Rec'd 2/19/02
Parametrix 2002

Jarbidge River Fisheries Inventory

Prepared for:

United States Forest Service
Humboldt-Toiyabe National Forest
2035 Last Chance Road
Elko, Nevada 89801

Prepared by

Parametrix
Suite 200
5808 Lake Washington Blvd. NE
Kirkland, WA 98033
(425) 822 8880
www.parametrix.com

February 2002
Projecl No. 553 4190 002 ***(01/06)***

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The 2001 habitat and fish survey of the upper Jarbidge River (Task Order SWINAO-TO-17-01-08) was supported by the Region 4, SW Idaho/Nevada office of the Forest Service under Contract No. 53-0261-1-06. Carol Schwartz was the Contracting Officer in the SW Idaho/Nevada Acquisitions Office, Boise, ID. The scope of work was detennined by Kelly Amy, Fisheries Biologist of the Humboldt-Toiyabe National Forest, with assistance from Dan Duffield, USFS Region 4 Fisheries Biologist in Ogden, UT.

The field crew included the authors as well as Dave Gillingham, Nick Ackerman, and Steve Mitchell. We were particularly appreciative of the fact that Nick Ackerman of Steve Cramer & Associates was able to join the team on relatively short notice. Sarah Sydor performed the statistical analysis on the bulk sediment data.

Kelly Amy, Fish Biologist for the Humboldt-Toiyabe National Forest at Elko, was very helpful by frequently providing critical information on points of access into the project area, particularly the East Fork wildemess. Kelly also provided office space at Elko for temporary storage of equipment and sediment samples, which was sincerely appreciated. She also facilitated the annotated bibliography by providing names and telephone numbers of key individuals to be contacted in various agencies.

We appreciated the helpful comments on a draft of this report frortl Bob Sullivan. Sue Martin entered the data into FBASE, with assistance from database specialist Lisa Allen of Parametrix, and Sherry WolIrab of the USFS Rocky Mountain Research Station.

REPORT PREPARED BY

Bob Pfeifer, Senior Fisheries Scientist

Michael Burger, Scientist

Pete Lawson, Fish Biologist

ESA	Endangered Species Act
FWS	u.S. Fish and Wildlife Service
GPS	Global Positioning System
INFISH	Inland Native FISH strategy
LWD	Large Woody Debris
NdoW	Nevada Division of Wildlife
NEPA	National Environmental ~~Protection~~ Policy Act
QC	Quality Control
USFS	United State Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

A survey of fish relative abundance and distribution was conducted in the West and East forks of the Jarbidge River and Pine Creek in mid-October, 2001. Habitat was also surveyed in the West Fork and Pine Creek. The surveys extended from the National Forest boundary to the headwaters of these streams on national forest land. The purpose of the surveys was to provide updated information on habitat and bull trout abundance and distribution to support the planning process for the Jarbidge River and South Canyon Road area. The fish survey data, collected by daytime snorkeling, adds slightly to existing information on these streams. The habitat survey, which followed the RIIR4 protocol, is baseline for Pine Creek, and adds to earlier partial information on the West Fork. Habitat was not surveyed on the East Fork.

Very few bull trout were observed in the West Fork or Pine Creek, while low numbers were seen in the East Fork. Bull trout abundance was probably under-estimated due to the late date of the survey, cold water temperatures, and survey methods being unavoidably limited to daytime snorkeling. This survey documented bull trout further downstream in the East Fork than previous surveys (just upstream of Slide Creek), although bull trout are known to occur in Slide Creek.

Bulk sediment samples were collected to provide more detailed characteristics of the West Fork streambed in the vicinity of the recent channel changes adjacent the South Canyon Road, near Pine Creek. Eight or nine sediment cores were collected in one site upstream, and in each of three sites at or downstream of the channel change. A site with similar elevation and stream gradient was sampled on the East Fork near Cougar Creek for comparative purposes. These data supplement pebble counts collected throughout the West Fork and Pine Creek, and incidental visual observations of embeddedness and surface fines in all three streams. The streambed percent fines «0.85 rnm) by sample volume was not significantly different between any of the five sites and, with the exception of four of the 44 bulk samples, were low or very low «10%). Three of the four samples with a higher fines fraction occurred at the junction of the old and new channels just above the mouth of Pine Creek. This limited survey of streambed characteristics failed to demonstrate any appreciable accumulation of fine sediment that would degrade significant amounts of salmonid spawning habitat in the West Fork Jarbidge River.

1.1 BACKGROUND AND STUDY PURPOSE

The bull trout *(Salvelinus confluentus)* inhabiting the Jarbidge River drainage compnse the only population of this species within the state of Nevada, and is the southern-most range of bull trout (Partridge and Warren 1998). The bull trout inhabiting the East and West Forks of the Jarbidge River were recently listed as threatened under the Endangered Species Act (ESA) (Fish and Wildlife Service [FWS] 1999). Accordingly, the U.S. Forest Service (USFS) is focusing increased attention to land management practices in the Jarbidge River watershed that potentially impact stream characteristics and habitat quality (McNeill et al. 1997; Stowell et al. 1998).

Both forks of the Jarbidge River are popular recreation areas for hiking, fishing, hunting, photography, and more. Much of the West Fork drainage has an extensive mining history, with gold having been discovered in approximately 1904, leading to the rapid development of the Town of Jarbidge. Early development of mining in the West Fork basin led to road construction and logging to near the headwaters (Sawmill Creek). Much of the upper drainage of both forks is located within a designated wilderness area.

The South Canyon Road washed out in numerous locations during a rain-on-snow flood in 1995. After the flood, alteration of the stream channel occurred on the West Fork near the Pine Creek confluence. Channel alterations have occurred from planned channel restoration initiated by the Forest Service, as well as non-permitted channel reconstruction activities initiated by local citizens attempting to maintain vehicular access to the wilderness boundary at Snowslide Gulch, approximately 1.4 miles upstream of Pine Creek. The long term management status of the South Canyon Road above Pine Creek Campground is the subject of current Forest Service evaluations.

The purpose of this report is to present an updated baseline collection of fisheries habitat and fish population data to support the planning process for the Jarbidge River and South Canyon Road area. The latest USFS habitat and fish survey protocols were used to update previous data to current USFS survey standards. Habitat and fish abundance data were collected from both the West and East Forks of the Jarbidge River, with the East Fork representing a control reference area due to its relatively pristine, un,developed condition. An annotated bibliography of fish distribution and habitat information in the Jarbidge River basin was concurrently prepared to support this report (Lawson-and Pfeifer 2002).

The habitat survey documented the quality and quantity of native salmonid habitat in the West Fork Jarbidge River and Pine Creek, a principal West Fork tributary, from the National Forest boundary to their headwaters (Figure J). Particular emphasis was placed on channel sediment characteristics in areas potentially affected by recent channel disturbances and road relocation activities just upstream of Pine Creek. Bulk sediment samples were collected to assess the quality of potential trout and char spawning habitat in the West Fork in the general vicinity of these channel and road disturbances. These samples were intended to provide a higher level of accuracy in characterizing potential spawning habitat sediment characteristics than the corresponding Wolman pebble counts collected under the standard habitat survey protocol.

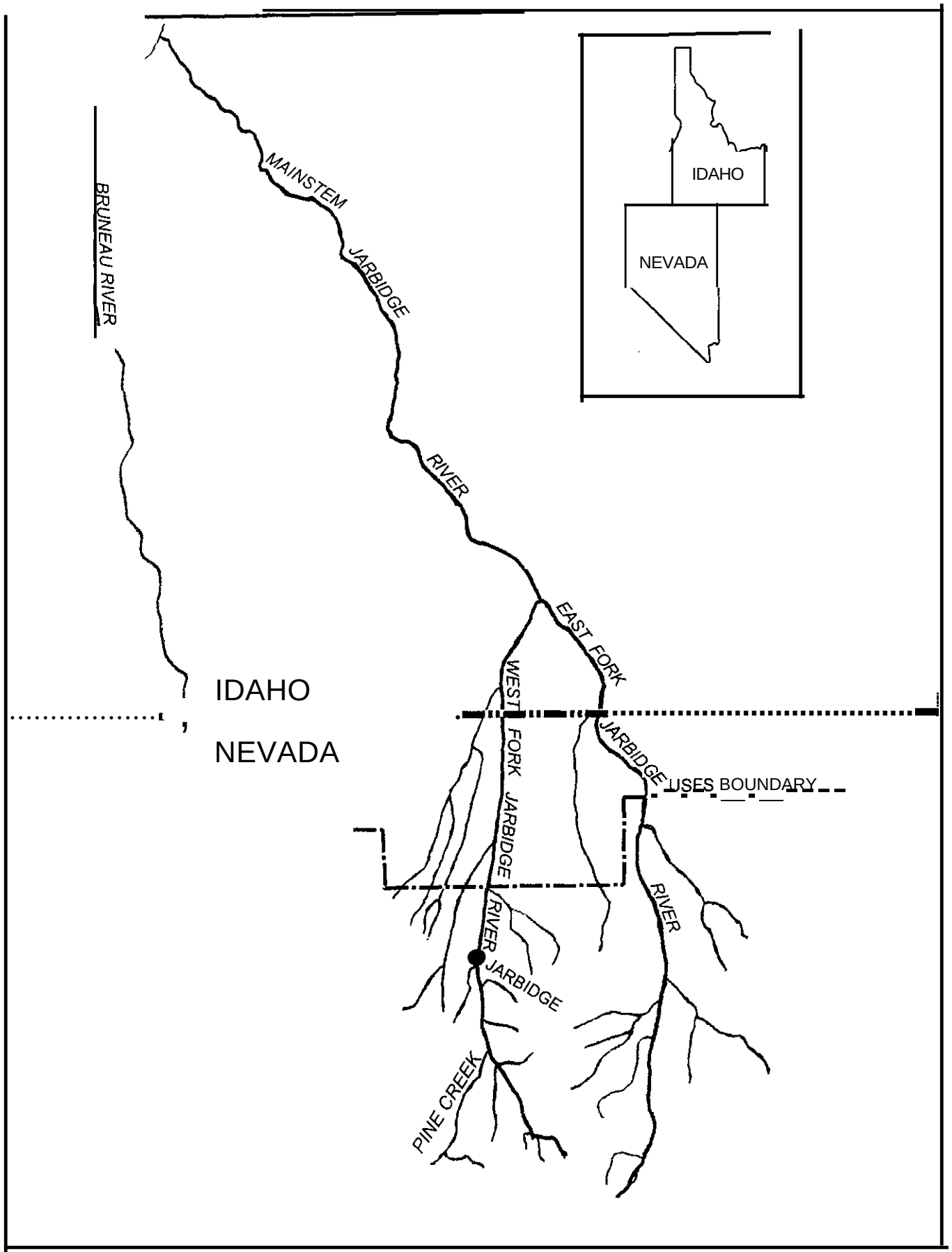

Figure 1
Vicinity Map of the
Jarbidge River System

Fish enumeration, distribution, and general population size structure data were collected in both Jarbidge River forks and in Pine Creek. Although all observed fish were documented, the emphasis of this survey was to update and extend current information on the abundance and distribution of spawning bull trout in these streams.

1.2 OBJECTIVES

The specific objectives of these surveys were to:

1. Conduct habitat survey using USFS RlIR4 protocols on the West Fork Jarbidge River and Pine Creek upstream of the National Forest boundary, with the exception of private land located within the Forest Service boundary (Section 16). The upstream limit of the habitat survey was defined by the apparent limit of bull and redband trout access/habitat. .•

2. Conduct snorkel surveys of fish abundance and distribution in the East and West Forks of the Jarbidge River, and Pine Creek, upstream of the National Forest boundary, again excepting the river reach within the Town of Jarbidge.

3. Collect supplemental bulk sediment samples in the West Fork Jarbidge River, potentially affected by the recent channel modifications and road work near the Pine Creek confluence, as well as in control (reference) areas upstream of the channel change area, and at an equivalent elevation and channel gradient in the East Fork Jarb.idge River.

Much of the general geographic information in this section was obtained from Frederick and Klott (1999), which is itself largely a compilation of information obtained by others, particularly McNeill et aJ. (1997). See these references for more detailed basin geology, soils, and sediment transport characteristics.

The Jarbidge River watershed varies in elevation from 1128 m (3700 ft) at the confluence of the Jarbidge and Bruneau rivers to 3220 m (10,565 ft) near the headwaters of the East and West Forks (see Figure 1). The East and West Forks join near the Idaho/Nevada border at about elevation 1425 m (4675 *tt).* The Jarbidge River mainstemjoins the Bruneau River in Idaho, and the combined flow enters the Snake River about 24 km (15 mil southwest of Mountain Home, roughly midway between Twin Falls and Boise, Idaho. For the purposes of this report, West Fork refers to the West Fork of the Jarbidge River, East Fork refers to the East Fork of the Jarbidge River, and Jarbidge River refers to the mainstem of the river, downstream of the East and West Forks confluence, in Idaho. Reach gradients and lengths of the surveyed streams are listed in Tables 1 and 2.

Table 1. Lengths of Surveyed Stream Reaches and Stream Gradient, Jarbidge River Fisheries Survey, October, 2001.

Stream	Reach	Reach Length (m)'	Total Surveyed Length" (m)	Main Channel Length (mi)	Gradient'
West Fork					
	W1	702	737	0.44	3.4
	W2	3113	3979	1.93	1.9
	W3	1588	1818	0.99	2.4
	W4	603	788	0.37	2.5
	W5	1514	1900	0.94	2.7
	W6	1173	1173	0.73	4.2
	W7	1335	1565	0.83	4.1
	W8	1433	1470	0.89	6.7
	W9	1433	1488	0.89	5.1
	W10	590	613	0.37	7.3
	WI1	640	640	0.40	11.4
	Totals:	14,125	16,169.2	8.8	
Pine Creek					
	PI	1184	1188	0.74	5.25
	P2	1207	1260	0.75	5.8
	P3	2175	2267	1.35	5.9
	P4	1102	1206	0.68	6.3
	P5	757	757	0.47	5.4
	P6	662	662	0.41	5.9
	P7	527	527	0.33	11.4
	Totals:	7,613	7,866	4.7	

• Main channel length was measured along the thalweg in yards with a hip chain and later converted to meters.

b Includes the length of off- or side-channel areas surveyed

c Stream gradients estimated from USGS maps

Table 2. Lengths of Stream Reaches, Jarbidge River Fisheries Survey, October, 2001.

	Reach	Elevation	Gradient'
East Fork	E1	5700	2.3
	E2	5760	3.4
	E3	5850	2.1
	E4	5905	1.3
	E5	5940	1.5
	E6	5980	1.9
	E7	6030	1.9
	E8	6080	2.3
	E9	6140	1.5
	E10	6180	1.9
	E11	6230	1.5
	E12	6270	1.5
	E13	6310	1.9
Reaches were 0.5 mi in length, starting at the NF Boundary; snorkeling was conducted at site or reach	E14	6360	1.5
	E15	6400	1.5
	E16	6440	1.9
	E17	6490	2.7
	E18	6560	2.7
	E19	6630	2.7
	E20	6700	3.4
	E21	6790	3.4
	E22	6880	6.1
	E23	7040	4.5
	E24	7160	3.4
	E25	7250	4.2
	E26	7360	9.1

• **Stream gradients estimated from USGS maps**

River flow is derived primarily from the snow pack in the surrounding mountains, but spring and fall rains can significantly contribute to the flow. Peak flows correspond with spring snowmelt, and generally occur in Mayor June (Figure 2). Flow data for the Jarbidge River are generally lacking (McNeill et a!. 1997). Annual low flows occur in late August or September. Annual precipitation is snow-dominated and can be 20 inches annually, but totals vary by elevation. A significant portion of the precipitation may also occur during spring and fall rain storms. Air temperatures also vary with elevation, but can be as high as 3SoC (100° F) (and as low as 0° C [32° F] at higher elevations) in the summer, and as low as -ISoC (0° F) in the winter. Additional detail on stream hydrology and temperature can be found in McNeill et al (1997).

The West Fork has a combined total of IS ephemeral, intermittent, and perennial tributary streams. Of these tributaries, eight are fish-bearing streams, while only five of the fish-bearing tributaries occur within the present study area (Table 3). The East Fork has six perennial tributaries. Of these, all except Cougar Point Creek are fish-bearing streams. Four of the five fish-bearing streams occur within the present study area.

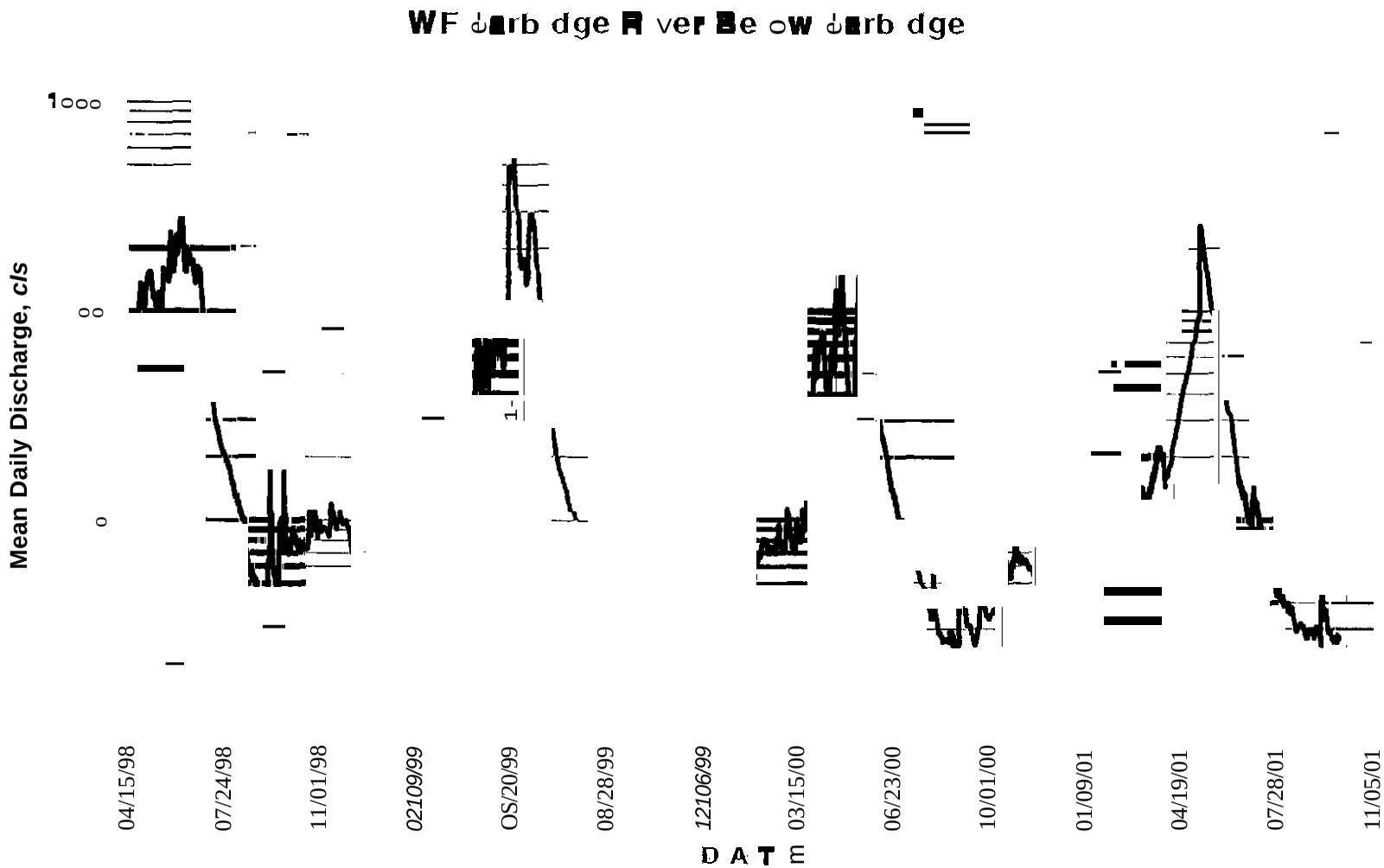

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Table 3. Fish-Bearing Tributaries to the West and East Forks of the Jarbidge River.

Drainage	Stream	Elevation of Stream Mouth (ft)	Study River **Mile**[a]	Redband or Bull Trout Presence"
West Fork	Jack Creek	5908	*nla*	Bull Trout, Redband (Rainbow)
	Bear Creek	6191	*nla*	Redband
	Pine Creek	6590	*nla*	Bull Trout, Redband
	Fox Creek	6720	*nla*	Redband
	Sawmill Creek	7400	*nla*	Bull Trout, Redband
East Fork	Robinson Creek	5849	1.2	Redband
	Slide Creek	6356	6.4	Bull Trout, Redband
	Fall Creek	6424	7.4	Bull Trout, Redband
	Cougar Creek	6580	8.7	Bull Trout, Redband

[a] **For the purposes of this study, River Mile 0.0 of the East Fork Jarbidge is located at the National Forest Boundary**

[b] **Fish presence data are from Frederick and Klatt (1999).**

The geology of the Jarbidge watershed is dominated by rhyolite, a fine-grained rock of volcanic origin. Alluvium, glacial moraines, landslide deposits, and colluvium make up the remaining geological material of the Jarbidge River watershed. Differences in landscape stability between the West and East Forks indicate that the East Fork is more prone to catastrophic events relative to the West Fork (Parrish 1998).

Federal land within the Jarbidge River watershed in northern Nevada is managed by the USFS as part of the Humboldt-Toiyabe National Forest. The Bureau of Land Management manages the majority of the Jarbidge watershed in Idaho. Current and historic human uses of the Jarbidge watershed include mining, milling of gold and silver, timber harvest, road construction and maintenance, livestock grazing, and recreation. Recreation use of the Pine Creek sub-basin is likely limited to very low levels.

