tectorium*), the desert plant community is more susceptible to stand replacing fire. In an attempt to out-compete cheatgrass, large areas of the burned desert has been seed-drilled with crested wheatgrass, also a non-native plant to the Jarbidge River watershed. As a result, large acreages of monocultures of crested wheatgrass dominate the Resource Area. Positive aspects of crested wheatgrass include out-competing cheatgrass, high resistance to fire, and a high resistance to erosion. Negative impacts are predominantly on wildlife where it provides little habitat value to sage grouse and other native wildlife species of the high desert.

10.3.6. Urban Encroachment

Murphy Hot Springs is the only urban development on the watershed within Idaho. Steep topography, poor access, and isolation from public services have limited urban development. Undoubtedly, the few residences which do exist within the Idaho portion of the watershed contribute nutrient loading to the Jarbidge River from leaking or improperly installed septic systems.

Restriction of the flood plain due to home development along the stream has not been a significant problem. This is probably a result of a high frequency of significant flood events defining the limits of safe building envelopes.

10.3.7. Recreation

Incidental harvest of bull trout has been documented by incidental creel surveys conducted on the Jarbidge River within Idaho, by IDFG. Due to the low numbers of bull trout within the watershed and the low angling effort, threats to persistence of bull trout, from angling, is not considered significant.

The Jarbidge and Bruneau River system is considered on of the premier desert whitewater runs in the western U.S.. The canyons are heavily used by Idahoans, as well as visitors from throughout the nation. The Jarbidge and Bruneau Rivers averaged more than 600 visitor use days per year through the 1980's, although this figure is extremely low due to non-compliance with the voluntary registration. In 1993, after six years of drought, the Jarbidge-Bruneau River system saw over 2,000 individual users during the float season which ran from late April until the end of June (Robertson,

1994). The majority of use was from the confluence of the Jarbidge and Bruneau Rivers to the Snake River. Unregulated use could eventually lead to impacts on riparian vegetation and water quality.

In stream flow volumes to support recreational use of the Jarbidge River in Idaho, as recommended to the Idaho Water Dept. of Water Resource Board during hearing on May 20, 1994, ranged from a low of 48 cubic feet per second from July 1 - January 31, to 1,135 cubic feet per second from May 1 - May 31. These flows are well in excess of minimum flows necessary to support fishery needs within the watershed (Horton 1985).

11. Priority sub-watersheds and Migration/Overwintering Habitat

The entire Jarbidge River within Idaho is considered a migratory corridor or wintering habitat (Partridge 1998). No perennial tributaries suitable for spawning or juvenile rearing purposes enter the Jarbidge River Key Watershed within Idaho.

12. Additional limiting factors to bull trout in the Jarbidge River Key Watershed

The Jarbidge River, within Idaho, is not considered to contain sub-watersheds due to the lack of perennial tributaries. Habitat modifications which provide sediment input or morphological changes to the channel configuration are considered the most significant threats.

A unique threat to bull trout, identified by the Air Force in their 1998 Environmental Impact Statement for Enhanced Training in Idaho, is from the effects of sound and shock waves associated with jet aircraft. This issue came to light in scoping for expansion of training and air space restrictions purposed by the U.S. Air Force in Idaho. Potential effects of sonic booms on bull trout included disruption of normal behavior, physiological stress responses, and increased mortality of eggs due to noise-related vibrations during critical periods of development (U.S.A.F., 1998).

Little research on this topic exists to support any definite conclusion as to the significance of this issue as a threat or it's impact on the persistence of bull trout within the Jarbidge River watershed.

12.1. Habitat Degradation

Upland terrestrial areas within the immediate vicinity of the Jarbidge River watershed, within Idaho, have been impacted by land management and natural disasters. Of the 85,238 acres located within the Bruneau-Jarbidge-Sheep Creek BLM management unit, only 10,716 acres are classified in "excellent" or "good" condition. The majority of acreage, 70,829 acres, is categorized as "fair" or "poor" as of 1987 (U.S.D.I. 1987).