The East and West Forks provide habitat in the project area for the southern-most population of bull trout, in addition to native redband (rainbow) trout *(Oncorhynchus mykiss),* mountain whitefish *(Prosopium williamson*i), bridgelip sucker *(Catostomus columbianus),* and sculpins *(Cottus* spp.) (Zoellick et al. 1996).

3.1 HABITAT SURVEYS

Habitat surveys of the West Fork and Pine Creek were conducted in accordance with USFS Level III R1/R4 habitat survey protocol (Overton et al. 1997). Approximately 14.2 km (8.8 mi) of the West Fork were surveyed from the National Forest boundary to the headwaters (exclusive of the reach adjacent to the Town of Jarbidge). Pine Creek was surveyed from the confluence with the West Fork to its headwaters (approximately 7.6 km [4.7 mi]). The upper limit of the surveys were determined on site by the identification of impassible fish barriers in the headwater areas (e.g. Photograph 28, Roll 6, Reach W11, October 13, 2001; supplemental photo file).

The West Fork and Pine Creek were stratified into reaches using stream gradient and geographic features (elevation, tributaries, etc.), in that order of priority, to determine reach breaks and lengths (Figure 3). Each stream reach was further stratified into habitat units based on channel characteristics. However, only fish surveys were conducted on the East Fork, so reach breaks based on site habitat conditions and landmarks were not established on that fork.

Variables measured or estimated during the field habitat survey, or later calculated, are presented in Table 4. Survey methods follow Overton et al. (1997), except or in addition to those noted below. Where reaches were not segmented by obvious landmarks, a Garmin Etrex Venture pocket GPS unit was used to obtain either latitude and longitude, or UTM values, or both. This occurred most frequently on Pine Creek and the lower East Fork. One end of the snorkel reaches was also located with GPS when these points did not coincide with reach breaks. The GPS values were recorded on the field data sheets and typically had a position resolution of within 9 or 10 m (30-32 ft).

Table 4. Habitat Variables Measured, by Habitat Type, In the 2001 Jarbidge River Survey.

Habitat Type	Habitat Variables Measured	General Channel Characteristics[a]
Low and High Gradient Riffle	Length, Width, Average Depth, # and Max. Depth Pocket Pools	Large Woody Debris (single, aggregates, root wads, % Submerged), Channel Morphology, Bank Shape and Stability, Riparian Community
Run and Glide	Length, Width, Average Depth	
Pool (Dammed, Lateral Scour, Mid Channel, Plunge)	Length, Crest Depth, Average and Max. Depth, Width	
Cascade	Length	
Step Pool Complex	Length, # and Max. Depth	

a Determined independent of habitat type.

'Water temperature was measured with a pocket thermometer several times per day, beginning with the first survey reach each day. The time of these temperature readings was also recorded. Elevations were taken with a Casio wristwatch altimeter or the GPS unit. These were frequently cross-checked with 7.5' USGS topographic map elevations at obvious landmarks.

Discharge levels in the West Fork were determined from the USGS real time recording gage (USGS 13162225) north of Jarbidge as published on the USGS Internet website (USGS 2001). West Fork discharge above Pine Creek was visually estimated. Pine Creek discharge was estimated using a floating chip method in a uniform channel section in Reach P6 (see Figure 3). Discharge was visually estimated on the East Fork in Reach E24, and in Reach E13 (about 200 m [655 ft] below Slide Creek).

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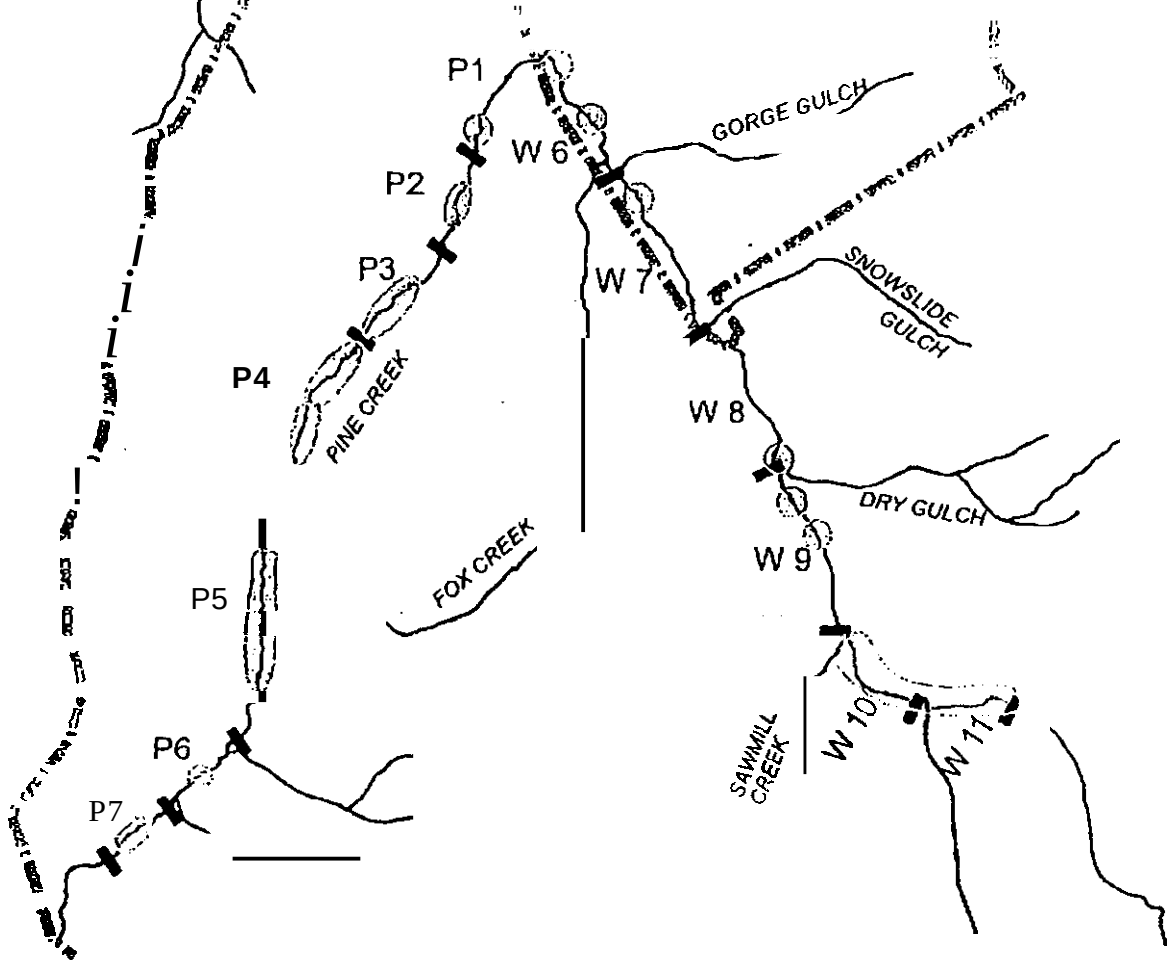

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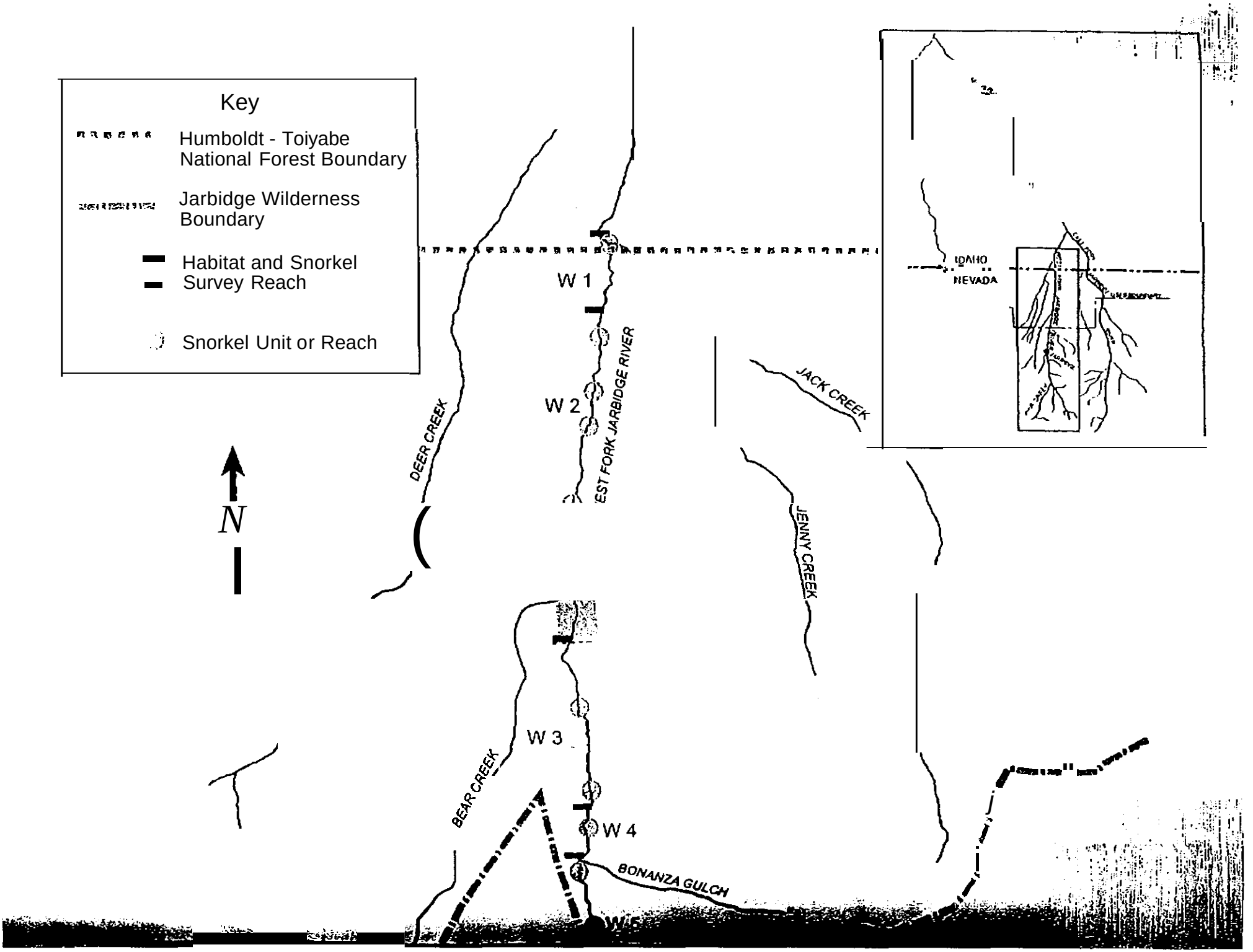
SCALE IN MILES

0 0.5 1.0

Figure 3
West Fork Jarbidge River Survey Locations.


Key
Humboldt - Toiyabe National Forest Boundary
Jarbidge Wilderness Boundary
Habitat and Snorkel Survey Reach
Snorkel Unit or Reach
N
W 1
W 2
W 3
W 4
DEER CREEK
EST FORK JARBIDGE RIVER
JACK CREEK
JENNY CREEK
BEAR CREEK
BONANZA GULCH
IDAHO
NEVADA

Habitat unit lengths were measured in yards with the hip chain by following the channel thalweg, and were summed to obtain the total reach length. Stream depths and widths were measured in tenths of feet with an extendable survey rod, or a calibrated walking staff.

Twenty-three Wolman pebble count surveys (Kondolf and Li 1992) were conducted on the West Fork at an average frequency of just over two per reach. Samples were selected by directing an index finger vertically to the substrate with eyes averted. Two samplers zig-zagged back and forth to collect samples relatively uniformly within the entire sample area. The sample area was usually extended slightly onto the adjacent exposed substrate to partially compensate for the extreme low flow condition. A minimum of 100 grains were measured to the nearest 1-2 mm in each count. When the finger contacted sand or fines (usually in very small pockets or interstices), a single point was logged on the data form in the "Fines" category « 2mm). Four pebble counts were conducted on Pine Creek in the lower four reaches; four visual estimates (Overton et al. 1997) of grain size distribution were made upstream, two in Reach P5, one in P6, and one in P7 (Appendix A).

The USFS *RIIR4* habitat survey protocol (Overton et al. 1997) does not provide a rigorous method for documenting the abundance and distribution of spawning or rearing habitat that may be unique to specific salmonid species, such as bull trout. Pebble counts and visual estimates of surface fines are usually not sufficiently focused or site-specific to adequately quantify bull trout spawning habitat, although they do give a general assessment of gravel quality in the stream. To help increase the relative value of the pebble count data for estimating spawning habitat quality, they were primarily conducted on the tailouts of pools, a habitat feature commonly used by spawning salmonids, although not necessarily preferentially by bull trout.

No attempt was made to thoroughly quantify potential bull trout spawning habitat in the study streams since this was beyond the survey scope. A senior fish biologist with extensive bull trout spawning assessment experience visually assessed the general character and abundance of spawning habitat in areas of the three streams known to support bull trout spawning based on the work of others (e.g. Johnson 1999). Particular attention was paid to the distribution of such habitat in reaches downstream of the headwater areas.

Large woody debris (LWD) information was recorded for each stream reach. Recorded LWD data included the number and dimension of each LWD piece, as well as the percent of i,ts volume submerged at the time of the survey. Wood pieces estimated to be above ordinary high water were not tallied or measured. The gross species mix of the riparian community was also noted, and later converted to standardized community codes.

Field data were recorded on USFS *RIIR4* inventory forms (Appendix A) and reviewed each night for quality control. A photographic record of representative habitat and field methods was developed concurrent with collection of habitat unit data. The 35mm slides were organized into clear plastic sheets in a 3·ring binder, and were also digitized into individual .jpg files on a CD. An MS-Word captions file was developed that relates each date-stamped photograph to the direction faced (upstream or downstream) and identifies the stream reach location.

3.2 FISH SURVEYS

Daytime fish surveys were conducted by snorkeling on Pine Creek and both the East and West Forks (see Figures 3 and 4) following methods described by Thurow (1994). On the first day, the snorkeler, confirmed their ability to visually estimate fish lengths by an underwater calibration method of viewing of plastic fish silhouettes of a size known only to a shore-based observer. The snorkelers were equipped

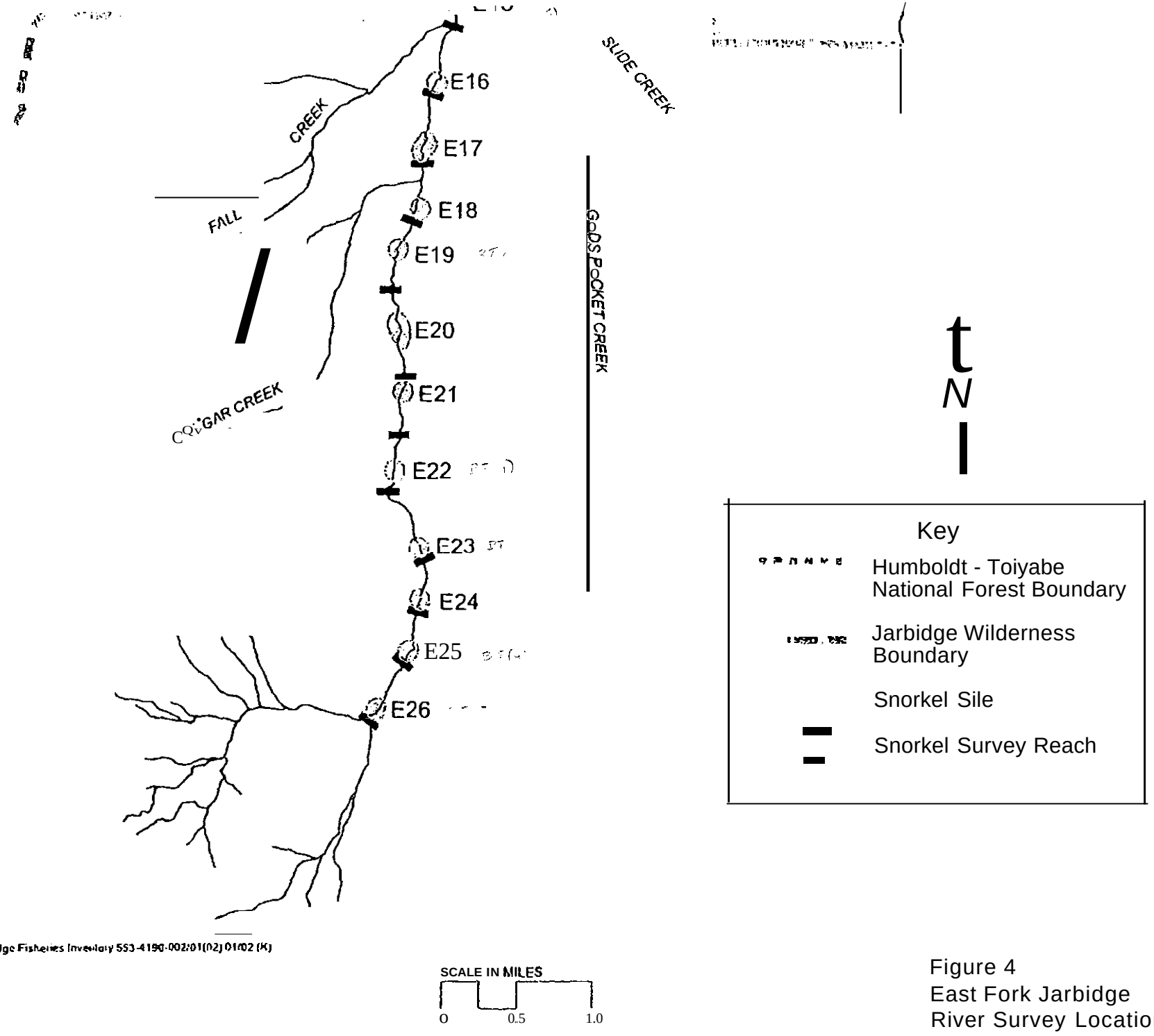


Figure 4
East Fork Jarbidge River Survey Locations

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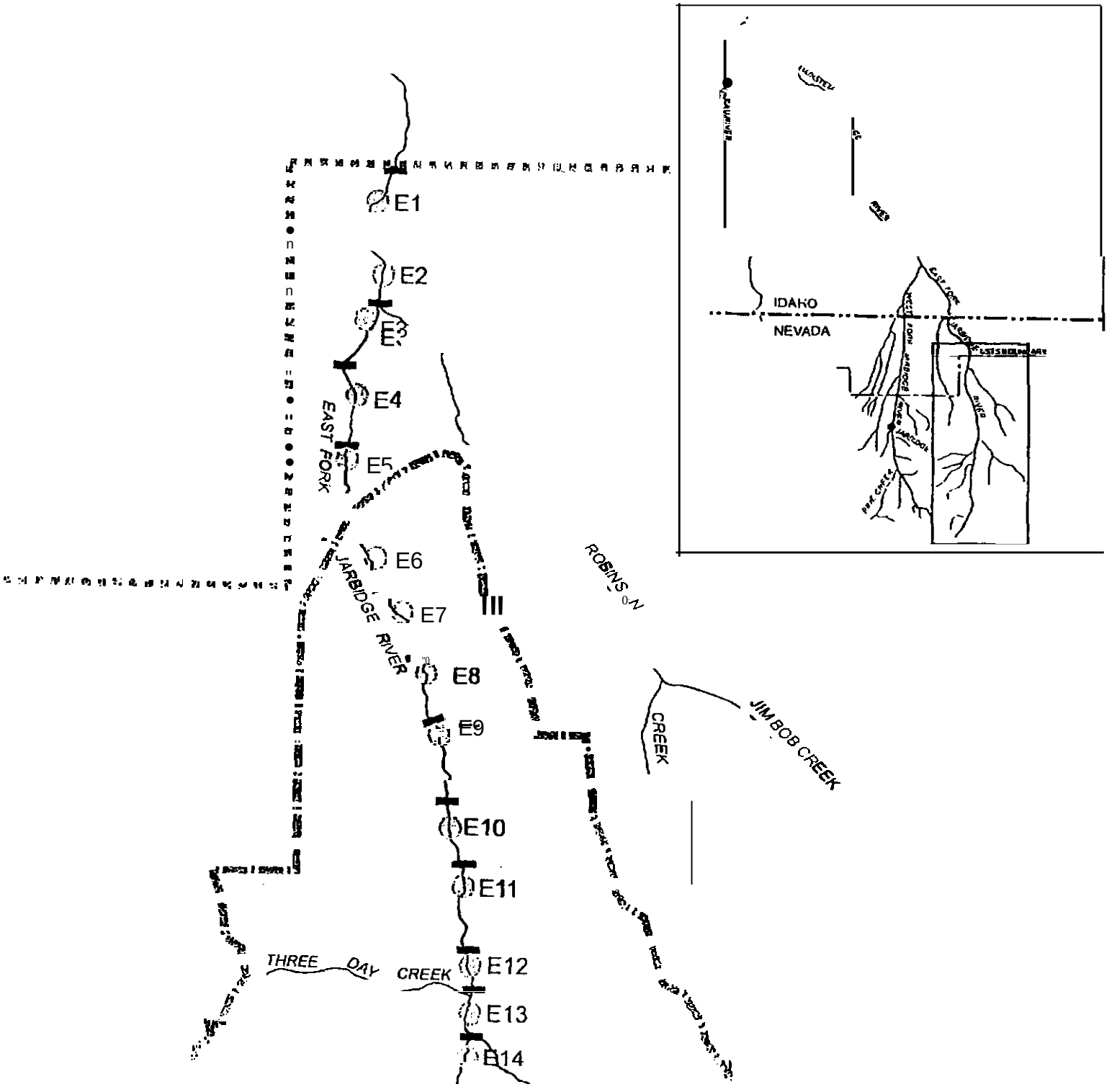
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
EAST FORK
JARBIDGE RIVER
THREE DAY CREEK
ROBINSON
CREEK
JIM BOB CREEK
IDAHO
NEVADA

with an underwater writing plate. A team of two snorkelers and a shore-based observer surveyed Reaches WI through W7 on the West Fork. We found that one snorkeler could adequately observe fish throughout the snorkel unit because of the extreme low flows, and relative fish inactivity due to low water temperature. Therefore, all other reaches were surveyed with one snorkeler in the water. and one observer/data recorder. Virtually all these surveys were conducted by entering the unit at its downstream end and snorkeling slowly upstream. Given the late date and relatively cold water temperatures. snorkelers took extra time and care to thoroughly examine all fish holding areas and substrate interstices that could be seen or reached. Larger substrate elements were periodically lifted to check for small fish.