Wildfires are also considered a significant threat to the Jarbidge River watershed. Increases in

sediment yield have been identified by both the BLM and the Air Force as potential impacts from managed and un-managed wildfire activity. Post fire invasion of non-native plant species which are less erosion resistant could also increase sedimentation (U.S.A.F. 1998).

12.2. Harvest or Over-utilization

Fish management on the Jarbidge River in Idaho has evolved from generous limits in the 1940's and 1950's to the present limit of two trout and closed to the harvest of bull trout. From 1945 to 1976 bag limits for trout, including bull trout, ranged from 10 to 20 fish per day and season lengths lasted from five months per year to open year-around (memo 10/7/98 IDFG to USFWS). In 1994, Idaho closed the Jarbidge River to the harvest of bull trout. Nevada, however, continued to allow the harvest of bull trout within the Jarbidge watershed until January 1, 1998. In 1998, the USFWS implemented an emergency listing of the entire Jarbidge River bull trout population as "endangered" under the federal Endangered Species Act. The entire watershed is now closed to the harvest of bull trout.

12.3. Exotic Species

Although angling pressure is considered "light" by both states, primarily due to very limited access, rainbow trout have been stocked in the Jarbidge River to support a "put and take" fishery. In Idaho, 2,000 to 5,000 rainbow trout were stocked annually from 1970 to 1989. Fish stocking in the Jarbidge River within Idaho was discontinued in 1989 and "wild" trout regulations were implemented. Nevada continued to stock catchable sized rainbow trout until 1997. During the period 1989 to 1997 rainbow trout planted in Nevada commonly were observed in scientific sampling and the creel of anglers within Idaho.

12.4. Predation

A potential influence on winter population persistence in Idaho could come from natural predators such as otter. No studies or literature on the Jarbidge River regarding the influence of predation have been conducted, however, with the limited numbers of bull trout in the system and small number of pools available for winter habitat, there is no doubt predation could have a significant influence on persistence of bull trout within the Key Watershed.

14. Recommendations

The Jarbidge River in Idaho has few opportunities for recovery of complex interacting groups of bull trout or modification of limiting habitat parameters. This is due to only nodal habitat existing within the lower reaches of the Jarbidge River within the state boundaries.

14.1. Conservation Actions

The following bullet statements have been developed by the authors of this document as recommendations until a conservation plan for the watershed can be developed. These actions are based on discussion, direct observation, and the content of this problem assessment.

14.1.1. Interagency Cooperation

To recover spawning and juvenile rearing habitat and populations, state agencies should continue participation in the Jarbidge River Bull Trout workgroup formed to seek funding for the Jack's Creek bridge in Nevada. The group is comprised of private landowners, interested public, federal agencies, and state agencies.

14.1.2. Roads

Local and state agencies need to identfy ways to reduce road impacts and explore ways to move the road from the flood plain. Agencies, the local highway district, and residents need to develop a transportation plan for moving hazardous materials within the drainage.

14.1.3. Fish Harvest

1. Replace and increase number of fishing regulation and bull trout identification signing.

2. Continue enforcement efforts during the fall, winter, and spring periods to reduce illegal harvest of bull trout.

14.1.4. Livestock Management

1. Continue to work with the Bureau of Land Management and permitees to develop watergaps and off-stream livestock watering facilities.

2. Continue to work with the Bureau of Land Management and permittees to install riparian fencing to facilitate management of livestock in riparian areas.

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Appendix A. Descriptions of habitat assessment sites

Legal descriptions of habitat assessment sites.

Site Number	U.S.G.S. River Mile	Legal Description
Jarbridge River		
1	1.0	NW1/4, NE1/4, Sec 09, T13S, R7E
2	3.0	NE1/4, SE1/4, Sec 15, T13S, R7E
3	5.0	SE1/4, SW1/4, Sec 24, T13S R7E
4	7.0	SW1/4, NW1/4, Sec 31, T13S, R8E
5	20.0	NE1/4, SE1/4, Sec 24, T15S, R8E
6	20.1	SE1/4, SE1/4, Sec 24, T15S, R8E
7	21.0	SE1/4, NE1/4, Sec 30, T15S, R9E
8	22.0	SW1/4, NW1/4, Sec 32, T15S, R9E
9	23.0	SW1/4, SW1/4, Sec 33, T15S, R9E
10	24.0	SW1/4, NW1/4, Sec 03, T16S, R9E
11	25.0	SW1/4, NE1/4, Sec 10, T16S, R9E
East Fork Jarbridge River		
12	0.1	NW1/4, SE1/4, Sec 10, T16S, R9E
13	0.6	SW1/4, SW1/4, Sec 11, T16S, R9E
14	1.8	SE1/4, SE1/4, Sec 14, T16S, R9E
15	2.4	SE1/4, NW1/4, Sec 24, T16S, R9E
16	4.1	NW1/4, NE1/4, Sec 36, T16S, R9E
West Fork Jarbridge River		
17	0.6	NE1/4, NW1/4, Sec 15, T16S, R9E
18	1.7	NE1/4, NE1/4, Sec 21, T16S, R9E
19	3.4	NW1/4, NE1/4 Sec 14, T16S, R9E

Appendix B. Habitat data collected from all sites surveyed in the Jarbridge River drainage, 1992. (Warren and Partridge 1993)

Habitat data collected from all sites surveyed in the Jarbridge River drainage, 1992.
See Figures 2 and 3 and Appendix A for site locations.

Site	Length (m)	Mean width (m)	Mean Dept (cm)	Habitat (%)				Substrate Class (%)				
				Pool	Run	Pocket	Riffle	Sand	Gravel	Rubble	Boulder	Bedrock
Jarbridge River												
1	86	11.0	13	0	80	0	20	7	51	40	2	0
2	110	9.7	14	17	39	17	28	5	30	34	31	0
3	100	7.8	31	33	40	20	7	17	22	20	41	0
4	100	10.3	17	0	72	11	17	1	13	42	44	0
5	104	11.9	22	41	41	6	12	5	22	46	22	5
6	79	9.3	23	30	30	18	22	6	11	31	37	15
7	84	11.8	18	80	13	7	0	16	21	45	18	0
8	134	9.6	16	33	33	15	19	10	14	49	27	0
9	100	9.0	11	0	50	6	44	3	18	74	5	0
10	100	9.1	23	50	17	5	28	6	28	46	20	0
11	112	9.1	14	22	56	0	22	10	17	28	27	18
East Fork Jarbridge River												
12	127	8.5	20	9	48	5	38	6	16	43	35	0
13	112	6.6	24	11	50	11	28	3	16	37	36	8
14	103	9.1	7	0	44	17	39	12	30	57	1	0
15	100	7.4	14	22	39	6	33	11	15	63	8	3
16	111	6.5	12	0	5	24	71	5	24	45	26	0
West Fork Jarbridge River												
17	113	702	18	6	27	6	61	0	16	41	43	0
18	75	6.6	19	0	50	25	25	4	15	39	42	0
19	115	7.4	21	11	61	0	28	5	24	49	17	5

Appendix C. Daily minimum, maximum and average water temperatur (Celcius) recorded on the Jarbidge River, 1994.

Table 6. Daily minimum, maximum and average water temperature (Celcius) recorded on the Jarbidge River, 1994.