Electrofishing was not conducted due to 1) inadequate time following the contract award to obtain the proper permits; 2) electrofishing was strongly discouraged by regulatory agencies (Nevada Division of Wildlife [NdoW], FWS); and 3) mutual agreement with the USFS to limit the techniques used to visual (shore-based) and snorkel surveys.

Night snorkeling was not conducted due to the time constraints imposed on completion of the survey. We recognize that this is a preferred method to determine bull trout presence or absence (Bonar et al. 1999).

At least one 90 m (or longer) unit was snorkeled in each reach. Two units were snorkeled in the longer reaches (see Figure 3). Snorkeling was relatively continuous, i.e. in each pocket pool, in Reaches 10 and '11 of the West Fork headwaters. The East Fork was divided uniformly into 0.8 km (0.5 mil reaches from the National Forest boundary to the headwaters. resulting in 26 reaches. A snorkel reach at least 100 m long was selected arbitrarily within each 0.8 km reach, with the intent of surveying habitat that had at least some pools likely to hold trout or char. The GPS unit and wristwatch altimeter were used. individually or in combination, to locate snorkel reaches when they did not start or end at obvious landmarks.

Snorkel surveys were planned to occur continuously along 100-200 m stretches. However, extremely low water levels made it impossible to snorkel survey many ofthe riffles. The surveys were therefore mainly conducted in pools, glides and runs at least 0.2 m (8 inches) deep. In addition to fish species, estimated size, and number, habitat features were also recorded (undercut bank, overhead cover, submerged cover and large substrate). Fish survey information was recorded on USFS R1/R4 inventory forms (Appendix A) and reviewed each night for quality control.

The number of redband and bull trout observed in each stream reach was tabulated, and to the extent possible or meaningful, related to similar studies performed by others. Length frequency plots were developed for these two species for each of the three principal streams surveyed.

3.3 DATABASE DEVELOPMENT

All habitat and fish data collected were entered into an FBASE database as described by Wollrab (1999). After initial data QC in the field, all field data forms were further inspected and discussed prior to data entry. All habitat unit length, width, and depth data were converted, as necessary, to consistent English units (feet). The Streams.dbf file provided by the USFS on the Rocky Mountain website did not have codes for certain stream reaches. We assigned codes for these reaches (Table 5) to allow these data to be entered into FBASE.

Table 5. FBASE Stream Codes Assigned to the Surveyed Areas

Stream	Reach Description	EPA Number	FBASE Stream Code
West Fork	Jack Creek to Headwaters	17050102 091 00.00	NV9991
East Fork	Dave Creek to Slide Creek	17050102 095 00.00	NV 99993'
East Fork	Slide Creek to Headwaters	17050102 096 00.00	NV9994
Pine Creek	(All)		NV9992

[8] The space after "NV" is required unless the Streams.dbf file is

Since there was no obvious way to enter miscellaneous comments (Form 5, Appendix A) into FBASE, these forms were submitted to the USFS without further processing. The "Photographs" section of these forms have photo site identification information which can be linked to the captions file prepared for the bound 35mm slides.

Although the snorkel unit lengths were measured, stream widths were not collected consistently. Forty one of 316 snorkel units (13%) were not measured for width (Table 6). Since the FBASE software will not accept fish survey data unless a value is entered for Dive Average Width, mean width values from the associated reach habitat surveys were entered. This should have no effect on FBASE reports for general habitat area calculations, but will affect FBASE fish per unit area calculations to some degree in affected reaches.

Table 6. Snorkel Units Surveyed for Fish Presence or Abundance, with No Associated Steam Width Measurements.

Stream	Reach	Habitat Units Lacking Dive Width Data	Number of Units
West Fork	W8	22-25	4
West Fork	W9	2-5; 35-39	9
West Fork	W10	19-27	7
West Fork	W11	NA'	
Pine Creek	P4	1-33	17
Pine Creek	P7	2-6	4

[8] Habitat units were not surveyed/tallied by the habitat crew; all pools were snorkeled.

3.4 SPECiAL SEDIMENT SAMPliNG

A more detailed sediment survey was conducted on the West Fork, near Pine Creek, to evaluate whether recent road construction and channel changes had increased the amount of fine sediments « 0.85mm) in potential trout or char spawning areas. The initial criterion for site selection was to adequately test the hypothesis that mean percent fines in typical channel sections (including at least one exposed point bar) upstream, within, or downstream of the affected reach of the West Fork were not significantly different. A related hypothesis was that percent fines in a typical, geomorphically similar East Fork reach did not differ from percent fines in the West Fork sites.

Four sampling locations were identified along the West Fork (Figure 5). A reference site (WF-l) was located upstream of the perturbations. A second location (WF-2) was chosen at the lower end of the new USFS-constructed channel realignment, where the river approaches the road. Two additional sites were chosen at increasing distances downstream from the channel realignment area under the assumption that average percent fines in the substrate would decrease with increasing distance from the disturbed area.

The first of these two downstream sites (WF-3) was located just downstream of the Pine Creek Campground where the river abuts the road. The fourth site (WF-4) was located about 0.8 km (0.5 mil further downstream where the river passes beneath a bridge. This separation of sample reaches meets the guidance of Bunte and Abt (2001) and Rosgen (1996) to sample at least 20-30 bankfull widths when spatially characterizing streambed materials.

A fifth sediment sample location (EF-l) was selected along the East Fork (see Figure 6) at an elevation and channel gradient similar to the West Fork locations. The East Fork site was sampled to provide a reference from a similar but less-developed and presumably less-impacted basin.

The initial sampling design identified stream sections to test for general differences in substrate upstream, within, and downstream of the putative impacted area. We also selected replicate bulk sample locations (within the five general sites) in areas that were deemed potentially suitable for trout or char spawning, based on the professional judgment and experience of the senior fishery biologist. Local site conditions affecting the selection of these sites included, but were not limited to water depth and velocity, proximity to cover, substrate size, and influence from spring or groundwater (if apparent). This sampling scheme was designed to answer two questions;

- Whether substrate percent fines differs between four sampling sites on the West Fork, or between the West Fork sites and the East Fork site; and

- Whether there are differences in percent fines in areas potentially suitable for redband trout or bull trout spawning.

Between 8 and 12 replicate bulk sediment samples were taken at each of the five sampling locations. Because of the natural variability in sediment grain size across natural streambeds, large sample sizes are often needed to obtain much confidence in estimates of actual size distribution (Bunte and Abt 2001). The number of replicates taken was dictated primarily by time constraints and by the logistics of handling relatively large volumes of sediment in the remote East Fork area.

Sketch maps were prepared for each of the five general sites sampled (Appendix B). Individual replicate sample sites were located within the sketch maps. Photographs were taken of each of the five general sampling areas, as well as at each replicate sample site to show its spatial relationship within the overall sample area, and the surface characteristics of the sample site before excavation.

Sediment collection procedures followed Grost et al. (1991) fairly closely, however all samples were processed as wet volumes. While we did not oven-dry our samples, we provide a data summary spreadsheet which includes conversions of the wet volumes to estimated dry weights using conversion factors reported by Platts et al. (1983). At each sample location, individual sediment samples were taken by gently shoveling approximately 15 liters of sediment into a plastic bucket. Care was taken to assure that the "core" removed by shovel was at least 20 cm deep. Sediment greater than 2 mm was sieved and separated in the field, and its volume determined by water displacement in a separate bucket which drained to a graduated cylinder. The remaining sediments «2 mm) were transported back to the laboratory in doubled plastic soil sample bags, and separated into two size classes (2.0-0.85 mm and <0.85 mm). While the fisheries literature differs as to the particle size threshold used in evaluations of impacts on salmonid egg to fry survival, the 0.85 mm size class is arguably the most relevant (Kondolf 2000). We provide a spreadsheet which tabulates both the 2 mm and 0.85 mm fractions. Differences in percent fines «0.85 mm) by volume among sampling locations was assessed using analysis of variance and subsequent multiple contrasts.

A total of 21.7 kln (13.5 mil of stream were surveyed along the West Fork and Pine Creek from 10/09/01 to 10/16/01. Habitat survey information included standard habitat variables, pebble counts and LWD counts. No habitat data was collected along the East Fork Jarbidge River.

Fish snorkel surveys were conducted in the same 21.7 kln (13.5 mil area of West Fork and Pine Creek as the habitat surveys, as well as 21.2 kln (13.2 mil of the East Fork. Fish surveys in the West Fork and Pine Creek were conducted concurrently with the habitat surveys; fish surveys along the East Fork were conducted from *10119/01* to 10/21/01.

Bulk sediment samples were collected along the West Fork (33 samples, 4 locations) and East Fork (12 samples, 1 location) concurrently with fish and habitat surveys.

4.1 HABITAT SURVEYS

4.1.1 West Fork

A total of 14.2 kln (8.8 mil of the West Fork Jarbidge River were surveyed from the Humboldt-Toiyabe National Forest boundary (RM 0.0) to beyond Sawmill Creek (RM 8). The West Fork is generally a wooded, moderately confined to confined channel with the reaches above Pine Creek almost exclusively confined. Juniper, aspen, wi1low and fir dominated the riparian community. Habitat type was dominated by low gradient riffles (LOR) throughout; 45% of the habitat units were classified as LOR and 75% of the stream was classified as riffle habitat.

Stream water temperatures ranged from 3.3° to 10.0° C (38° to 50°F), but water temperatures were strongly influenced by time of day and atmospheric conditions. A significant cold front brought snow to the area on October 11, and the weather was cold and clear on October 12. This is evidenced by a 3.4° C (6° F) drop in morning water temperature in Reach W2 between these dates (Table 7). Water temperatures in the West Fork and Pine Creek remained cold (below, to well below 7° C) for the balance of the surveys (through October 16). This had significant implications for our ability to survey the fish population for overall abundance in these two streams, particularly when compared to the East Fork.

Table 7. Water Temperature of the Jarbidge River Forks and Pine Creek by Date, Reach, and Time, 2001.

Stream	Dale	Time	Reach	T(F)	T (e)
West Fork	9·0ct	915	W2	40	4.4
		1125	Wl	46	7.8
		1410	Wl	52	11.1
		1740	W2	52	11.1
	10-0ct	1200	W2	46	7.8
		1405	W2	50	10.0
		1530	W3	50	10.0
	11-0ct	840	Wl	46	7.8
		1020	W2	46	7.8
		1211	W2	46	7.8

Table 7. Water Temperature of the Jarbidge River forks and Pine Creek by Date, Reach, and Time, 2001 (Continued).

Stream	Date	Time	Reach	T (F)	T (C)
West Fork (con't)		1430	W2	46	7.8
		1519	W3	45	7.2
		1612	W3	46	7.8
		1624	W3	44	6.7
		1715	W4	44	6.7
	12-0ct	805	W2	40	4.4
		850	W2	40	4.4
		1030	W5	39	3.9
		1130	W5	40	4.4
		1300	W6	43	6.1
		1350	W6	45	7.2
		1500	W7	44	6.7
	13-0ct	1045	Wll	38	3.3
		1145	Wll	39	3.9
		1245	Wl0	40	4.4
		1330	Wl0	41	5.0
		1405	W9	41	5.0
		1530	W9	42	5.6
		1600	W8	43	6.1
Pine Creek	15-0ct	1100	P7	40	4.4
		1215	P6	40	4.4
		1255	P6	40	4.4
		1400	P5	42	5.6
		1420	P5	43	6.1
		1512	P5	45	7.2
	16-0ct	900	Pl	40	4.4
		1000	Pl	40	4.4
		1200	P2	40	4.4
		1330	P2	44	6.7
East Fork	19-0ct	1100	E26	42	5.6
		1226	E25	42	5.6
		1342	E24	44	6.4
		1449	E23	45	6.9
		1631	E22	47	8.1
	21-0ct	937	El	44	6.7

Habitat data for each West Fork reach of the are summarized in Table 9. The habitat width, volume, depth, and area decline with increasing elevation. However, aside from characteristics relating to stream size, habitat characteristics are generally consistent among the stream reaches and elevations. Notable exceptions are discussed below.

Average pool frequency was 4.6 *1100* m *(74/mi),* and the mean (wetted) width-to-depth ratio was 27.4. This pool density is almost identical to that recommended by INFlSH standards (Ramsey 1997). However, the *WID* ratio of 27.4 is substantially higher than the 10 recommended by INFlSH. The West Fork channel was broad and shallow in October; this contributes to the high *WID* value that we observed in most areas of both the West Fork and Pine Creek (see Table 9). Flows were also anecdotally reported by locals to be exceptionally low in the fall of 2001.

A data summary report from FBASE was used to prepare Figure 7 which plots the distribution of maximum and residual depths from pocket pools and slow water habitats, respectively. Pocket pool depth averaged 0.4 m, and exceeded I m as a mean only in Reach W7 (see Table 9). Considerably more depth was seen in pools created by LWD, boulders, and scour (Figure 7). Still, most of these pools were no more than 0.46 m (1.5 ft) deep. W8 and WIO were the only reaches not dominated by riffle habitat. W8 contained a significant number of step pool complexes (STP), while WF-IO had more wood and boulder scour pools. There were very few pools 0.76 m (2.5 ft) or deeper, and most of the 0.6 m-deep (2.0 ft) pools were located in Reach W2, as seen in the following table:

Table 8. Distribution of West Fork Jarbidge River Pools by Depth Category and Stream Reach, October, 2001

West Fork	Number of Pools by Maximum Pool Depth			
Reach	2.0 -2.5 ft	2.5 - 3.0 ft	3.0 - 3.5 ft	3.5 - 4.0 ft
	2	0	0	0
2	9	1	1	0
3	1	1	0	0
4	1	0	0	0
5	2	0	0	0
6	0	1	0	0
7	0	0	0	0
8	0	1	0	0
9	0	1	0	0
10	1	0	0	0

Bank stability was generally high (mean 88.3%). Portions of Reaches W6, W9, and WIO had slightly lower bank stability (75-80%). Reach WIOhad low bank stability (10%) at the upper portion of the reach. This area was a highly confined and wooded area with numerous trees (alder and willow) blown down along the stream bank, exposing root wads and soils. Reach W6 includes the USFS road and bridge washout areas and the stream re-ehannelization, resulting in several areas of low bank stability (0-10%).

A total of 23 Wolman pebble TABLE 10 were conducted along the West Fork to characterize the surface sediment composition (Table 9). Surface sediment composition was consistent throughout the West Fork, with no appreciable differences among the reaches. The surface sediments were dominated by gravel and rubble, which accounted for an average of 73% of the surface material. Embeddedness was almost universally low.

Table 9. Summary of West Fork Habitat Statistics by Reach, Jarbidge River Fisheries Study, 2001

	West Fork Survey Reaches											
Variable·	W1	W2	W3	W4	W5	W6	W7	W8	W9	Wl0	Mean	S.D.
Habitat Unit Length (m)	18.8	39.9	44.8	34.7	59.4	30.6	52.8	41.5	31.7	21.1	37.5	12.89
Habitat Wetted Width (m)	4.7	5.1	4.3	4.3	4.4	3.3	3.1	2.7	2.5	2.5	3.7	0.96
Habitat Area (m^2)	89.6	214.0	214.3	153.2	274.0	103.3	152.7	115.1	84.4	52.0	145.2	70.19
Habitat Mean Depth (m)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.03
Habitat Maximum Depth (m)	0.6	0.8	0.7	0.6	0.6	0.6	0.5	0.6	0.4	0.4	0.6	0.13
Habitat Volume (m^3)	16.3	34.3	29.0	20.9	33.5	14.0	16.9	12.8	10.3	3.7	19.2	10.17
Percent Fast Habitat	82.5	94.0	92.6	78.4	96.5	82.3	89.4	35.5	89.6	55.7	79.7	
Percent Slow Habitat	17.5	6.0	7.4	21.6	3.5	17.7	10.6	64.5	10.4	44.3	20.4	
Percent Riffle Habitat	74.6	82.7	86.0	76.9	90.0	79.8	88.6	34.8	88.2	52.3	75.4	
Pocket Pools *(n/l00m)*	0.1	3.0	1.1	2.7	2.5	5.8	1.9	2.5	3.6	1.5	2.5	1.53
Pocket Pool Depth (m)	0.2	0.4	0.4	0.4	0.4	0.3	1.2	0.4	0.3	0.3	0.4	0.27
Residual Maximum Depth (m)	0.4	0.6	0.6	0.4	0.4	0.4	0.3	0.5	0.3	0.3	0.4	0.12
Widthldepth Ratio	28.1	32.6	30.1	33.3	32.3	24.9	23.6	18.4	21.5	29.3	27.4	5.09
Number of Large Class *LWD/l00* m	0.6	0.03	0.00	0.8	0.3	1.1	0.75	0.5	0.4	0.3	.48	.35
Number of Pieces LWD *l* 100 m (all size classes)	5.1	3.1	1.8	5.6	3.4	4.9	3.4	2.6	2.6	3.6	3.60	1.19
Number of Pieces *LWD/aggregate*	4.2	4.3	7.0	3.0	3.5	1.1	3.9	3.1	4.3	2.8	3.7	1.52
Number of LWD Aggregates *11* 00 m	2.4	1.5	0.1	0.2	0.1	0.9	1.1	2.0	1.1	1.4	1.1	0.79
Rootwad *LWD/l00* m	2.0	1.5	1.1	0.7	0.6	2.1	2.0	1.0	1.4	1.0	1.3	0.55
Percent Stable· Left Bank	87.7	96.4	90.5	83.1	94.8	79.6	92.0	94.9	86.2	77.9	88.3	6.54
Percent Stable· Right Bank	86.5	92.2	86.2	85.2	89.8	76.3	84.8	87.9	74.9	76.3	84.0	6.06

* INFISH standards', 76 pools1mi *(4.7/100* m) for wetted width of 4.3 m; widlh:depth ratio <10.

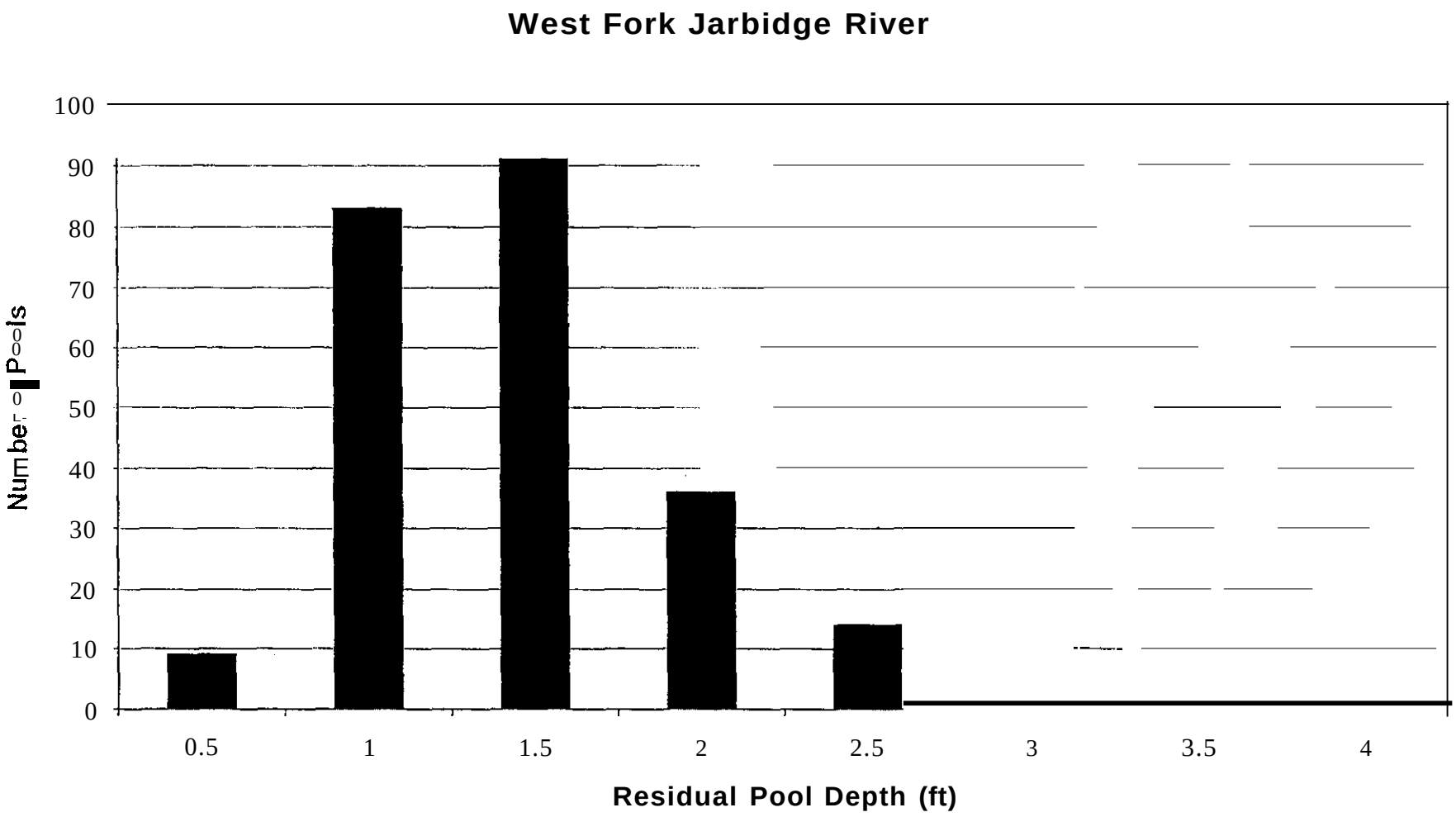

Figure 7. Depth Distribution of West Fork Jarbidge River Pools, October, 2001.

With the exception of Reach W6, all areas surveyed were substantially below the INFISH standard of 1.24 pieces /100 m of LWD, with each piece at least 9.1 m (30 ft) long, and 0.3 m (I ft) in diameter (Table 10). In the West Fork, the lowest frequency ofLWD occurred in Reaches W2, W3, and W5, all areas accessible by automobile. The average LWD dimensions (all size classes combined) were 6.0 m by 0.27 m (19.8 ft by 0.87 ft) in length and diameter, respectively, for the West Fork. Equivalent values for Pine Creek were 6.1 m by 0.24 m (20.1 ft by 0.80 ft), nearly identical to the wood size in the West Fork. Also notable, is the low percentage of LWD submerged in the stream (see Table II) rendering the available LWD largely non-functional in terms of creating or providing fish habitat under the observed low flow conditions. Rootwads were far more numerous than individual wood pieces, particularly in the West Fork. However, rootwads were nearly absent from Pine Creek (see Table II).

Table 10. Pebble Count Summaries for the West Fork Jarbidge River and Pine Creek by Survey Reach, 2001.

Survey Reach	Fines <2mm (!o)	Small Gravel 2-8mm (!o)	Gravel 8-64 mm (!o)	Small Cobble 64·128 mm (!o)	Cobble 128·256 mm (!o)	Small Boulder 256·512 mm (!o)	Boulder > 512 mm (!o)	Bedrock (!o)	Replicate Counts
West Fork									
W1	6	4	37	38	14	2	0	0	4
W2	3	3	44	36	11	2	0	0	5
W3	5	3	42	37	12	2	0	0	2
W4	10	0	29	38	20	3	0	0	1
W5	7	1	33	41	15	4	0	0	2
W6	6	4	36	38	16	2	0	0	2
W7	6	10	31	35	14	7	0	0	2
W8	7	8	27	34	20	5	0	0	2
W9	4	5	40	37	14	2	0	0	2
W10	5	1	35	44	14	1	0	0	1
Average:	6	4	36	38	15	3	0	0	23
Pine Creek									
P1	6	lB	26	34	7	7	2	0	1
P2	6	6	41	34	10	2	0	0	1
P3	15	B	44	26	6	1	0	0	1
P4	6	12	31	36	11	5	0	0	1
P5	2	33	10.5	24.5	15	15	0	0	1
P6	1	4	20	20	20	35	0	0	1
P7	2	70	24	0	4	0	0	0	1
Average:	5	22	28	25	10	9	0	0	7

Table 11. Size and Percent Submergence of LWD in the West Fork Jarbidge and Pine Creek, 2001.

Stream	Reach	Rootwads	Rootwads /100 m	Mean Percent Submerged	Range in Percent Submerged	Number of Class 7,8 **Pieces**•	Pieces / 100 m[b]	Mean Piece Length *(tt)*	Mean Piece Diameter *(tt)*
West Fork									
	W1	15	2.14	0.48	0·4	4	.57	15.8	1.03
	W2	46	1.48	1.85	0·65	1	.03	13.9	0.86
	W3	18	1.13	1.18	0-5	0	.00	17.1	0.91
	W4	4	0.66	3.74	0-90	5	.83	20.1	1.01
	W5	9	0.59	2.69	0-50	4	.26	19.8	0.80
	W6	24	2.05	0.47	0-5	13	1.11	22.6	0.88
	W7	27	2.02	1.96	0-20	10	.75	27.8	0.88
	W8	13	0.91	0.32	0-3	7	.49	22.5	0.93
	W9	20	1.40	1.08	0-25	6	.42	22.1	0.77
	W10	6	1.02	1.05	0-5	2	.34	16.7	0.67
Pine Creek									
	P1	1	0.08	0.14	0-5	3	.25	19.8	0.91
	P2	2	0.17	0.87	0-5	2	.17	20.2	0.78
	P3	2	0.09	0.40	0-10	4	.18	18.9	0.81
	P4	2	0.18	4.92	0-50	2	.18	23.1	0.93
	P5	0	0.00	1.04	0-5	5	.66	23.7	0.73
	P6	0	0.00	0.30	o· 1	2	.30	20.6	0.66
	P7	0	0.00	4.33	0-10	0	.00	14.7	0.75

• Class 7 = 10-20" in diameter, >35 ft long; Class 8 = >20" in diameter, >35 ft long.

b INFI$H standard = >20 pieces/mile >12" in diameter. >30 ttin length. 201mile = 1.24/100 m.

Areas of significant bank erosion along the lower reaches of the West Fork (W1-W4) were commonly associated with road fill and old mine tailings (Table 12; supplemental photo file). Elsewhere on the West Fork, most of the sites of significant erosion were those associated with high, steep, naturally erosive soils exposed to the river. Other instability areas upstream of Jarbidge were most commonly associated with natural events such as landslides and washouts from steep valley sidewalls.

Table 12. Location of Significant Bank Erosion, West Fork Jarbidge River and Pine Creek, 2001.

Stream	Reach	Habitat Unltls	Description	Photographs
West Fork	Wl	22	High Eroding LB	1
	Wl	28-34	Eroding RB Road Fill	5
	Wl	37	High Eroding LB	1
	W2	27	High (incised), eroding RS	2
	W2	68	RS Erosion at Sawmill Campground	2
	W2	71	RB Erosion at Sawmill Campground	2
	W2	74	RB Road Fill Erosion	2
	W3	7	RB Mine Tailings	1
	W3	9	RB Mine Tailings	1
	W3	15	RB Erosion	1

Table 12. Location of Significant Bank Erosion,
West Fork Jarbidge River and Pine Creek, 2001. (Continued)

Stream	Reach	Habitat Unitls	Description	Photographs
West Fork (con't)				
	W3	33	High AS Erosion	
	W4	12	Erosion of Aoad Fill	None
	W6	27	LS Erosion	
	W7	22	RS Erosion	None
	W8	9	RS Erosion	
Pine Creek				
	P5	1	Eroding RS	
	P5	5	High RS Erosion	None
	P6	6	High RS Erosion	2
	P7	4	LS Erosion	1

4.1.2 Pine Creek

A total of 7.6 kln (4.7 *mil* of Pine Creek were surveyed. The'survey began at the confluence with the West Fork and ended near the headwaters (RM 4.7). Pine Creek is a wooded, moderately-confined to confined channel with a riparian zone consisting of alder, cottonwood, fir and willows. As in the West Fork, habitat type was dominated by riffle habitat which comprised 90.8% of the habitat surveyed. Stream water temperatures ranged from 4.4° to 7.2° C (40° to 45° F), but these water temperatures were strongly influenced by time of day (see Table 7).

Habitat data for Pine Creek are summarized in Table 14. Habitat characteristics were fairly consistent along all stream reaches, with the exception of variables related to stream size, which decreased with increasing elevation. In addition, the upper reaches were almost exclusively riffle habitat with fewer pocket pools relative to the lower reaches. Overall pool frequency was higher than in the West Fork, averaging 5.8 per 100 m (93.3 per *mil.* Pool frequency in Pine Creek clearly meets the INFlSH standard of 4.7/ 100 m, but the majority of the pools were 0.46 m (1.5 *tt)* deep or less (Figure 8). There were almost no pools at least 0.46 m deep in the upper reaches of Pine Creek, as seen in the table below. The mean ratio was 24.6, very close to that of the West Fork. The width-to-depth ratio is still higher than may be desired for ideal salmonid habitat. The extreme low flow conditions affected this ratio in both the West Fork and Pine Creek.

Table 13. Distribution of Pine Creek Pools by Depth Category and Stream Reach, October, 2001

Pine Creek	Number of Pools by Maximum Pool Depth			
Reach	1.5 - 2.0 ft	2.0 - 2.5 ft	2.5 - 3.0 ft	3.0 - 3.5 ft
1	3	0	0	0
2	3	1	0	0
3	3	2	1	0
4	4	2	1	0
5	0	0	0	0
6	0	1	0	0
7	0	0	0	0

Table 14. Summary of Pine Creek Habitat Statistics by Reach, Jarbidge River Fisheries Study, 2001

	Pine Creek Habitat Survey Reaches								
Variable	P1	P2	P3	P4	P5	P6	P7	**Mean**	S.D.
Habitat Unit Length (m)	33.9	40.6	48.8	29.3	75.7	73.6	75.2	53.9	20.49
Habitat Wetted Width (m)	3.7	4.0	2.8	2.4	2.8	2.8	1.7	2.9	0.74
Habitat Area (m2)	133.2	159.5	143.3	72.2	230.5	189.4	153.7	154.5	48.96
Habitat Mean Depth (m)	0.2	02	0.2	0.2	0.1	0.1	0.1	0.1	0.04
Habitat Maximum Depth (m)	0.6	0.6	0.7	0.5	0.0	0.6	0.4	0.5	**0.22**
Habitat Volume (m3)	19.1	21.9	19.9	8.4	23.8	15.8	12.3	17.3	5.46
Percent of Reach as Fast Habitat	88.9	89.7	93.3	85.9	98.0	98.8	95.3	92.8	
Percent of Reach as Slow Habitat	11.1	10.3	6.7	14.1	2.0	1.2	4.7	7.2	
Percent of Reach as Riffle Habitat	85.4	89.2	88.8	84.1	95.7	97.1	95.3	90.8	
Pocket Pools *(n/100m)*	4.4	7.0	4.8	4.5	3.6	1.4	3.0	4.1	1.72
Pocket Pool Depth (m)	0.3	0.4	0.4	0.3	0.3	0.3	0.9	0.4	0.22
Residual Maximum Depth (m)	0.4	0.2	0.5	0.4	0.0	0.4	0.4	0.3	0.18
Width/depth Ratio	25.5	26.6	19.6	19.6	28.4	30.1	22.3	24.6	4.18
Number of Large Class *LWD/I00* m	025	02	0.2	0.2	0.7	0.3	0.0	0.25	0.20
Total Number of Pieces LWD *1100* m	3.1	1.2	2.4	1.2	3.7	3.0	1.1	2.26	0.99
Number of Pieces *LWD/aggregate*	3.0	3.9	3.8	5.5	4.2	4.0	2.4	3.8	0.96
Number of LWD Aggregates *1100* m	0.8	1.3	1.2	1.2	1.3	1.4	1.0	1.2	0.23
Rootwad LWDI100 m	0.1	0.2	0.0	0.2	0.0	0.0	0.0	0.1	0.08
Percent Stable· Lell Bank	78.8	87.8	82.2	88.1	72.5	86.7	72.5	81.2	6.85
Percent Stable· Right Bank	81.9	77.1	81.1	74.3	72.2	51.4	72.2	72.9	10.26

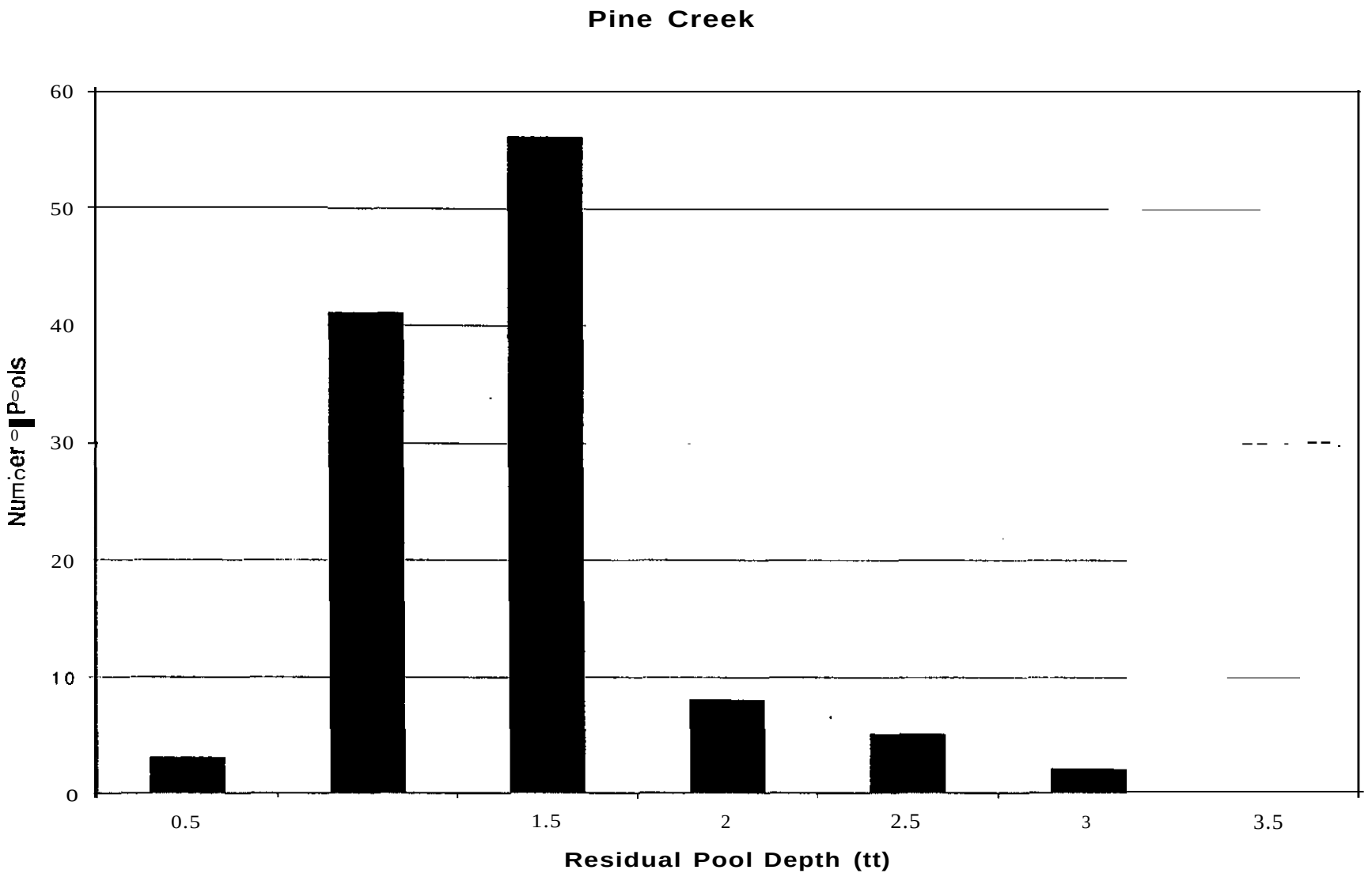

Figure 8. Depth Distribution of Pine Creek Pools, October, 2001.

A total of seven Wolman pebble counts were conducted along Pine Creek. The surface sediments were dominated by pea gravel, gravel and rubble. In general, there was a greater range of substrate size in Pine Creek compared to the West Fork, especially among the upper reaches of Pine Creek. Lengthy channel segments in Reaches P6 and P7 had relatively high proportions of coarse sand or fine pea gravel as seen in Photograph 34, Roll 14, October 15, 2001 (supplemental photo file). These substrate conditions are not adequately captured by the pebble count data (see Table 10). Small boulders comprised as much as 35% of the surface material in Reach P6, while P7 contained 70% pea gravel. (The low number of pebble counts taken in Pine Creek should be borne in mind [Bunte and Abt 2001] when considering extrapolation of these percentages.)

Larger LWD pieces meeting INFISH standards were generally absent in Pine Creek (see Table 11). The average LWD dimensions were 6.1 m (20.1 ft) long by 0.24 m (0.8 ft) in diameter. As observed on the West Fork, a low proportion (1.71%) of the LWD was submerged under the low water conditions. ROotwads were much less as abundant or dense than on the West Fork.

Areas of bank instability "along Pine Creek were associated with natural events and geologic features. There was little variability (72.2 to 88.1%) in bank stability between the seven reaches, with one exception. Right bank stability was low (51.4 %) overall in Reach P6 due to high, naturally-eroding banks in that area (see Table 12).

4.2 FISH SURVEYS

4.2.1 West Fork Jarbidge River

Special attention was paid in the headwater areas to determine the upstream limit of fish presence. An obvious barrier to upstream fish passage was noted in Reach W11 at about elevation 2353 m (7720 ft) (Photograph 28, Roll 6, October 13, 2002). A UTM location was obtained about 15 m (50 ft) north of these falls on the talus hillside: 633615, 4627942. Each step pool was surveyed from this point downstream to the confluence with an unnamed left bank tributary (upper end of Reach W10), and no fish were observed. There were numerous bedrock cascades and wood jams in this reach that were deemed barriers to upstream fish passage (see supplemental photographs). Most step and pocket pools in the next 590 meters (645 yds) of Reach WI0 were surveyed, and again no fish were observed. The first trout, a redband trout <5 em «2 inches), was seen in Unit 37 of Reach W9 at UTM 632775, 4628923. Since fish were not seen above putative barriers located near the top of Reach WI0, habitat surveys were not extended into Reach Wll.

A total of 173 redband trout were observed within the 11 stream reaches of the West Fork (Table 15). However, no bull trout were observed. Four mountain whitefish were observed in Reach 2, ranging in size from 5 to 25 em (2-10 inches). Three sculpins were also observed, although no length estimates were made.

Table 15. Stream Reach Lengths and Fish Densities,
Jarbidge River Fisheries Survey, October, 2001.

				Fish Observations			Fish Density	
Reach	Reach Length (m)	Cumulative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #!100m	Bull Trout #!100m
West Fork								
W1	702	42	39	7	0	0	18.1	0.0
W2	3114	197	181	64	0	4	35.5	0.0
W3	1588	74	68	5	0	0	7.4	0.0
W4	603	19	17	1	0	0	5.8	0.0

Table 15. Stream Reach Lengths and Fish Densities, Jarbidge River Fisheries Survey, October, 2001 (Continued).

				Fish Observations			Fish Density	
Reach	Reach Length (m)	Cumulative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #/100m	Bull Trout #1100m
West Fork (cont'd)								
W5	1514	111	102	15	0	0	14.7	0.0
W6	1173	66	60	18	a	0	29.8	0.0
W7	1335	25	23	44	0	a	195.1	0.0
W8	1433	NO	ND	15	0	a		0.0
W9	1433	NO	NO	4	0	a		0.0
WI0	590	NO	NO	0	a	a	0.0	0.0
WI1	640	NO	NO	a	a	a	0.0	0.0
Totals:	14,124	534	489	173	0	4	35.4	0.0
Pine Creek								
P1	1184	62	57	2	a	a	3.5	0.0
P2	1207	32	29	6	a	a	20.5	0.0
P3	2175	43	39	17	a	a	43.2	0.0
P4	1102	NO	NO	4	1	0		
P5	757	28	25	8	a	a	31.6	0.0
P6	662	9	8	0	a	a	0.0	0.0
P7	527	NO	ND	6	0	a		
Totals:	7,613	174	158	43	1	0	20	0
East Fork								
E1		92	84	21	0	1	25.1	0.0
E2		76	69	46	a	2	66.2	0.0
E3		49	45	22	a	0	49.1	0.0
E4		42	38	15	a	0	39.1	0.0
E5		26	24	31	a	a	130.4	0.0
E6		28	26	43	a	2	167.9	0.0
E7		38	35	31	0	a	89.2	0.0
E8		73	67	30	a	9	44.7	0.0
E9		52	48	49	a	10	103.1	0.0
E10		49	45	44	0	1	96.9	0.0
E11		52	48	15	a	1	31.3	0.0
E12		61	55	39	a	3	70.3	0.0
E13		124	113	50	a	a	44.2	0.0
E14		44	40	41	0	5	101.9	0.0
E15		56	51	49	1	0	95.7	2.0
E16		31	28	10	0	a	35.3	0.0
E17		38	35	25	a	0	71.9	0.0
E18		69	63	38	1	0	60.2	1.6

Table 15. Stream Reach Lengths and Fish Densities, Jarbidge River Fisheries Survey, October, 2001 (Continued).

				Fish Observations			Fish Density	
Reach	Reach Length (m)	CumUlative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #/100m	Bull Trout #/100m
E19		47	43	26		0	60.5	2.3
East Fork (conl'd)								
E20		46	42	8	0	0	19.0	0.0
E21		36	33	22	0	0	66.8	0.0
E22		45	41	27	1	0	65.3	2.4
E23		34	31	35	2	0	112.6	6.4
E24		31	28	3	0	0	10.6	0.0
E25		42	39	2	4	0	5.2	10.4
E26		36	32	0	2	0	0.0	6.2
		1316	1204	722	12	34	59.9	1.0

The redband trout in the West Fork ranged in estimated length from <5 em (2 inches) to >25 em (10 inches), with 62% <10 em (4 inches). The length frequency histogram was skewed towards smaller fish when compared to that seen in Pine Creek and the East Fork (Figure 9). The cause of this difference is largely a matter of speculation, but could indicate relatively greater reproductive success in the West Fork, greater mortality of older redband trout, or a lack of pool area to support larger fish. Estimated abundance ranged from 5.8 to 195.1 redband trout/lOa m (mean 35.4 trout/loa m).