	Downstream of confluence of East & West Fk. Jarbidge River June 29 - Oct. 16, 1994			Jarbidge River upstream of mouth of Bruneau River June 28 - Sept. 23, 1994		
	MAXIMUM 24.0 MINIMUM 3.8 AVERAGE 15.2			MAXIMUM 28.4 MINIMUM 10.9 AVERAGE 19.2		
DATE	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
28-Jun-94				22.8	15.0	18.5
29-Jun-94	20.5	13.3	16.5	23.3	16.4	19.8
30-Jun-94	20.3	12.5	16.3	23.1	16.7	19.9
01-Jul-94	20.3	12.7	16.2	23.6	16.1	19.8
02-Jul-94	18.4	13.1	15.7	21.3	16.9	19.3
03-Jul-94	19.8	12.0	15.6	21.1	14.7	17.8
04-Jul-94	17.5	10.9	14.1	21.0	14.2	17.7
05-Jul-94	15.6	11.9	13.4	17.7	13.8	16.0
06-Jul-94	16.9	10.3	12.9	20.1	12.5	15.6
07-Jul-94	20.0	10.5	14.7	22.3	13.9	17.9
08-Jul-94	21.6	12.4	16.5	24.3	15.6	19.8
09-Jul-94	21.4	13.8	17.4	23.8	16.9	20.4
10-Jul-94	22.1	14.2	17.6	24.3	17.7	20.6
11-Jul-94	21.1	12.5	16.5	24.1	15.8	19.8
12-Jul-94	21.4	12.4	16.5	23.8	15.9	19.7
13-Jul-94	21.6	12.4	16.6	24.1	15.8	19.7
14-Jul-94	21.8	13.0	17.0	24.8	16.4	20.2
15-Jul-94	22.6	13.1	17.5	25.4	16.7	20.6
16-Jul-94	22.4	14.2	18.0	25.9	17.4	21.2
17-Jul-94	22.1	14.8	18.4	26.4	18.5	21.9

Table 6. Continued.

DATE	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
18-Jul-94	23.5	14.5	18.5	26.2	18.5	22.0
19-Jul-94	22.9	14.5	18.3	25.4	18.4	21.2
20-Jul-94	23.6	13.6	18.1	26.4	17.2	21.1
21-Jul-94	23.8	14.1	18.7	26.6	17.9	21.8
22-Jul-94	22.3	15.3	18.9	25.5	18.7	22.0
23-Jul-94	21.0	16.7	18.9	24.5	20.0	22.0
24-Jul-94	22.8	14.8	18.7	25.7	18.2	21.6
25-Jul-94	24.0	15.3	19.5	28.0	19.1	23.0
26-Jul-94	22.9	15.9	19.5	27.5	20.0	23.4
27-Jul-94				28.4	20.3	23.4
28-Jul-94	20.8	15.9	18.5	27.1	19.8	22.6
29-Jul-94	20.8	15.3	18.2	24.7	19.0	21.7
30-Jul-94	22.9	16.1	19.1	24.3	20.1	22.0
31-Jul-94	21.3	16.3	18.7	24.1	19.3	21.6
01-Aug-94	21.4	15.8	18.2	25.9	19.5	21.9
02-Aug-94	20.1	14.2	17.1	25.7	18.8	21.6
03-Aug-94	22.6	13.8	17.8	27.3	18.2	22.1
04-Aug-94	24.0	14.2	18.8	27.7	19.0	22.7
05-Aug-94	23.5	15.1	19.2	27.5	19.1	22.6
06-Aug-94	23.6	14.5	18.9	26.9	18.4	22.0
07-Aug-94	23.1	13.9	18.4	26.6	17.5	21.5
08-Aug-94	19.6	15.3	17.6	23.5	18.8	20.6
09-Aug-94	22.9	14.4	18.3	26.0	16.9	20.7
10-Aug-94	20.1	15.0	17.7	24.0	17.7	20.7
11-Aug-94	20.6	14.4	17.6	25.5	17.9	21.2
12-Aug-94	21.8	14.8	18.2	24.0	18.7	20.9
13-Aug-94	21.8	15.0	18.3	25.1	17.5	21.0
14-Aug-94	21.0	15.0	18.2	24.8	18.4	21.4

Table 6. Continued.