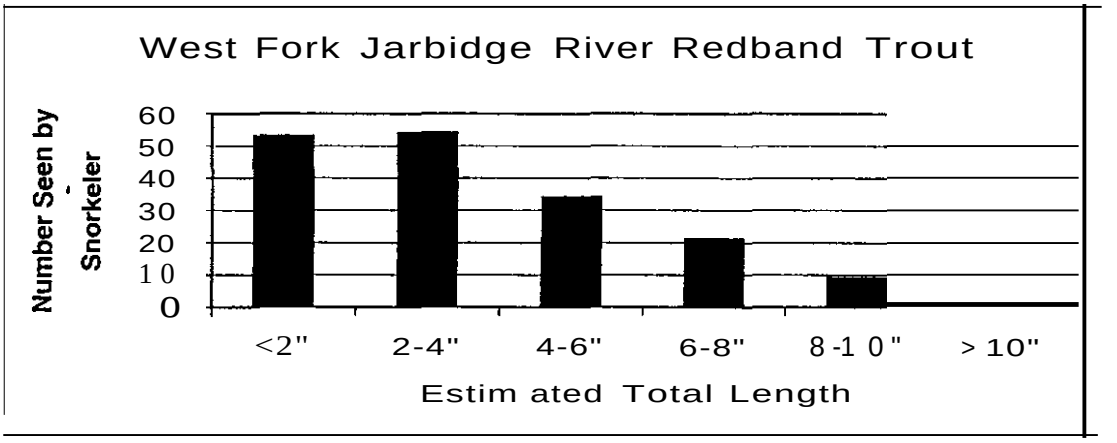

Figure 9. Categorical Length Frequency of West Fork Jarbidge River Redband Trout, October, 2001.

4.2.2 Pine Creek

A total of 43 redband trout and one bull trout were observed along the seven stream reaches of Pine Creek (see Table 15). There were four observations of sculpins, but no mountain whitefish were observed. The redband trout ranged in estimated length from <5 cm (2 inches) to 25 cm (10 inches), with 32% of the fish <10 cm (4 inches). Redband trout abundance ranged from 3.5 to 43.2 redband trout/l00 m (mean 20.8 trout/100m). The length-frequency histogram indicates a more normal population size structure than the West Fork, but is limited in sample size (Figure 10).

The single bull trout (10-15 cm [4-6 inches] in size) was observed in a run habitat unit in Reach P4 (elevation -2225 m [7300 ftD, approximately 5.2 km (3.2 mil upstream from the confluence with the West Fork. However, no accurate estimate of bull trout abundance or density can be generated because the snorkel distance was not recorded for this reach.

4.2.3 East Fork Jarbidge River

Over 21 km (13.15 mil of the East Fork were surveyed for fish. A total of 722 redband trout, 12 bull trout and 34 mountain whitefish were observed in the 26 reaches (see Table 15). There were also two observations each of sculpins and bridgelip suckers.

The redband trout ranged in estimated length from <5 cm (2 inches) to >25 cm (10 inches), with 14.7% <.10 cm (4 inches). Redband trout abundance ranged from 0.0 to 167.9 fish/IOO m (mean 59.9 fish/l00 m). The length-frequency histogram suggests there may be some limitations on redband reproduction in the East Fork (Figure 11).

The bull trout ranged in size from <5 cm (2 inches) to 20-25 cm (8-10 inches), with only one fish <10 cm (4 inches) and fish in the 15-25 cm (6-10 inches) size class were most abundant (66%) (Figure 12). Abundance estimates ranged from 0.0 to 10.4 fish/l00 m (mean 1.0 fish/l00 m). Bull trout were most abundant in the upper reaches of the East Fork; 75% of the bull trout observed were seen above 2100 m (6900 ft) elevation. There were no observations of bull trout below elevation 1951 m (6400 ft).

Mountain whitefish were observed in most reaches below 1950 m (6400 ft). The estimated size range of the mountain whitefish was 5 to >30 cm (2 to >12 inches).

4.3 BULK SEDIMENT SAMPLES

A total of 45 bulk sediment samples were collected along the West and East forks (Table 16). One sample collected at station WF-4 (sample #31) was discarded because the sample core was strongly biased by a root mass from the adjacent riparian vegetation. sediment samples from the four West Fork sites contained a mean of 7.1 % fine sediments «0.85 rom) and 85.3% >2 rom (see Section 5.3). With the exception of Sample #1 at Site WF-l, the WF-4 outlier, and three samples potentially affected by the channel change (see below), most samples had low to very low percent fines <0.85 mID (2.1 - 8.7 %). Since most of the replicate samples were taken from potential spawning sites, we conclude that spawning gravel in the areas sampled should support relatively high egg-to-fry survival rates, based strictly on substrate composition (Chapman 1988; Waters 1995; Kondolf 2000). Visual observations of gravel quality in most potential spawning areas surveyed in all three streams appeared similar to the bulk sample sites in terms of surface fines and embeddedness.

Analysis of variance of the <0.85 rom sediment size percentages revealed that the higher fines fraction (14-18.2%) at the junction of the old channel with the relocated channel (Site WF-2) relative to sites both upstream and downstream was statistically significant (Appendix D). The statistical analysis was repeated with the three "old channel face" samples removed to determine if the increase in percent fines was a highly localized phenomenon. This analysis resulted in statistically indistinguishable levels of percent fines among any of the five sampling sites.

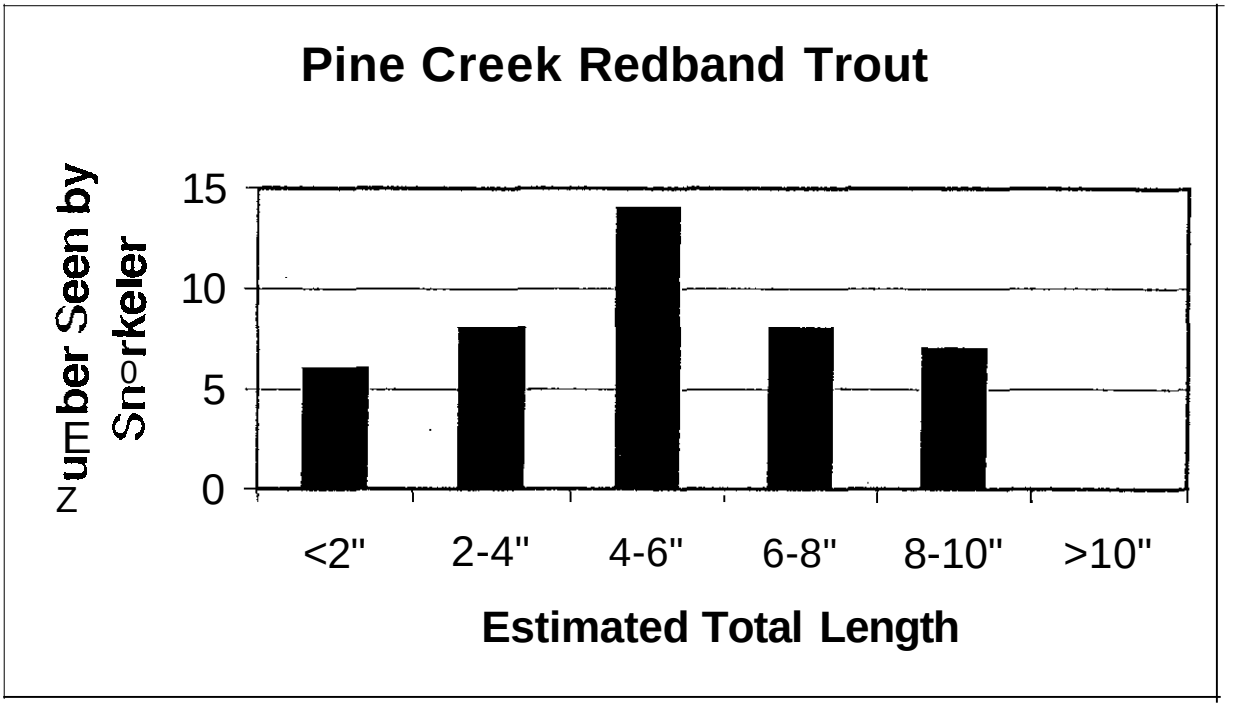

Figure 10 Categorical Length Frequency of Pine Creek Redband Trout, October, 2001.

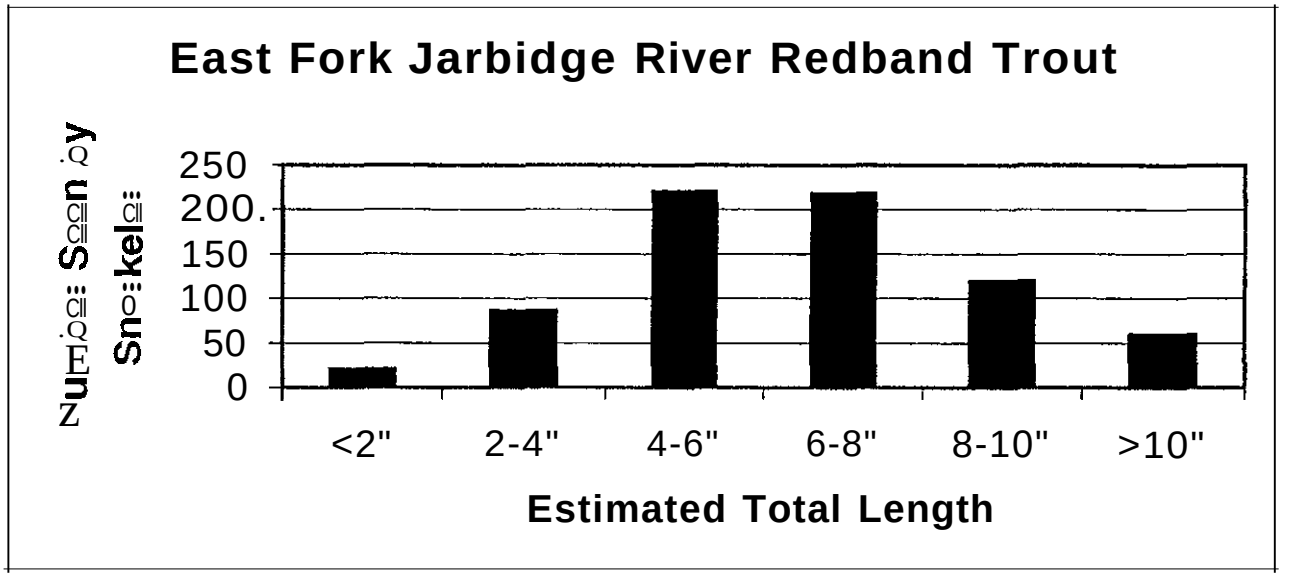

Figure 11. Categorical Length Frequency of East Fork Jarbidge River Redband Trout, October, 2001

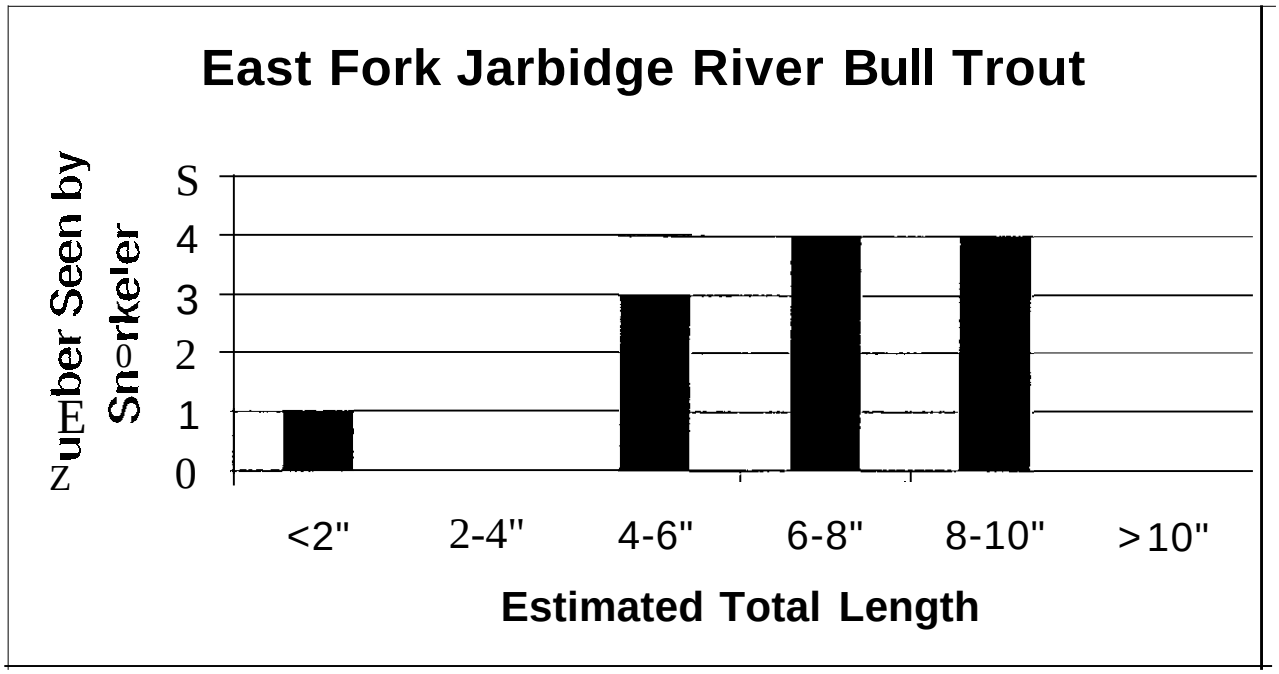

Figure 12 . Categorical Length Frequency of East Fork Jarbidge River Bull Trout, October, 2001.

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001.

Site Number	Site Description	Sample Number	Percent .85-2mm	Percent <.85mm
WF-1	Upper WF··Conlrol"	1	15.45	27.23
		2	5.96	7.76
		3	8.71	7.60
		4	5.10	2.14
		5	5.64	4.43
		6	5.41	4.02
		7	6.60	8.05
		8	6.31	7.79
		9	9.01	4.51
		Averages:	7.58	8.17
		SO	3.26	7.46
WF-2	Channel Relocation Site	10	12.32	8.16
		11	5.66	5.75
		12	13.65	18.15
		13	8.85	17.18
		14	7.66	14.01
		15	7.04	3.93

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001 (Continued)

Site Number	Site Description	Sample Number	Percent .85 -2 mm	Percent <.85mm
WF-2 (con't)		16	13.21	8.68
		17	8.95	6.53
		Averages:	9.67	10.30
		SO	3.01	5.42
WF-3	Lower Campground Site	18	9.00	10.21
		19	7.92	7.83
		20	9.53	4.87
		21	11.17	6.16
		22	9.80	6.58
		23	4.02	3.26
		24	2.77	3.67
		25	5.18	6.20
		Averages:	7.42	6.10
		SO	3.05	2.26
WF-4	Bridge Below Pine Creek	26	4.01	4.99
		27	3.40	4.21
		28	4.12	3.18
		29	5.43	5.86
		30	5.22	4.71
		31	14.76	13.94
		32	4.04	6.67
		33	3.95	3.95
		Averages:	5.62	5.94
		SO	3.76	3.41
Deleting Sample #31:		Averages:	4.31	4.80
		SO	0.74	1.18
EF-l	East Fork Jarbidge - 'Controls'	34	5.60	2.60
		35	10.12	7.34
		36	6.99	4.24
		37	4.66	4.25
		38	10.10	7.01
		39	7.87	3.88
		40	8.98	4.66
		41	9.91	4.14
		42	5.19	2.98

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001 (Continued)

Site Number	Site Description	Sample Number	Percent .85 - 2 mm	Percent <.85 mm
EF-1 (can't)		43	8.99	6.31
		44	5.60	4.98
		45	8.71	5.75
		Averages:	7.73	4.84
		SO	2.04	1.49

5.1 HABITAT SURVEYS

The habitat survey indicates that West Fork and Pine Creek contain adequate, although not ideal habitat for bull trout. A primary detenninant of suitable bull trout habitat is often considered to be the thermal regime (Dunham and Chandler 2001; NDoW 2000). The substantial number of fish and habitat studies conducted in the Jarbidge watershed unequivocally demonstrate, directly or indirectly, that the thermal regimes of the West Fork and Pine Creek are generally suitable for bull trout (Lawson and Pfeifer 2002). However, there are locations and times of the year when water temperatures probably limit bull trout movements or utilization of rearing habitat (McNeill et a1. 1997). This survey did not sample at a time of year when temperature may be problematic. The purpose of this report is to identify and describe the physical habitat, beyond temperature, available to fish utilizing these two streams..

Several studies have described habitat features thought to be beneficial to bull trout utilization (Table 17). Dambacher and Jones (1997), cited in Dunham and Chandler (2001), indicate important habitat variables include percent gravel, percent fines, LWD frequency and volume, and percent undercut banks. Other authors have indicated that bull trout distributions are influenced by the presence of other salmonids (e.g. Watson and Hillman 1997). INFISH riparian management objectives (USFS 1995; Ramsey 1997) provide habitat criteria for pool frequency, LWD, and width-to-depth ratio.

Table 17. Authorities and Habitat Variables Important to Bull Trout

Study	Variables listed as beneficial to bull trout habitat
Dambacher and Jones (1997)	Percent Gravel, Percent Fines, Percent Bank Erosion, Percent Undercut Bank. LWD Frequency, LWD Volume
Watson and Hillman (1997)	Undercut Bank, Other Salmonids, Large Substrate (low fines), Pools
INFISH, USFS (1995)	Pool Frequency, LWD Frequency, LWD Size, Width-to-Depth Ratio

Because of the lack of bull trout observed on the West Fork and Pine Creek, and the lack of habitat data on the East Fork, it is not possible to make direct comparisons between habitat characteristics and bull trout abundance or distribution in this study. However, it should be noted that the majority of bull trout observed on the East Fork were concurrent with the fewest observations of redband trout. This observation is in agreement with the predictions of Watson and Hillman (1997) who found that bull trout abundance was often inversely correlated with brook and/or redband trout abundance.

5.1.1 Substrate Quality

The pebble counts taken during the habitat study and the bulk sediment samples generally characterize the substrate quality in the West Fork and Pine Creek. The bulk sediment samples and the pebble counts indicated a low fraction of fine materials in the substrate. The percent of fine «0.85 mm) materials in the bulk sediment samples (7.1%) and the fraction of sediment <2 mm from pebble counts (5.7%) exceed the criteria for high quality bull trout habitat «8%) given by Dambacher and Jones (1997). The pebble counts along the West Fork and Pine Creek were dominated by gravel and rubble and should provide suitable substrate for bull trout spawning. Careful observation of potential spawning sites in the headwater areas during the survey suggested there is a significant amount of suitable gravel for bull trout spawning, but we did not quantify the area of this habitat, nor did we sample these sites below the substrate surface. Without seeing spawners on redd sites, it is very difficult, if not impossible to locally quantify what is or is not useable spawning area by bull trout that have exacting spawning requirements.

The relative abundance of potential spawning area is based on the senior author's years of experience conducting bull trout spawning surveys in Washington.

Sites selected for spawning by resident or fluvial bull trout are expected to be protected from scour, in clean, well-irrigated coarse sand or small gravel ranging in size from roughly 5-8 mm up to about 35 mm, depending on spawner size. Some stocks also utilize sites that include some cobble 50 mm or larger (Goetz 1989). Areas with groundwater influence are often used preferentially. Confined channels with moderate gradients often present conditions where char or trout must utilize appropriately sized substrate that is only found in pockets or small patches, often in areas of reduced velocity or hydraulic energy. We tended to see these general bull trout spawning site conditions stochastically distributed throughout most of the reaches surveyed from Jack Creek to the headwaters. Therefore, it was impossible to define the boundaries of bull trout spawning habitat without gaining feedback by seeing spawners from the locally adapted population choose their preferred sites. In general, bull trout spawn in extreme headwater areas within river basins, and the information on bull trout fry production collected by Johnson (2001. Personal Communication) tends to indicate this pattern in the Jarbidge River forks as well. However, other populations spawn in 2'" or 3" order river mainstems well below the headwaters, even though access to the headwaters is not blocked (e.g. Cedar River above Lake Chester Morse, Lake Washington drainage, King County, Washington). Bull trout use of lower Jarbidge River tributaries such as Dave Creek, Slide Creek, and Jack Creek suggest the potential for lower spawning in the West and East Forks proper, although this has not been documented to date. If bull trout naturally choose to spawn only in higher headwater areas in the Jarbidge River forks, this may be a response to somewhat more limiting thermal or hydraulic regimes in the mainstems at lower elevations.

5.1.2 Large Woody Debris Abundance

Other variables identified as critical to quality bull trout habitat include the frequency and size of LWD although there is substantial variation in the guidelines. INFISH riparian management objectives indicate that good quality habitat should have more than 20 LWD pieces per mile (l1l00 m) of the larger size classes, while Dambacher and Jones (1997) suggests a frequency of at least 25 pieces/100m for "high" quality habitat. However, Dambacher and Jones (1997) describe habitat needs in Oregon, where both the sources of LWD and the need for LWD (for controlling erosion rate in higher flows) are greater. Only 1 of the 17 stream reaches surveyed on the West Fork and Pine Creek had large LWD present at 1.0 piece / 100 m or more (Reach W6). There was a distinct lack of this size LWD elsewhere, and the mean occurrences for all reaches of the, West Fork and Pine Creek were 0.48 and 0.25/100 m, respectively. Therefore, it appears that the frequency of larger LWD observed in this study a potential habitat deficiency for bull trout. This presumes that the larger (Class 7 and 8) LWD abundance guidelines cited above are appropriate for high elevation streams in northeast Nevada. When all sizes of LWD are considered, the number of pieces/lOO m is greater than the INFISH goal of 1.0 /lOOm for both streams (see Tables 9 and 14).

A 1996 habitat study along the West Fork (Ramsey 1997) documented a frequency of larger LWD of2.41 pieces / 100m (n=31 pieces) for portions of Reach W8. This study documented only seven large pieces (0.54 / 100 m). We cannot explain this very large difference between statistics reported for 1996 and 2001. A possible cause might be differences in the physical start and end points of the surveys between the years. The large wood deficit in the Jarbidge River forks is noted in several recent reviews (e.g. Ramsey 1997). Past logging and citizen access to the wood for firewood collection have been noted as probable causes of the lack of large wood (McNeill et al. 1997).

LWD jams were common, particularly in the wilderness portions of the West Fork and Pine Creek. This is reflected in part by the very similar values for the number of aggregates/lOO m in the upper reaches of both of these streams (see Tables 9 and 14) - generally around 1.1-1.4/ 100 m. Few, if any of these were

judged to be likely barriers to upstream fish passage. However, a notable exception was two relatively large jams fully spanning the East Fork at about elevation 2150 m (7060 ft) in Reach E23 (Roll 18, Photographs 14-17, October 19, 2001). Both bull trout and redband trout were observed above these jams, but all were less than 25 cm (10 inches), and all of the bull trout were less than 10 cm (8 inches). One 25-30 em (10-12 inch) bull trout was holding in a pool immediately downstream of the lower jam. The stream had a 2.4 m (8 ft) vertical drop to this pool at the low flow condition. Upstream passage at this site is problematic, and should be surveyed during higher flows, particularly when fluvial bull trout may be moving upstream.

5.1,3 Large Woody Debris Size

Only a fraction of the LWD surveyed is in accordance with the INFISH size objectives for LWD piece density. INFISH recommends that the diameter of the LWD be >30 em (12 inches) and >9.1 m (30 feet) in length, Although some wood certainly was seen in 2001 that met these criteria, the reach means were below, or well below 30 em for all reaches except WI and W4 (see Table 14). Average LWD piece diameters ranged from 20 to 30 em (8 to 12 inches) on the West Fork, and 20 to 28 em (8 to II inches) on Pine Creek. The lack of larger wood is again probably largely due to historic logging, slow growth of new riparian timber, and firewood collection (McNeill et aI. 1997).

5,1.4 Pools and Bank Conditions

INFISH management objectives recommend a pool frequency of approximately 4.7 pools per 100 meters based on a wetted width of 4.3 m (14.25 ft) (Ramsey 1997). In the present survey we documented an average of 4.6 pools !lOO m in the West Fork and 5.8 pools *!100m* in Pine Creek. Most of these pools were relatively shallow due to the low flow period.

The extent of undercut banks along the West Fork (12-14%) exceeded the benchmark (>II%) for high quality bull trout habitat suggested by Dambacher and Jones (1997). However, there was very little undercut bank habitat along Pine Creek (<1%). The primary reason for the limited undercut banks on Pine Creek is likely a result of the geomorphology of the stream. The bedrock formations and large boulders common along Pine Creek are not conducive to the development and maintenance of large expanses of undercut banks.

The sources of bank erosion were not similar between the West Fork and Pine Creek. Major sources of bank erosion on the lower reaches of the West Fork were primarily associated with road fill and mine tailings. There was also a significant area of bank instability or erosion associated with the rechannelization work in Reach W6. Along the upper reaches of West Fork and along Pine Creek, bank instability or erosion was associated with natural events such as landslides and washouts, or simply steep erosive soils exposed to river toe cutting. The tally of bank erosion sites provides a rough index of the relative amount of conspicuous bank erosion, but this study was not designed to quantify sources of sediment or the area of banks being eroded. Twenty-one West Fork surveyed habitat units (5 percent) and four Pine Creek units (2.3 percent) had notable bank erosion points (see Table 12). These translate to 1.49 sites/km (2.4/mi) and 0.53/km (0.85/mi) in these streams, respectively, for a preliminary guideline on the frequency of significant erosion sites.

Bank erosion sites are also often sources of smaller sediment that is needed for spawning material by the fish community. Significant fine sediment accumnlations were generally not seen in this survey except in some pools or other slow-water habitat. Given the apparent capability of the West Fork and Pine Creek to mobilize and transport fines from faster water habitat (pool tailout riffles, bar edges; see Section 4.3), bank erosion does not appear to be a significant factor potentially limiting bull trout reproduction. This sediment source may even be essential to retain a supply of the smaller grain sizes for pocket spawning

habitat (but see further discussion in Section 5.3). Direct or indirect evidence of bull trout spawning has only been documented in headwater areas of the West Fork, primarily above Sawmill Creek (Johnson 1999,2001), but we did not note any substantial bank erosion points in these locations (Table 12).

5.2 FISH SURVEYS

5.2.1 Bull Trout Abundance

There have been several fish surveys conducted on the Jarbidge River watershed over the past 45 years (Appendix Table C-I) using a variety of collection methodologies and occurring at different times of the year, making direct comparisons among the findings difficult. The present study is unique in timing. coverage, and methodology. For example. of the 31 fish surveys conducted in the West and East Forks, only eight utilized snorkeling methods. and each of these were conducted during the summer months. This survey was conducted from October 9-21, 2001. No studies along Pine Creek have utilized snorkeling. With this caveat in mind. our findings concur with several of the general observations previously reported. Those surveys showed that bull trout are present in relatively low numbers along the East and West Forks and their tributaries. that bull trout occurrence is generally greater at higher elevations, and is also greater in the East Fork than in the West Fork (e.g. Parrish 1998; Johnson 1999).

The apparent absence of bull trout in the West Fork and their extremely low abundance in our survey of Pine Creek are most likely a result of the timing of the survey, and not necessarily an indication of true abundance or habitat use. Bull trout commence spawning when water temperatures drop to approximately 7_9° C (44.5-48° F) (Goetz 1989). Since spawning can be completed in a few days. it would be easy for us to have missed members of a small fluvial spawning population. Goetz (1989) reports studies of populations where spawning was completed in 4-6 days, and where females moved downstream after spawning. We saw no paired up bull trout, or any obvious redds. However, the substrate conditions in the likely spawning areas would make detection of redds quite difficult unless they were either very fresh, or spawners were nearby.

The morning water temperatures in the West Fork and Pine Creek decreased to 4.4-7.2° C (40-45° F) prior to beginning this survey. and a majority of the migratory bull trout might have already spawned and moved downstream, beyond the lower reaches of the survey. In particular. water temperatures ranged from 3.3-6.1° C (38-43° F) in the known bull trout spawning areas in the headwater areas. The resident fish and young of the year had probably moved into the substrate and deep into cover. rendering them unobservable to the snorkelers. In fact, a brief electrofishing survey (covering about 90 m of stream) conducted by NDoW and USFS personnel on the West Fork (near Dry Gulch) shortly after our survey produced three bull trout. The surveyors reported that the fish were deep in substrate cover and difficult to capture (Amy 2001. Personal communication). Therefore, the low abundance of bull trout observed in the West Fork and Pine Creek in this study should not be interpreted as accurately representing true population size, and likely underestimates abundance due to sampling difficulties inherent in daytime snorkeling and the cold water temperature (Peterson et al. 2001).

The greater number of bull trout observed in the East Fork may be due to one or more factors. Stream temperatures may have warmed somewhat in the East Fork by the time we conducted our snorkel surveys. The observed temperature at midday in the headwaters (5.6° C or 42° F) was several degrees warmer than what we encountered in the West Fork at a similar time and elevation (3.3-4.4° C [38 - 40°F]) (see Table 7). We noted that the far more abundant redband trout were more active in the afternoon, with more individuals venturing out from deep cover and feeding as stream temperatures approached 7.5° C (45° F) or higher. Movement out of refugia with stream warming may partly explain seeing more bull trout in the East Fork than in the West Fork or Pine Creek.

Despite the potential effect of water temperature on our study results, the East Fork may simply support a larger bull trout population size than the West Fork. Johnson (1999) and Johnson and Weller (1994) both suggest a greater population density in the East Fork relative to the West Fork. In addition, the East Fork is less impacted by anthropogenic influences due to its remoteness, both in terms of fishing pressure and habitat manipulations. Our total count of bull trout and their observed density in the three streams very likely under-represent their abundance at other times of the year regardless of the actual proportions of resident and fluvial life histories. The source of this probable bias is the late date of the survey, low stream temperatures, and the use of daytime versuS nighttime snorkeling methodology (Peterson et al. 2001). We believe a more accurate estimate of bull trout population size, including the fraction of spawning adults, can be obtained by a sampling design using at least some night snorkeling in combination with foot and daytime snorkeling surveys. This should be initiated as stream temperatures begin to drop to 9° C (48.2 ° F) in the fall as compared to the <6° C (42.8° F) temperature of our surveys.

5.2.2 Bull Trout Distribution

The bull trout distribution observed in the East Fork during the present survey is consistent with previous studies despite differences among survey methodology and timing. With the exception of Partridge and Warren (2000), all reported observations of bull trout occurred at elevations greater than 2134 m (7000 ft) in elevation. In addition, Warren and Partridge (2000) sampled fluvial fish using a weir upstream of the confluence of the East and West Forks in Idaho, and their findings are not comparable to the other surveys. *USFS/NDoW* (1993) located four bull trout from elevations 2219-2301 m (7280-7550 ft) and Johnson (1999) observed eight bull trout at elevations greater than 2316 m (7600 ft). Both of these studies sampled from at or below Robinson Creek (elev. 1783 m or 5850 feet) to the headwaters. A single site was electrofished by NDoW (2000) at 2243 m (7360 ft), and spot shocking slightly upstream revealed the presence of seven bull trout. In the present study, 75% of the bull trout were observed at or above this elevation. To our knowledge, we report the scientific observations of bull trout at the lowest elevation (1951 m [6400 ft], Station E-15) in the Jarbidge River system.

There is a slight indication of an increase in fish length below 2134 m (7000 ft). Bull trout collected below 2134 m (7,000 ft) ranged in estimated length from 15-25 cm (6 to 10 inches), while fish collected above 2134 m (7,000 ft) ranged in estimated size from <5 to 10 em (2 to 8 inches). This shift in size range suggests that perhaps the lower elevation fish were or included fluvial migrants, and the fish above 2134 m (7,000 ft) represent resident and young of the year fish. However, the limited number of fish observed, especially below 2134 m (7000 ft), limits the of this inference.

In addition to the uncertainties associated with the sampling methodologies, we collected little or no habitat information in the East Fork. Therefore, we are unable to detennine if habitat availability is influencing bull trout distribution and abundance among the three fish sampling areas.

5.2.3 Redband Trout and Other Fish Species

Redband trout were observed throughout all stream reaches surveyed, however the number of redband trout observed was lower in the upper-most reaches of all three streams. Mountain whitefish were observed in both the East and West Fork but there were no observations of whitefish in Pine Creek. The mountain whitefish observations were confined to the lower reaches of the streams (below 1950 m). Other fish species observed during the survey were bridgelip suckers (low numbers in East Fork only) and sculpins (all streams).

5.3 SPECIAL SEDIMENT SAMPLING

In the Jarbidge River system, the accumulation of fine-grained sediments in potential spawning areas does not appear to be a problem due to the system's ability to flush fines downstream (Ramsey 1997; Warren and Partridge 1993). The bulk sediment samples obtained in this study confirm this finding. Analysis of the bulk sediment samples indicated that substrate quality in the West Fork near Pine Creek is generally high, and should pose no limitation on egg-to-fry survival for salmonids. The percentage of fines averaged 7.1% among the four sites sampled. There was a localized site with an increased fraction of fine sediments in the area of the old channel adjacent to Pine Creek Campground. These may have been deposited during the earlier heavy equipment work in the original channel, and have not been scoured out despite being exposed to flow in the new channel. Although most of our samples were low in fines, there are likely other areas in eddies and behind boulders or other structures where the percent fines is higher, similar to what we observed at this site. The salient point of our samples, we believe, is that most of the sites sampled were low in fines <0.85 mm, and these sites were in part chosen for sampling based on their potential as spawning sites by trout or char species.

Kondolf (2000) noted in his recent review of salmonid spawning gravel assessment that field and laboratory studies of the effect of interstitial sediment on salmonid egg to fry survival varies both in terms of the sediment size threshold examined, and the resultant effect. Selection of the 0.85 mm threshold is largely arbitrary, and was originally based on the early work of McNeil and Ahnell (1964). It is largely an artifact of the Tyler sieves used in that study, and it does not correspond to a break in size classes found on the standard Wentworth (1922) scale, which has since been modified by others (Cummins 1962) for the convenience of fisheries workers (Bain 1999). Other researchers have proposed other measures such as the geometric mean diameter (Shirazi and Seim 1981) or fredle index (Lotspeich and Everest 1981) to obtain a more accurate reflection of the overall substrate size composition. However, as pointed out by Kondolf (2000), "gravel quality" is by nature highly variable and complex, making selection of a single variable descriptor problematic as a suitable index of salmonid egg to fry survival following spawning. Field and laboratory studies to date generally that egg and alevin survival falls below 50 percent when fines 0.85 mm or smaller more of the redd matrix (McNeil and Ahnell 1964; Koski 1966; Cederholm and Salo 1979; NCASI 1984; Tagart 1976). Results for coarser particles (e.g. < 2mrn) are less consistent (about 30% for 50% emergence; Koski 1966, 1975; Phillips et al. 1975), hence our choice of the smaller particle size cutoff. Empirical and quantitative field observations of the senior author of this report are consistent with the observation by Kondoif (2000) and others that redd site selection and the spawning action of bull trout, chinook, and steelhead are often major factors influencing the composition of the redd gravel after spawning. However, the fractions of particles <2 mm and <0.85 mm that we observed in potential spawning sites were both below levels that current literature suggests would yield egg to fry survival levels exceeding 75% or more (Hall and Lantz 1969).

Our visual appraisal and pebble count samples indicate spawnable gravel pockets and riffles in the upper West and East Forks and Pine Creek are generally low in [mes, and are considered good to excellent substrate for salmonid spawning. However, these conditions are not necessarily what will exist throughout the lengthy bull trout egg incubation period. Percent fines alone is an inadequate measure of gravel suitability throughout egg and alevin incubation (Reiser and White 1988; Kondolf 2000). Higher flows and higher suspended sediment levels during freshets or floods can infiltrate fines into constructed redds, and create conditions leading to low egg or alevin survival (Cooper 1965; Tagart 1976). Conversely, salmon and trout typically reduce, or liberate fines as part of their redd-construction process (Kondolf et al. 1993). Thus, some potential spawning sites with percent fines in the 10-15% range may still be rendered suitable for relatively high egg to fry survival after redd construction.

It is important to note that the results of our bulk sediment sampling should not be extrapolated to bull trout spawning areas without qualification and careful consideration. Bull trout spawning and young of the year have only been documented in headwater areas on the West and East Forks (Johnson 2001). We did not physically sample substrate in unequivocal bull trout spawning areas. We also emphasize that although streambed gravel in areas potentially suitable for spawning by bull and redband trout had generally very low fines content in the fall, that does not guarantee that redds are invulnerable to sedimentation during the lengthy egg and alevin incubation period, as noted above. Exposed road fill banks, mine tailings, and natural exposed soils are sources of such sediment during periods of increased stream height and erosive ability. Our study was not designed to sample known trout or char redds in a manner to determine whether this is a problem in the West Fork Jarbidge River.

Several general conclusions can be drawn from the results of this survey:

- Based on the timing and level of detail of habitat elements surveyed, the West Fork Jarbidge River and Pine Creek appear to have suitable habitat for bull trout spawning and rearing in the fall. Fluvial bull trout can likely utilize most of the surveyed areas with the possible exception of the East Fork above approximately elevation 2150 m (7060 ft). This survey revealed no obvious habitat limitations for bull trout apart from the possible limitation on upstream movement just noted. However, other studies suggest water temperature may limit bull trout movements or habitat utilization at times, particularly in the lower forks or mainstem Jarbidge River, or some tributaries. There was a possible deficiency in larger sizes of woody debris, but this did not appear to translate into a lack of pools per se. There was a general lack of deep pools. Whether this is a limitation on holding habitat for fluvial char, or rearing resident char was not determined.

- Measured substrate parameters along with careful observation indicate that the sediment composition throughout most of the West Fork and Pine Creek is consistent with generally high quality salmonid habitat. The introduction or retention of fine sediments as a result of the rechannellzation of the West Fork appears to be limited to the immediate channel change area.

- The limited number of bull trout observed during this survey was likely the result of the late date of the survey and associated cold water temperatures and does not represent an accurate measure of habitat use or population size.

Further information regarding the quality and utilization of habitat in the Jarbidge River watershed would be gained by:

- Conducting a fish survey prior to the onset of cold water temperatures (>9° C or 48.2° F).

- Fish surveys utilizing nighttime snorkeling.

- Habitat survey on the East Fork concurrent with fish survey.

- Monitoring scour and fines content of known bull trout redds or surrogate redds constructed in immediately adjacent, similar spawning habitat through the egg and alevin incubation period.

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APPENDIX A

RVR4 Survey Protocol Field Data Collection Forms

Appendix A: Inventory Data Forms

Rl/R4 Fish Habitat Inventory
FORM 1 Header Data

Stream: ___ Stream ID, ___

Trib. of, ___ Study/year' ___

Survey **Reach** #: ___ Reach Type: ___

Survey **Reach Lower** Boundary: ___

Survey Reach Opper Boundary: ___

Forest: ___ Code' ___

District: ___ Code' ___

Admin. Forest= ___ Code' ___

Admin. District: ___ Code' ___

Non-USFS **Inclusions** (Y/N): ___ **If** Y, Owner' ___

Ecoregion: Bailey: ___ Gross Geology, ___

Omernik: ___ Sub-geology, ___

EPA Reach Number: ___

EPA Reach Lower Boundary: ___

EPA Reach Upper Boundary: ___

Location, T R S___,___1/16_1/4 Base Quad, ___

Survey Lat: **Survey Long**: ___

survey Da.te: _____ **Chan.** Type: ___

Observer: _____ **Cover Group:** ___

Recorder: _____ Discharge: ___

Elevation: _____ **Confinement**: ___

Map Grad.; Weather: ___

Obs. Grad.: _____ **Wilderness:** ___

Comments: (Back side of form)

Note: Complete bolded variables in the field; complete all others prior to field work.

Discharge (Q) W x D x k x L / T ___ T W D ___ (Time. width, and depth **measurements for discharge calculation)**

T	s	k =		1	5 m	m
W	m	L	m	2	s m	m
D	m			3	s m	m
				Avg.	5 m	m

FORM 1 - Header Data (01/17/96)

UTM at top of Reach _____

R1/R4 Fish Habitat Inventory
FORM 2 - **Habitat Inventory Form**

:ream: _____ Reach #: _____ Page: _____
orest: _____ **Observer:** _____ **Date:** _____
i.strict: _____ **Recorder:** _____ **Weather:** _____

UTM·									
HABITAT UNIT #									
CHANNEL CODE									
SIDE UNIT #									
HABITAT TYPE									
LENGTH									
WIDTH									
AVG. DEPTH									
FAST TYPE									
# POCKET POOLS									
AVG. MAX DEPTH									
SLOW TYPE									
MAX DEPTH									
CREST DEPTH									
TP STEP POOL #									
TP # POOLS >lm									
TP AVG. MAX DP									
URFACE FINES %									
ubstrate Compo									
ank Length (L)									
ank Length (R)									
Length/Percent									
Stable (L)									
Undercut (L)									
Stable (R)									
Undercut (R)									
Chan·Shape (L)									
Chan Shape (R)									
Water Temp									
Air Temp									
Temp Time									
LWD SINGLES									
LWD AGGREGATES									
LWD ROOT WADS									
Riparian									
RCT1 (L)									
RCT2 (L)									
RCT1 (R)									
RCT2 (R)									
COMMENTS (X1									
snorkel Tally									

NOTE: **Capitalized variables** (except RCT1 and RCT2) are collected *in* **all reach types and side channels**

R1/R4 Fish Habitat Inventory
FORM 3 - Substrate Composition

Stream: Reach #: Date: Page:

Hab unit #	Method*	Fines <2mm	Small Gravel 2-8mm	Gravel 8-64mm	Small Cobble 64-128mm	Cobble 128-256mm	Small Boulder 256-512mm	Boulder >512mm	Bedrock

*WPC = Wolman pebble count (Measured)
EST = Ocular (Estimated)

R1/R4 Fish Habitat Inventory

FORM 4 - Large Woody Debris

Stream: ____________________ Reach #; ________ **Date:** ____________ Page: ________

Single Pieces			Single Pieces			Aggregates		Aggregates	
Hab **Unit. #**	Ln X Dia	% Submg.	Hab Unit #	Ln X Dia	% Submg.	Hab Unit #	# Pcs.	Hab Unit #	# Pes.