DATE	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
15-Aug-94	22.8	14.7	18.4	26.6	18.0	21.5
16-Aug-94	22.1	13.1	17.5	25.5	16.7	20.5
17-Aug-94	22.3	13.3	17.6	25.4	16.3	20.1
18-Aug-94	22.3	13.4	17.6	25.7	16.4	20.3
19-Aug-94	21.9	13.4	17.6	25.1	16.4	20.2
20-Aug-94	21.4	14.2	17.7	25.5	17.0	20.6
21-Aug-94	22.3	14.7	18.1	25.9	17.0	20.7
22-Aug-94	20.6	13.0	16.6	24.1	16.1	19.5
23-Aug-94	21.4	11.9	16.4	23.6	14.4	18.6
24-Aug-94	21.3	12.5	16.7	24.8	15.1	19.3
25-Aug-94	21.3	12.4	16.7	24.5	15.3	19.4
26-Aug-94	20.3	12.4	16.2	23.5	15.1	19.0
27-Aug-94	20.6	12.8	16.4	23.1	15.5	18.7
28-Aug-94	21.6	14.2	17.4	24.5	15.6	19.3
29-Aug-94	20.5	12.8	16.5	23.6	15.0	18.7
30-Aug-94	19.6	11.6	15.5	22.8	13.9	17.8
31-Aug-94	19.8	11.1	15.3	22.8	13.3	17.4
01-Sep-94	17.5	11.9	14.9	22.9	13.9	17.8
02-Sep-94	17.9	10.9	14.5	21.1	14.1	17.5
03-Sep-94	19.0	12.2	15.3	21.9	14.5	17.7
04-Sep-94	18.7	10.9	14.5	22.1	13.4	17.1
05-Sep-94	18.7	9.9	14.2	22.1	12.4	16.5
06-Sep-94	19.5	11.6	15.3	23.1	13.0	17.2
07-Sep-94	20.1	11.9	15.8	24.1	13.9	18.3
08-Sep-94	20.3	12.7	16.2	23.1	14.7	18.4
09-Sep-94	18.5	12.2	15.1	21.1	14.1	17.1
10-Sep-94	15.6	9.9	13.0	18.5	11.6	14.8
11-Sep-94	15.5	8.8	12.1	17.4	10.9	14.0

Table 6. Continued.

DATE	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
12-Sep-94	16.4	9.4	12.7	19.5	11.1	14.6
13-Sep-94	13.1	10.2	11.8	15.9	12.0	13.4
14-Sep-94	15.1	9.4	11.8	19.0	10.9	13.9
15-Sep-94	16.4	9.1	12.4	20.0	11.4	14.8
16-Sep-94	16.6	8.5	12.4	20.5	11.1	14.9
17-Sep-94	16.3	10.0	13.1	20.0	11.9	15.3
18-Sep-94				21.3	12.5	15.9
19-Sep-94				21.3	12.5	16.0
20-Sep-94				20.3	12.2	15.6
21-Sep-94				20.5	11.9	15.3
22-Sep-94				20.5	11.4	15.2
23-Sep-94				20.5	11.3	15.1
24-Sep-94						
25-Sep-94						
26-Sep-94						
27-Sep-94						
28-Sep-94	15.8	10.2	13.0			
29-Sep-94	13.9	12.2	12.8			
30-Sep-94	12.0	10.8	11.3			
01-Oct-94	14.7	10.3	12.1			
02-Oct-94	13.6	9.4	11.3			
03-Oct-94	9.9	6.2	7.8			
04-Oct-94	11.7	5.8	8.4			
05-Oct-94	9.9	7.7	8.8			
06-Oct-94	11.4	7.2	8.9			
07-Oct-94	11.6	5.8	8.5			
08-Oct-94	12.0	5.8	8.7			
09-Oct-94	12.2	5.8	9.0			

Table 6. Continued.

DATE	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
10-Oct-94	11.7	6.9	9.2			
11-Oct-94	11.4	8.3	9.6			
12-Oct-94	10.3	5.8	8.2			
13-Oct-94	10.0	7.8	8.7			
14-Oct-94	8.0	4.7	6.4			
15-Oct-94	5.2	3.8	4.5			
16-Oct-94	7.1	4.3	5.5			

Appendix D. Daily temperature summeries (celcius) for East Fork and West Fork Jarbidge River. (Partridge. 1997)

Table 2. Daily temperature summaries (celcius) for temperatures taken with continuously recording thermographs on the East Fork and West Forks Jarbidge River at the fish trapping sites from August 27 through December 2, 1997.