Rl/R4 Fish Habitat Inventory
FORM 5 - Comments

Stream' Reach #: **Date:** **Page:**

Hab. #	Comments: Habitat/Fish (Circle One)

PHOTOGRAPHS

Hab.#	R#	EX#	Description	Hab.#	R#	EX#	Description

Rl(R4 Fish Habitat Inventory
FORM 6 - Fish Data

Stream: Reach #: Date: Page: _
Diverl (Dl): Diver2 (02) : _

Habitat Unit #	1		1		1		1		1		1		1		1		'		1	
Habitat Type																				
Habitat Length																				1
Dist. Betw. Units	1		1		1		1		1		1		1		1		1		1	
Dive Date											1		1		1		1		1	
Dive Water Temp									1		1		1		1		1		1	
Dive Air Temp			1		1										1					
Dive Time									1		1									
DIVE LENGTH																				
DIVE AVG. WIDTH																			1	1
DIVE AVG. DEPTH	1	1							1										1	1
Dive Max Depth	1								1											1
% Undercut Bank	1								1		1			1			1			1
% Overhead Cover	1													1						1
% Submerged Cover	'										1									1
% Large Substrate																				1

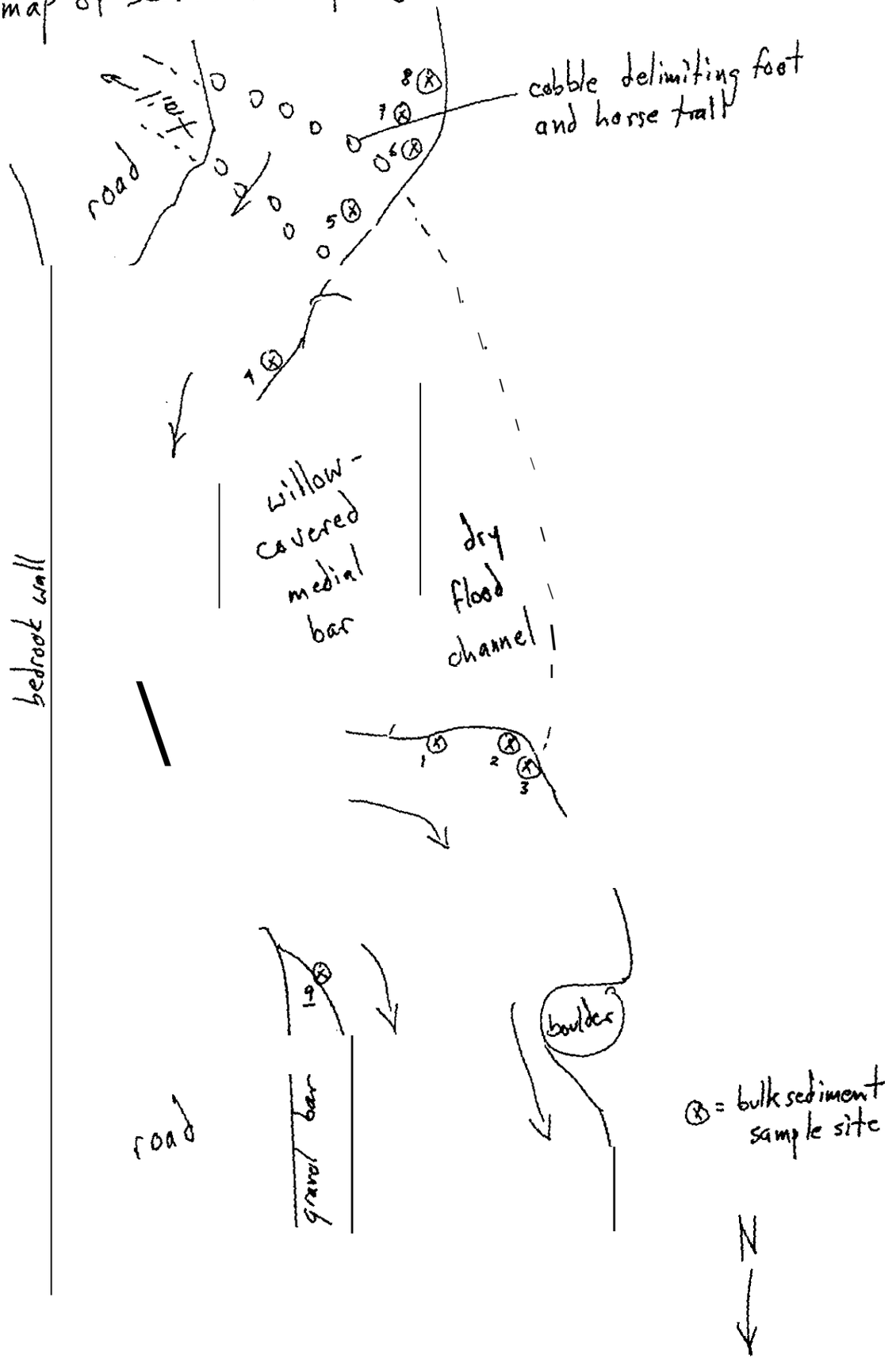
COUNTS	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
CHIN 0 (50-80)																				
CHIN 1 (> 100)																				
Adult Chinook																				
ST1 (70-130)																				
ST2 (130-200)																				
ST3 (200-250)																				
RB > 250																				
RD < 100																				
RD 100-200																				
RD > 200																				
CT < 100																				
CT 100-200																				
CT 200-300																				
CT > 300																				
ET < 100																				
BT 100-200																				
BT 200-300																				
BT 300-400																				
BT 400-500																				
ET > 500																				
BK < 100																				
BK 100-200																				
BK 200-300																				
EK > 300																				
BN < 100																				
BN 100-200																				
BN 200-300																				
BN 300-400																				
EN > 400																				
YOY <70 (+ = Yes)																				
No Fish (X = Yes)																				
Comments (X)																				

CHIN = Chinook. ST = Steelhead, RB = Rainbow, RD = Redband, CT = Cutthroat, BT = Bull Trout, BK = Brook Trout, BN = Brown Trout, YOY = Young-of-the-Year
NOTE: Capitalized variables are required fields

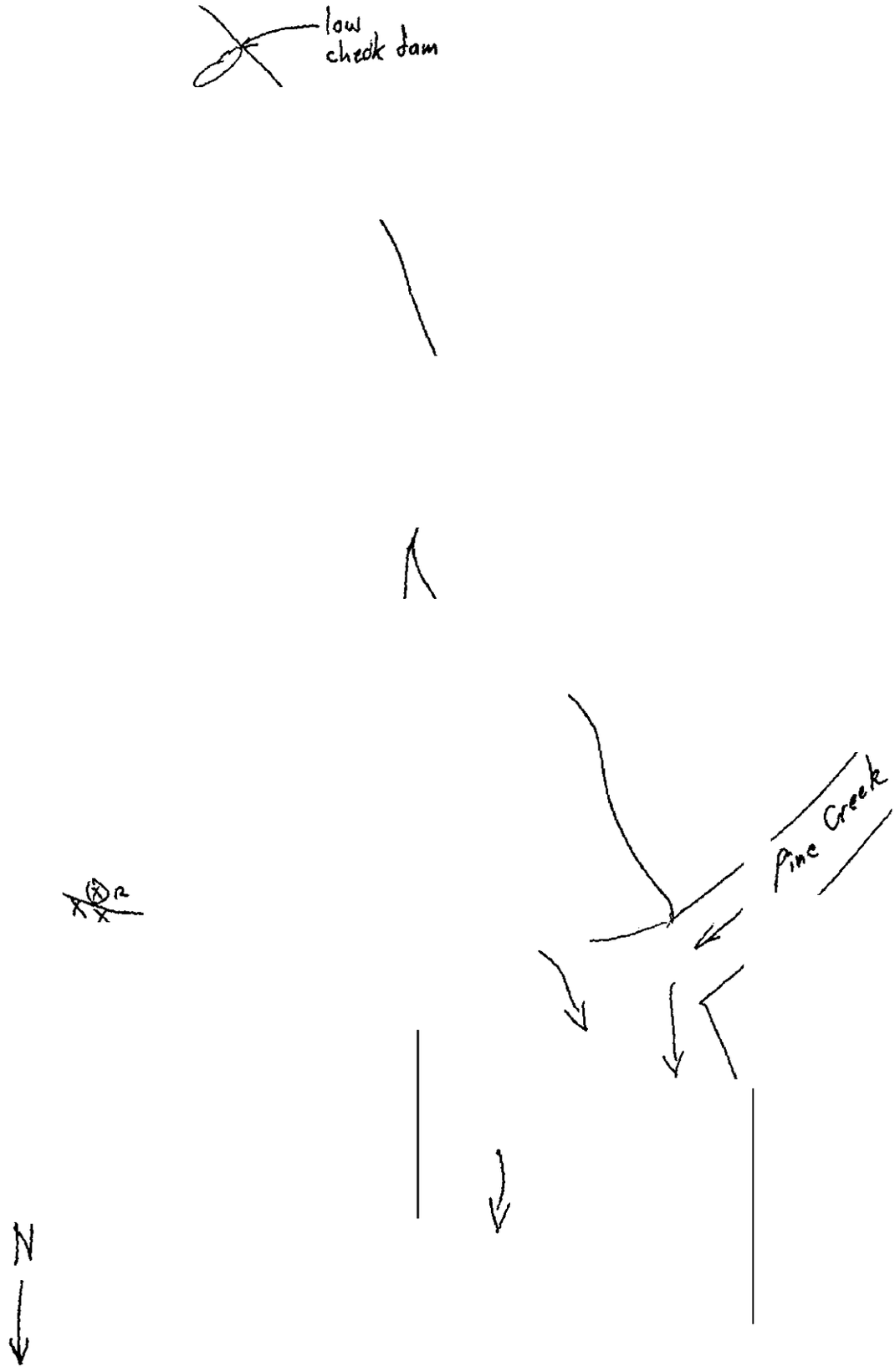
APPENDIX B

Sketch Maps of Bulk Sediment Collection Sites Jarbidge River, 2001

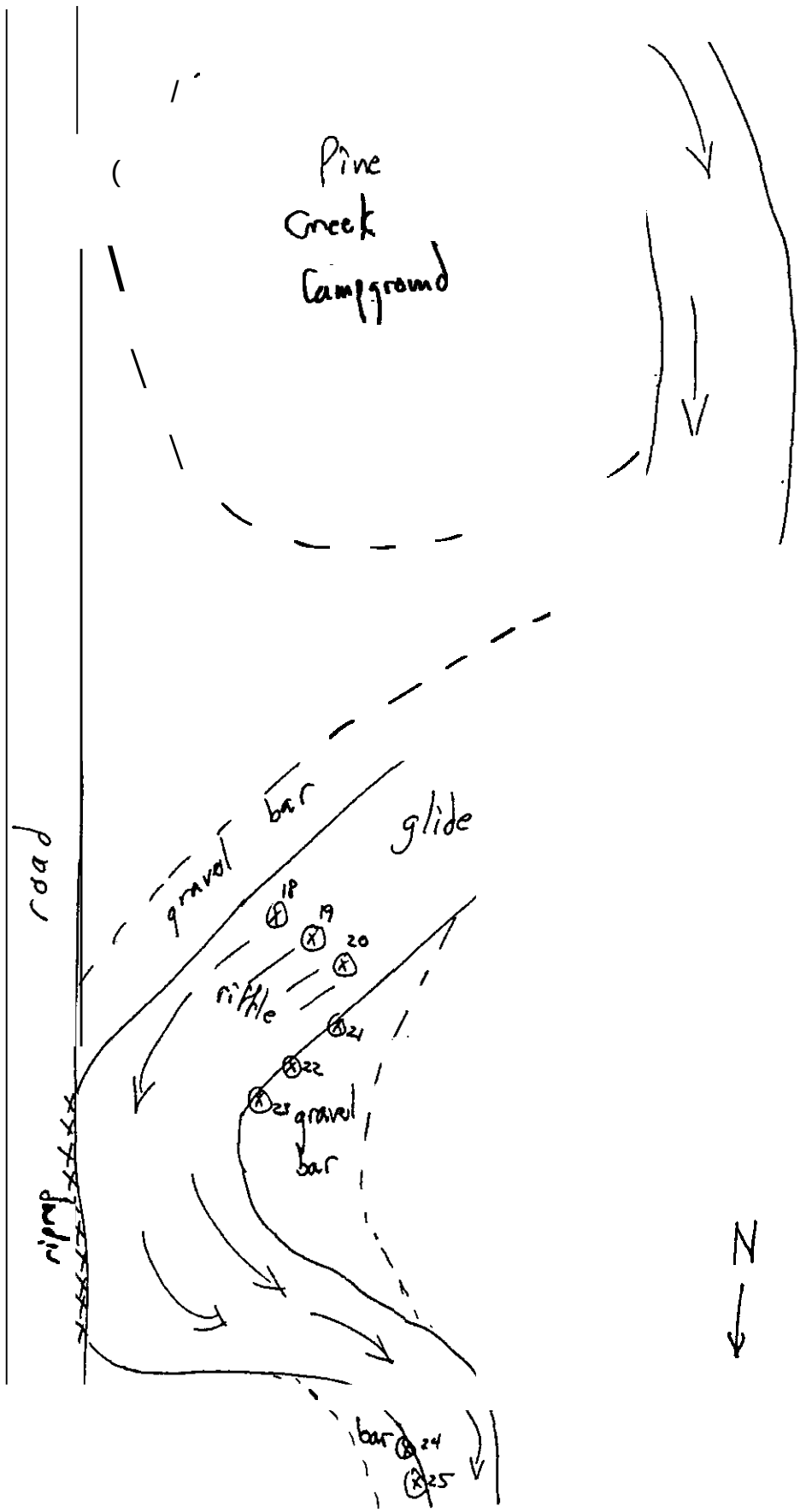
Sketch map of sediment sampling site WF-1, Oct. 2001.



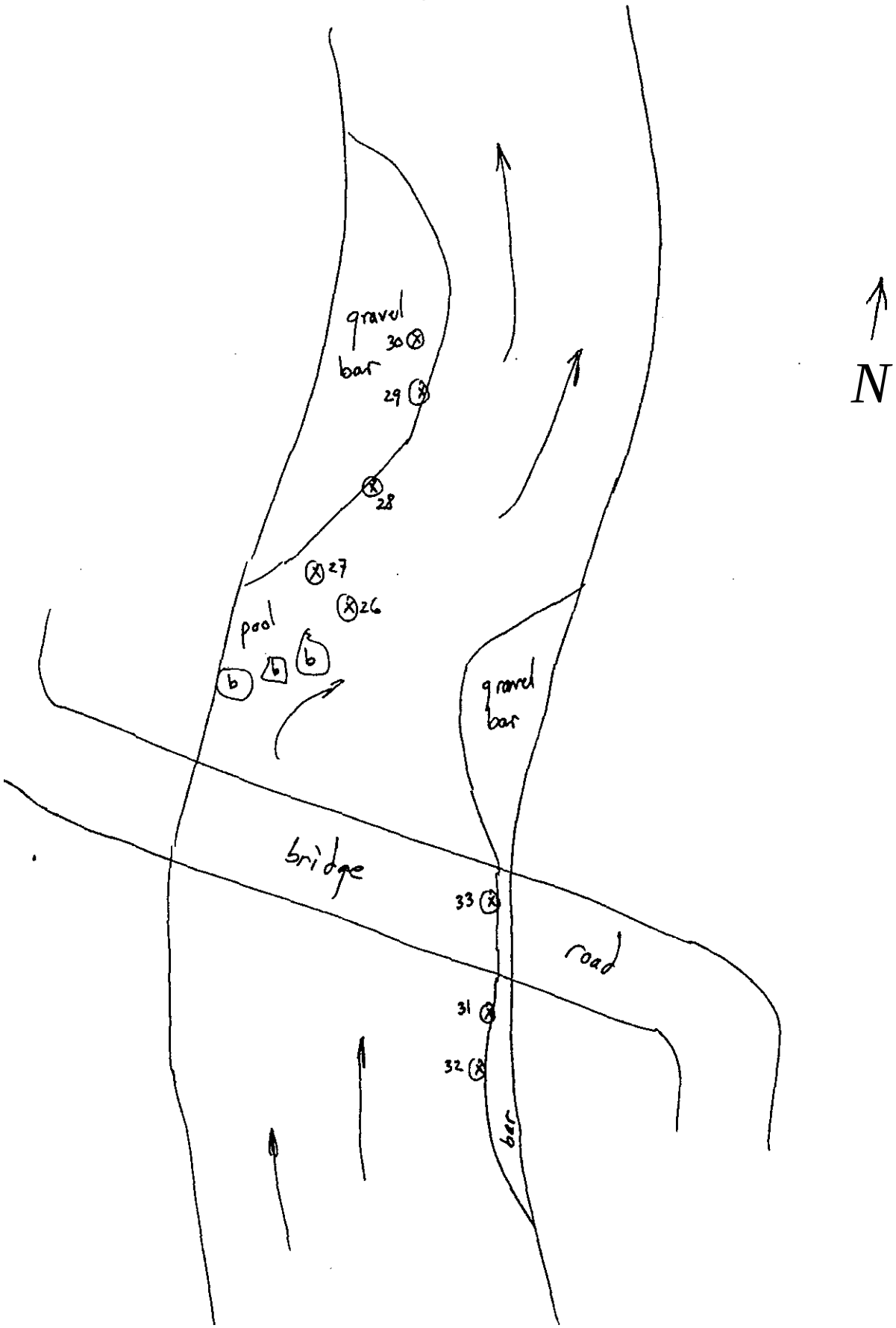
Sketch map of sediment sampling site WF-2, Oct. 2001.



Sketch map of sediment sampling site WF-3, Oct. 2001.

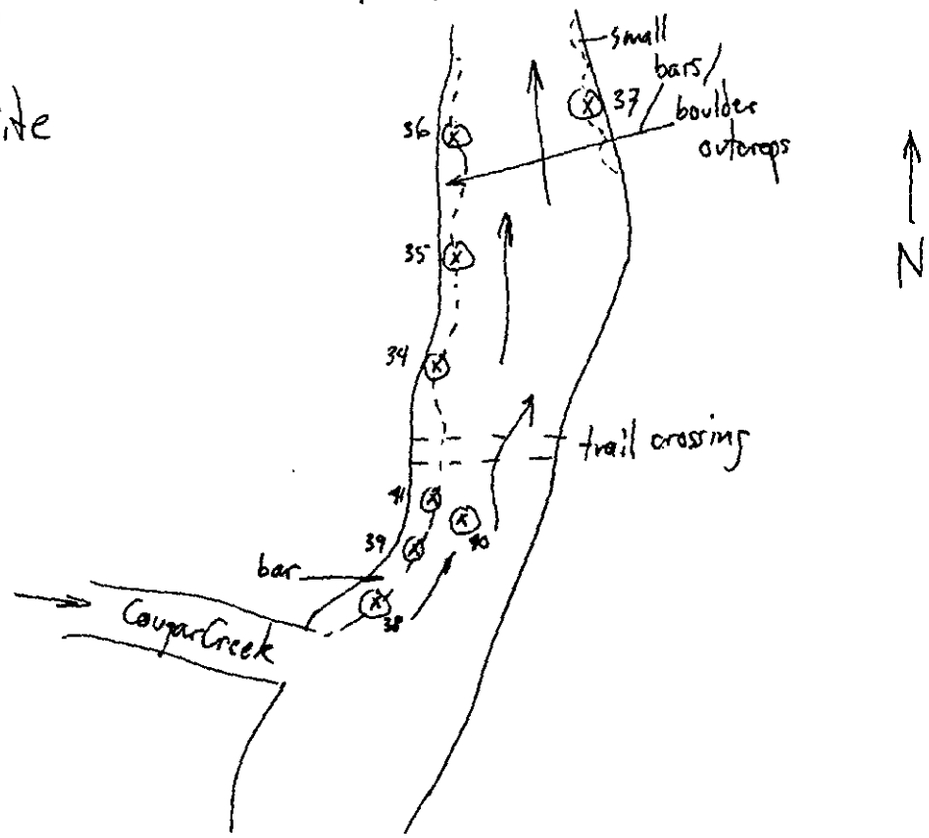


Sketch map of sediment sampling site WF-4, Oct. 2001.

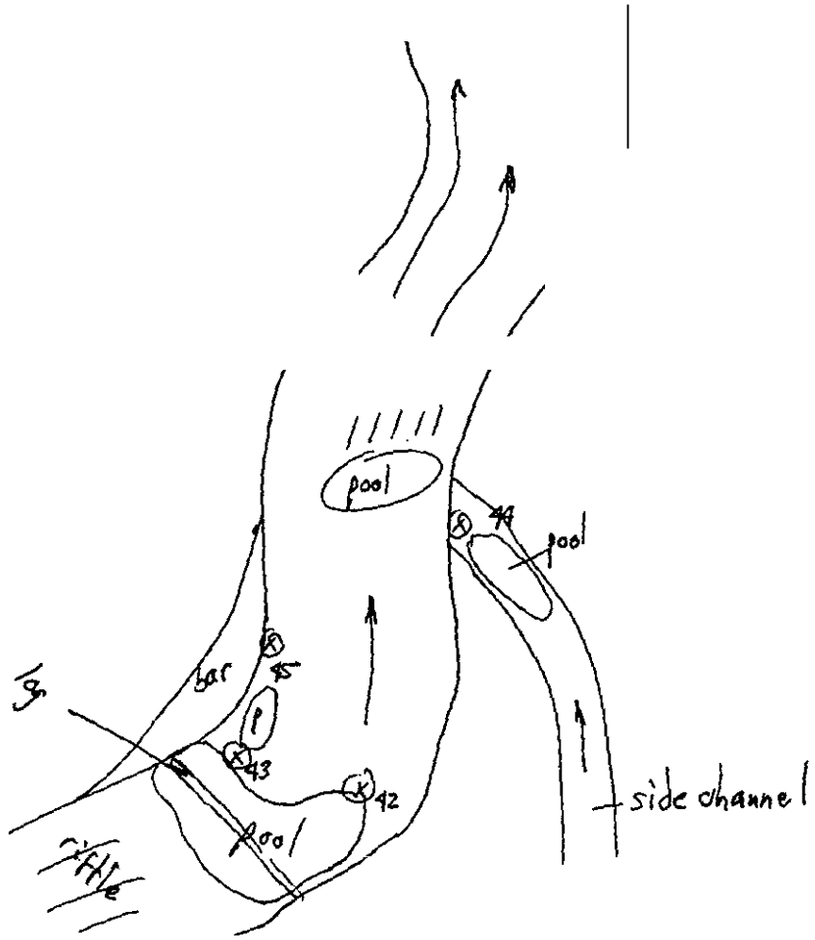


Sketch map of sediment sampling site EF-1, Oct. 2001.