	East Fork Jarbidge River				West Fork Jarbidge River			
Date	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature
8/27/97	16.3	2.99	21.1	12.2				
8/28/97	15.8	3.06	20.6	11.7	15.2	2.50	19.6	11.7
8/29/97	15.8	3.06	20.3	11.7	15.0	2.41	19.3	11.9
8/30/97	16.0	3.24	20.8	11.7	15.3	2.61	19.8	11.9
8/31/97	15.5	2.16	18.8	12.5	15.0	1.60	17.7	12.8
9/1/97	16.5	2.68	20.5	13.3	15.7	1.92	19.0	13.6
9/2/97	16.0	1.17	17.9	14.7	15.6	0.83	17.2	14.8
9/3/97	16.5	1.80	19.5	14.2	15.9	1.39	18.2	14.2
9/4/97	15.7	2.13	19.1	12.7	15.0	1.56	17.5	12.7
9/5/97	16.4	2.15	19.6	13.8	15.7	1.79	18.7	13.6
9/6/97	15.7	1.67	17.9	13.3	15.1	1.30	17.2	13.3
9/7/97	15.6	2.80	19.6	11.7	14.7	1.84	17.5	12.2
9/8/97	15.9	2.60	19.5	12.2	15.0	1.80	17.4	12.4
9/9/97	16.4	2.75	20.5	12.7	16.0	2.24	20.0	13.1
9/10/97	16.9	1.44	19.1	14.8	16.4	1.25	18.5	14.7
9/11/97	15.0	0.79	16.4	13.9	14.5	0.64	15.6	13.3
9/12/97	14.1	2.54	17.9	10.6	13.3	1.87	16.3	10.6
9/13/97	14.6	2.72	18.7	10.9	13.8	2.18	17.5	10.9
9/14/97	14.8	2.35	18.5	11.6	14.0	1.90	17.4	11.4
9/15/97	12.8	1.40	15.3	10.8	12.1	1.26	14.7	10.6
9/16/97	12.5	2.27	16.1	9.4	11.2	1.91	14.8	8.8
9/17/97	12.4	2.82	16.9	8.6	11.1	2.11	14.7	8.1
9/18/97	11.6	0.93	13.0	10.3	10.7	0.58	11.7	9.7
9/19/97	11.1	2.44	14.7	8.0	9.8	1.94	13.3	7.2
9/20/97	11.0	0.86	12.2	9.7	9.9	0.56	10.8	9.1
9/21/97	11.6	2.32	15.0	8.5	10.2	1.92	13.6	7.8
9/22/97	12.3	2.63	16.3	8.8	11.1	2.18	15.0	8.3
9/23/97	12.9	2.60	16.7	9.2	11.7	2.14	15.5	8.9
9/24/97	13.4	2.63	17.2	9.7	12.2	2.06	15.8	9.4
9/25/97	13.0	1.28	14.7	10.9	11.8	0.90	13.0	10.3
9/26/97	14.2	1.80	17.0	11.9	13.1	1.77	16.3	11.1
9/27/97	12.1	1.58	14.5	9.4	11.3	1.41	13.8	9.1
9/28/97	10.7	2.44	14.2	7.2	9.6	2.01	13.1	6.9
9/29/97	11.3	2.78	15.3	7.5	10.1	2.32	14.1	7.2
9/30/97	12.4	2.86	16.6	8.6	11.5	2.35	15.6	8.9
10/1/97	13.4	2.31	16.9	10.3	12.5	1.97	16.1	10.3
10/2/97	12.6	0.73	13.9	11.7	11.8	0.62	12.7	10.3
10/3/97	11.0	2.12	14.1	7.8	9.9	1.86	13.3	7.4
10/4/97	10.6	2.01	13.6	8.0	9.8	1.83	13.0	7.8
10/5/97	9.5	1.64	12.0	6.9	8.7	1.46	11.4	6.8
10/6/97	8.6	2.22	11.7	5.5	7.4	1.57	9.9	5.2
10/7/97	8.3	0.66	9.2	6.9	7.2	0.54	7.8	5.8
10/8/97	7.2	2.14	10.3	4.4	5.8	1.77	8.8	3.5

Date	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature
10/9/97	8.8	1.42	10.9	7.1	7.4	1.19	9.6	6.2
10/10/97	7.8	1.20	9.6	5.8	6.4	0.91	7.7	4.7
10/11/97	5.8	0.46	6.8	5.1	4.7	0.67	6.2	3.6
10/12/97	5.5	1.24	7.4	3.8	4.5	1.07	6.3	3.0
10/13/97	6.1	2.27	9.2	3.3	4.8	1.88	8.1	2.7
10/14/97	7.1	2.30	10.3	4.1	6.0	1.82	9.2	3.6
10/15/97	7.7	2.36	10.9	4.6	6.7	1.85	10.0	4.4
10/16/97	8.3	2.29	11.4	5.2	7.3	1.82	10.6	5.1
10/17/97	8.6	2.19	11.7	5.7	7.7	1.77	10.9	5.5
10/18/97	8.2	1.95	10.9	5.5	7.5	1.45	10.3	5.7
10/19/97	7.8	2.09	10.8	4.9	6.8	1.68	9.7	4.6
10/20/97	7.9	1.43	9.9	5.8	6.9	1.31	9.4	5.2
10/21/97	6.9	1.83	9.4	4.1	6.0	1.54	8.9	4.0
10/22/97	No Data - Thermograph Serviced							
10/23/97	No Data - Thermograph Failure				5.5	0.43	6.3	4.6
10/24/97					3.5	0.69	4.7	2.4
10/25/97					2.0	1.40	4.6	0.3
10/26/97					2.5	1.80	5.5	0.5
10/27/97					3.4	1.53	6.2	1.7
10/28/97					3.3	1.23	4.9	1.7
10/29/97					4.7	0.87	5.8	3.6
10/30/97					6.3	1.09	8.1	5.1
10/31/97					6.7	0.43	7.5	5.7
11/01/97					4.6	1.05	6.5	3.2
11/02/97					3.7	1.39	6.2	1.9
11/03/97					4.4	1.31	6.5	3.0
11/04/97					5.4	1.22	7.5	4.0
11/05/97					5.8	1.32	8.1	4.3
11/06/97					5.3	1.40	7.8	3.5
11/07/97					5.5	1.08	7.5	4.6
11/08/97					4.8	0.69	6.0	4.0
11/09/97					3.9	0.92	5.5	2.4
11/10/97					2.2	0.90	3.6	0.8
11/11/97					3.1	0.47	3.8	2.5
11/12/97					3.3	0.59	4.4	2.9
11/13/97					2.0	1.05	3.8	0.5
11/14/97					1.2	1.08	3.2	0.0
11/15/97					0.6	0.81	2.4	0.0
11/16/97					1.0	1.02	2.9	0.0
11/17/97					1.4	0.73	2.7	0.5
11/18/97					1.2	0.95	2.7	0.0
11/19/97					2.6	0.71	3.6	1.7
11/20/97					2.2	0.54	2.9	1.3
11/21/97					1.6	0.44	2.4	0.8
11/22/97					0.0	0.08	0.3	0.0
11/23/97					1.3	1.39	3.8	0.0
11/24/97					1.7	1.12	3.8	0.5
11/25/97					2.5	0.60	3.6	1.9

Date	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature	Daily Mean Temperature	Standard Deviation	Daily Max. Temperature	Daily Min. Temperature
11/26/97					3.4	1.63	5.5	1.4
11/27/97					3.6	0.50	4.4	2.5
11/28/97					1.8	0.86	3.5	0.6
11/29/97					1.3	0.96	3.0	0.1
11/30/97					1.8	0.92	3.3	0.6
12/01/97					1.6	0.50	2.2	0.8
12/02/97					0.6	0.54	1.6	0.0