Lower site



Upper site



APPENDIX C

Fish Surveys and Fish Observations in the Dalbridge River System

Table C-1. Fish Surveys and Fish Observations in the Jarbidge River System

Author	Objectives	Dates of **Investigation**	Methods	**Stream Name**	Upstreaml Downstream Limits	Target Species	Species Present	Number of char
USFS/NDOW 1993	B,C,D	June-September 1993	Electrofishing	East Fork	13 stations from NF boundary to headwater forks	All Present	BT,RB,SC,DA	4
Warren and Partridge 1993	B,C,D	July and August 1992	Electrofishing	East Fork	RM 0,1-4.1	All Present	RB, MW, SCP, DA, SU, RS	0
BLM and USFW 1995		August 8, 1995	Snorkel	East Fork	Confluence of West Fork, 0.3mi *DIS* and OAmi upstream of Murphy Hot Springs	All Present	RB,MW,SCP,DA,SU,RS	0
Zoellick et al. 1996	A,C,D	March 1994	Electrofish	East Fork	RM 0.6 & 3,5	All Present	RB, SCP, DA,	0
Zoellick et al. 1996	A,C,D	July 1994	Snorkel	East Fork	From RM 0.85 to USFS Boundary	All Present	RB, MW, SCP, DA, SU, RS	0
Ramsey, 1997b	B,C,D,E	October 6-8,	Walk through	East Fork	From the NF Boundary to about ,25 miles inside the Wilderness area	BT, RB	BT, RB	3
Partridge and Warren 1998	A,C	Aug 27-Oct 17 1997	Downstream fish weir / trap boxes	East Fork	Weir installed 100m upstream from West Fork confluence	All Present	RB, MW, DA, SU, RS	0
Johnson 1999	B,C	August 12, 1998	Electrofish	East Fork	From confluence of Robinson Creek to headwaters fork	All Present	BT,RB, SCP,DA	8
NDOW2000	B,C,D	September 28-29, 1999	Electrofishing	East Fork	At elevation 7360 and just upstream	BT, RB	BT,RB	7
Partridge and Warren 2000	A,C	September 8-November 30 2000		East Fork	Weir installed 100m upstream from WF	All Present	BT,RB,MW,SCP,DA,SU	2

Table C-1. Fish Surveys and Fish Observations in the Jarbidge River System (Continued)

Author	Objectives	Dates of Investigation	Methods	Stream Name	Upstream! Downstream Limits	Target Species	Species Present	Number of char
					confluence			
Johnson 1999	B,C	August 5, 1998	Electrofish	Pine Creek	From confluence with West Fork to **near headwater** forks	All Present	BT,RB,SCP	
NDOW 2000	B,C	August 31-September 2, 1999	Electrofishing	Pine Creek	From elevation 7015 to 7675 feel	BT, RB	BT, RB	14
NDOW 1954	C	June and August 1954	Electrofishing	West Fork	5 selected stations from 6250 to 7268ft.	All Present	BT, RB, MW, EB, CT	2
NDOW 1961	C	October 3-4, 1961	Electrofishing	West Fork	Selected **reaches from** State line to just upstream of Sawmill Creek	All Present	BT, RB, MW, SCP	3
NDOW 1972	B,C,D	August 24, 1972	Electrofishing	West Fork	4 selected **reaches from** National Forest boundary to Snowslide Gulch	All Present	BT, RB, MW, SCP	
NDOW 1974	B,C,D	November 17-18,1974	Electrofishing	West Fork	6 selected **reaches from** Stateline to Snowslide Gulch	All Present	BT, RB, MW, SCP	0
NDOW 1979	B,C,D	October 22-26, 1979	Electrofishing	West Fork	10 selected **reaches from** Mahoney Ranger Station to Pine Creek Campground	All Present	BT, RB, MW, SCP	2
NDOW 1980	B,C,D	October 22-28, 1980	Electrofishing	Wesl Fork	6 selected reaches from Mahoney Ranger Station	All Present	BT, RB, MW, SCP	2 or **more**

Table C-1. Fish Surveys and Fish Observations in the Jarbidge River System (Continued)

Author	Objectives	Dates of Investigation	Methods	Stream Name	Upstreaml Downstream Limits	Target Species	Species Present	Number of char
					to Pine Creek Campground			
NDOW 1985	B,C,D	September-October 1985	Electrofishing	Wesl Fork	17 selected reaches from State line to near Sawmill Creek	All Present	BT, RB, MW, SCP	13
Warren and Partridge 1993	B,C,D	July 1992	Electrofishing	West Fork	RM 0.6, 1.7,3.4	All Present	RB,MW,SCP.DA,SU	0
BLM and USFW 1995	a,C,D	August 8, 1995	Snorkel	West Fork	O.4mi below Jack Creek and 0.4 down stream of Buck Creek.	All Present	RB, MW. SCP, DA, RS	0
Zoellick et al. 1996	A,C,D	March 1994	Electrofishing	West Fork	RM 0,6 & 3.4	All Present	RB,MW,SCP,DA,SU	0
Zoellick et al. 1996	A,C,D	July 1994	Snorkel	West Fork	From RM 0.6 to USFS Boundary	All Present	BT,RB,MW,SCP,DA,SU	1
Ramsey, 1997a	B,C,D	October 1, 1996	Walk through	West Fork	Frbm Pine Creek to headwaters	BT	BT	4
Ramsey, 1997b	B,C,D,E	October 6-8, 1997	Walk through	West Fork	From Pine Creek confluence to 50 yards below Sawmill Creek.	RB	RB	0
Partridge and Warren 1998	A,C	Aug 28-0ct 17 1997	Downstream fish weir / trap boxes	West Fork	Weir installed 1.7 km upstream from EF confluence	All Present	BT, RB, MW, SCP, DA, SU, RS	
Johnson 1999	B,C	August 5, 1998	Eiectrofishing and Snorkel	West Fork	From Idaho/Nevada border to headwaters forks	All Present	BT, RB, MW, SCP, DA, SU	23
Partridge and Warren 2000	A,C	September 9-November 30 1999	Downstream fish weir / trap boxes	West Fork	Weir installed 10m upstream from EF confluence	All Present	BT,RB,MW,SCP,DA,SU	3

Table C-1. Fish Surveys and Fish Observations in the Jarbidge River System (Continued)

Author	Objectives	Dates of Investigation	Methods	Stream Name	Upstreaml **Downstream** Limits	Target Species	Species Present	**Number** of char
Werdon 2000a	D	June 30 and August 24, 1999	Snorkel	West Fork	From mouth of Pine Creek (elevation 6733ft) upstraam to elevation 7370fl	BT,RB	BT, RB	8
Werdon 2000b	D	June 19-22, 2000	Electrofishing and Snorkel	West Fork	Selected **reaches from** Pine Creek confluence to wildemess area	BT,RB,SCP	BT, RB, SCP	7
NDOW 2001	A,B,C	June 27-29, 2000	Snorkeling	West Fork	Selected **reaches from** Jack Creek to Pine Creek (3.8 miles total)	All Present	BT, RB, MW,SCP	16
NDOW 1975	B,C	September 24, 1975	Electrofishing	West Fork	7 selected reaches from State line to Snowslide Gulch	All Present	BT, RB, MW, SCP	O

KEY

BT = Bull trout
RB = Redband / rainbow trout
MW = Mountain whitefish
SCP = Sculpin spp.
DA = Dace spp.
SU = Sucker spp.
EB = Eastern Brook trout
CT = Cutthroat trout

A = Investigation of migratory BT popUlation
8 = **Determination of current BT population distribution**
C = Collection of data on other fish species
D = Collection of data on instream habitat and BT hebitat usage
E = Collection of BT spawning data

APPENDIX F

Statistical Analysis of Jarbridge River Sediment Data

ANALYSIS OF JARBIDGE RIVER SEDIMENT DATA

I. IvlETHODS

Analysis of variance was determined to be the best method for analyzing the Jarbidge river sediment data. ANOVA and post-ANOYA comparisons using multiple contrasts enable us to address the questions of interest with respect to these data. The hypotheses of interest relate to the percent of fine sediment «O.85mm) found in streambeds at sampled locations.

The initial hypotheses tested by the ANOVA are:

For the Fine sediment «O.85mml data set

$H_{010}: \mu_{WF-1} = \mu_{WF-2} = \mu_{WF-3} = \mu_{WF-4} = \mu_{EF-1}$ The mean % fines are equal at all sites.

Should the above hypothesis be rejected, post-ANOVA multiple contrasts will be conducted to determine where differences between treatments lie, focusing in on the following hypotheses;

For the Fine sediment «O.85mml data set

$H_{011}: \mu_{WF-1} - \mu_{WF-2} \leq 0$ The mean % fines of Site WF -1 is equal to or less than WF - 2

$H_{012}: \mu_{WF-1} - \mu_{WF-3} \leq 0$ The mean % fmes of Site WF -1 is equal to or less than WF - 3

$H_{on}: \mu_{WF-1} - \mu_{WF-4} \leq 0$ The mean % fines of Site WF -1 is equal to or less than - 4

$H_{014}: \mu_{WF-4} - \mu_{WF-2} \geq 0$ The mean % fines of Site WF -4 is greater than or equal to WF 2

$H_{015}: \mu_{WF-4} - \mu_{WF-3} \geq 0$ The mean % fines of Site WF - 4 is greater than or equal to WF - 3

$H_{016}: \mu_{EF-1} - \frac{\mu_{WF-1} + \mu_{WF-2}}{4} + \frac{\mu_{WF-3} + \mu_{WF-4}}{2} < 0$ The mean % rmes from the East Fork site is equal to or less than the West Fork sites

I!. OUTLIERS

One point in the data was extreme. The data point came from sample #1 at the control site, and was probably due to a local eddy effect. However, because we could not determine a sound reason for excluding it the data point was not removed from the dara.

A second point, #31 from site WF-4, was not strictly an outlier, but was determined to be biased by riparian vegetation root masses. and was excluded from the analysis.

III. ASSUMPTIONS OF ANOVA

ANOVA is robust to departures from its underlying assumptions of homogeneity of variance and normality of the population from which the data were sampled. With respect to normality, ANOVA is only slightly affected by considerable large deviations from the assumption. Lack of homogeneity of variance will have little impact on the validit)' of the ANOVA if the sample sizes for all groups are equal or approximately equal. Tests for normality and homogeneity of variances were conducted for the ANOVAs run for this data set, and the results of these tests discllssed in the context of the problem.

IV. ANALYSIS FOR FINE SEDIMENT DATA «O.85mm)

A. Percent Fines Data (WF-4 #31 removed)

Analysis of Variance «O 85mm)

	Sum of Sauares	dl	Mean Sauare	F	Sianificance
Between Groups	195.578	4	48.144	2.612	0.050
Within Groups	718.888	39	18.433		
Totar	911.485	43			

- At the 0.05 level of significance. the null hypothesis H_{010} that the mean proportion of fine sediment is equal at all sampling locations is rejected (p = 0.050). Conclude that the mean percent of fine sediment **is not the same at all sampling locations.**

Test of Homo eneit of Variances

Levene Statistic	df1	df2	Si nificance
3.047	4	39	0.028

- **Assumption of homogeneity of variances rejected.**

Tests 0 f Narmaltty

Kolmogorov-Smirnov				Shapiro-Wilk		
	Statistic	df	Sionificance	Statistic	df	Sianificance
<O.85mm	0.242	441	0.000	0.706	44	0.010

- Reject the hypothesis of normality of underlying populations. An examination was conducted site-by site. and it was found that the only significant deviation from normality occurred at site WF-I.

Contrast Tests

		Contrast H_0	Sic. (Hailed)
<O.85mm	Does not assume equal variances	$\mu_{WF-4} >= \mu_{WF-2}$	0.012

- **Reject the hypothesis H_{014}, assuming unequal variances since the tests for homogeneity of variances** was rejected. That is. the null hypothesis that the mean % fines at site WF-4 is greater than or equal to the mean % fines at WF-2 is rejected. It can be concluded that the mean % fines is greater at site WF-2 than at site WF-4.

B. Percent Fines in Reduced Data: Samples 12-14 and 31 Removed

Analvsis of Variance «O 85mm)

	Sum of Squares	df	Mean Square	F	SiQnificance
Between Grouos	70.449	4	17.612	1.201	.327
Within GrouDs	528.086	36	14.669		
TOlal	598.535	40			

- At the 0.05 level of significance. the null hypothesis $H_{0|O}$ that the mean percent of fine sediment is equal at all sampling locations is not rejected (p 0.327). Conclude that the mean percent of fine **sediment is the same at all sampling locations.**

Test of Homo **eneit'** of Variances

Levene Statistic	df1	I df2	Sianificance
3.047	4	36	0.143

- **Assumption of homogeneity of variances not rejected.**

Tests of Normality

KoJmogorav-Smimov				Shaoiro-Wilk		
	Statistic	I df	Sianificance	Statistic	d1	Sianificance
<O.85mm	0.217	I 41	0.000	0.606	41	0.010

- Reject the hypothesis of normality of underlying populations. An examination was conducted site-by site, and it was found that the only significant deviation from normality occurred at site WF-l.

January 14,2002

A total of 21.7 km (13.5 mil of stream were surveyed along the West Fork and Pine Creek from *10/09101* to *10/16101.* Habitat survey information included standard habitat variables, pebble counts and LWD counts. No habitat data was collected along the East Fork Jarbidge River.

Fish snorkel surveys were conducted in the same 21.7 km (13.5 mil area of West Fork and Pine Creek as the habitat surveys, as well as 21.2 km (13.2 mil of the East Fork. Fish surveys in the West Fork and Pine Creek were conducted concurrently with the habitat surveys; fish surveys along the East Fork were conducted from *10/19101* to 10121101.

Bulk sediment samples were collected along the West Fork (33 samples, 4 locations) and East Fork (12 samples, I location) concurrently with fish and habitat surveys.

4.1 HABITAT SURVEYS

4.1.1 West Fork

A total of 14.2 km (8.8 mil of the West Fork Jarbidge River were surveyed from the Humboldt-Toiyabe National Forest boundary (RM 0.0) to beyond Sawmill Creek (RM 8). The West Fork is generally a wooded, moderately confined to confined channel with the reaches above Pine Creek almost exclusively confined. Juniper, aspen, willow and fir dominated the riparian community. Habitat type was dominated by low gradient riffles (LOR) tbroughout; 45% of the habitat units were classified as LOR and 75% of the stream was classified as riffle habitat.

Stream water temperatures ranged from 3.3° to 10.0° C (38° to 50°p), but water temperatures were strongly influenced by time of day and atmospheric conditions. A significant cold front brought snow to the area on October 11, and the weather was cold and clear on October 12. This is evidenced by a 3.4° C (6° F) drop in morning water temperature in Reach W2 between these dates (Table 7). Water temperatures in the West Fork and Pine Creek remained cold (below, to well below 7° C) for the balance of the surveys (tbrough October 16). This had significant implications for our ability to survey the fish population for overall abundance in these two streams, particularly when compared to the East Fork.

Table 7. Water Temperature of the Jarbidge River Forks and Pine Creek by Date, Reach, and Time, 2001.

Stream	Date	Time	Reach	T (F)	T (e)
West Fork	9-0ct	915	W2	40	4.4
		1125	WI	46	7.8
		1410	WI	52	11.1
		1740	W2	52	11 .1
	10-0ct	1200	W2	46	7.8
		1405	W2	50	10.0
		1530	W3	50	10.0
	II-Oct	840	WI	46	7.8
		1020	W2	46	7.8
		1211	W2	46	7.8

Table 7. Water Temperature of the Jarbidge River forks and Pine Creek by Date, Reach, and Time, 2001 (Continued).

Stream	Date	Time	Reach	T (F)	T (C)
West Fork (can't)		1430	W2	46	7.8
		1519	W3	45	7.2
		1612	W3	46	7.8
		1624	W3	44	6.7
		1715	W4	44	6.7
	12-0ct	805	W2	40	4.4
		850	W2	40	4.4
		1030	W5	39	3.9
		1130	W5	40	4.4
		1300	W6	43	6.1
		1350	W6	45	7.2
		1500	W7	44	6.7
	13-0ct	1045	W11	38	3.3
		1145	W11	39	3.9
		1245	W10	40	4.4
		1330	W10	41	5.0
		1405	W9	41	5.0
		1530	W9	42	5.6
		1600	W8	43	6.1
Pine Creek	15-0ct	1100	P7	40	4.4
		1215	P6	40	4.4
		1255	P6	40	4.4
		1400	P5	42	5.6
		1420	P5	43	6.1
		1512	P5	45	7.2
	16-0ct	900	P1	40	4.4
		1000	P1	40	4.4
		1200	P2	40	4.4
		1330	P2	44	6.7
East Fork	19-0cl	1100	E26	42	5.6
		1226	E25	42	5.6
		1342	E24	44	6.4
		1449	E23	45	6.9
		1631	E22	47	8.1
	21-0cl	937	E1	44	6.7

Habitat data for each West Fork reach of the are summarized in Table 9. The habitat width, volume, depth, and area decline with increasing elevation. However, aside from characteristics relating to stream size, habitat characteristics are generally consistent among the stream reaches and elevations. Notable exceptions are discussed below.

Average pool frequency was *4.6/100* m *(74/mi),* and the mean (wetted) width-to-depth ratio was 27.4. This pool density is almost identical to that recommended by INFISH standards (Ramsey 1997). However, the *WID* ratio of 27.4 is substantially higher than the 10 recommended by INFISH. The West Fork channel was broad and shallow in October; this contributes to the high *WID* value that we observed in most areas of both the West Fork and Pine Creek (see Table 9). Flows were also anecdotally reported by locals to be exceptionally low in the fall of 2001.

A data summary report from FBASE was used to prepare Figure 7 which plots the distribution of maximum and residual depths from pocket pools and slow water habitats, respectively. Pocket pool depth averaged 0.4 m, and exceeded I m as a mean only in Reach W7 (see Table 9). Considerably more depth was seen in pools created by LWD, boulders, and scour (Figure 7). Still, most of these pools were no more than 0.46 m (1.5 ft) deep. W8 and WIO were the only reaches not dominated by riffle habitat. W8 contained a significant number of step pool complexes (STP), while WF-IO had more wood and boulder scour pools. There were very few pools 0.76 m (2.5 ft) or deeper, and most of the 0.6 (2.0 ft) pools were located in Reach W2, as seen in the following table:

Table 8. Distribution of West Fork Jarbidge River Pools by Depth Category and Stream Reach, October, 2001

West Fork	Number of Pools by Maximum Pool Depth			
Reach	2.0 -2.5 ft	2.5 - 3.0 ft	3.0 -3.5 ft	3.5 - 4.0 ft
1	2	0	0	0
2	9	1	1	0
3	1	1	0	0
4	1	0	0	0
5	2	0	0	0
6	0	1	0	0
7	0	0	0	0
8	0	1	0	0
9	0	1	0	0
10	1	0	0	0

Bank stability was generally high (mean 88.3%). Portions of Reaches W6, W9, and WIO had slightly lower bank stability (75-80%). Reach WIOhad low bank stability (10%) at the upper portion of the reach. This area was a highly confined and wooded area with numerous trees (alder and willow) blown down along the stream bank, exposing root wads and soils. Reach W6 includes the USFS road and bridge washout areas and the stream re-channelization, resulting in several areas of low bank stability (0-10%).

A total of 23 Wolman pebble counts were conducted along the West Fork to characterize the surface sediment composition (Table 9). Surface sediment composition was consistent throughout the West Fork. with no appreciable differences among the reaches. The surface sediments were dominated by gravel and rubble, which accounted for an average of 73% of the surface material. Embeddedness was almost universally low.

Table 9. Summary of West Fork Habitat Statistics by Reach, Jarbidge River Fisheries Study, 2001

	West Fork Survey Reaches											
Variable*	WI	W2	W3	W4	W5	W6	W7	WS	W9	W10	Mean	S.D.
Habitat Unit Length (01)	18.8	39.9	44.8	34.7	59.4	30.6	52.8	41.5	31.7	21.1	37.5	12.89
Habitat Wetted Width (01)	4.7	5.1	4.3	4.3	4.4	3.3	3.1	2.7	2.5	2.5	3.7	0.96
Habitat Area (01')	89.6	214.0	214.3	153.2	274.0	103.3	152.7	115.1	84.4	52.0	145.2	70.19
Habitat Mean Depth (01)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.03
Habitat Maximum Depth (01)	0.6	0.8	0.7	0.6	0.6	0.6	0.5	0.6	0.4	0.4	0.6	0.13
Habitat Volume (01')	16.3	34.3	29.0	20.9	33.5	14.0	16.9	12.8	10.3	3.7	19.2	10.17
Percent Fast Habitat	82.5	94.0	92.6	78.4	96.5	82.3	89.4	35.5	89.6	55.7	79.7	
Percent Slow Habitat	17.5	6.0	7.4	21.6	3.5	17.7	10.6	64.5	10.4	44.3	20.4	
Percent Riffle Habitat	74.6	82.7	86.0	76.9	90.0	79.8	88.6	34.8	88.2	52.3	75.4	
Pocket Pools (n/lOOm)	0.1	3.0	1.1	2.7	2.5	5.8	1.9	2.5	3.6	1.5	2.5	1.53
Pocket Pool Depth (01)	0.2	0.4	0.4	0.4	0.4	0.3	1.2	0.4	0.3	0.3	0.4	0.27
Residual Maximum Depth (01)	0.4	0.6	0.6	0.4	0.4	0.4	0.3	0.5	0.3	0.3	0.4	0.12
Width/depth Ratio	28.1	32.6	30.1	33.3	32.3	24.9	23.6	18.4	21.5	29.3	27.4	5.09
Number of Large Class LWD/100 01	0.6	0.03	0.00	0.8	0.3	1.1	0.75	0.5	0.4	0.3	.48	.35
Number of Pieces LWD / 100m (all size classes)	5.1	3.1	1.8	5.6	3.4	4.9	3.4	2.6	2.6	3.6	3.60	1.19
Number of Pieces LWD/aggregate	4.2	4.3	7.0	3.0	3.5	1.1	3.9	3.1	4.3	2.8	3.7	1.52
Number of LWD Aggregates /1 00 01	2.4	1.5	0.1	0.2	0.1	0.9	1.1	2.0	1.1	1.4	1.1	0.79
Rootwad LWD/100 01	2.0	1.5	1.1	0.7	0.6	2.1	2.0	1.0	1.4	1.0	1.3	0.55
Percent Stable - Left Bank	87.7	96.4	90.5	83.1	94.8	79.6	92.0	94.9	86.2	77.9	88.3	6.54
Percent Stable - Right Bank	86.5	92.2	86.2	85.2	89.8	76.3	84.8	87.9	74.9	76.3	84.0	6.06

* INFISH standards: 76 pools/mi (4.7/100 m) lor wetted width of 4.3 m; width:depth ratio

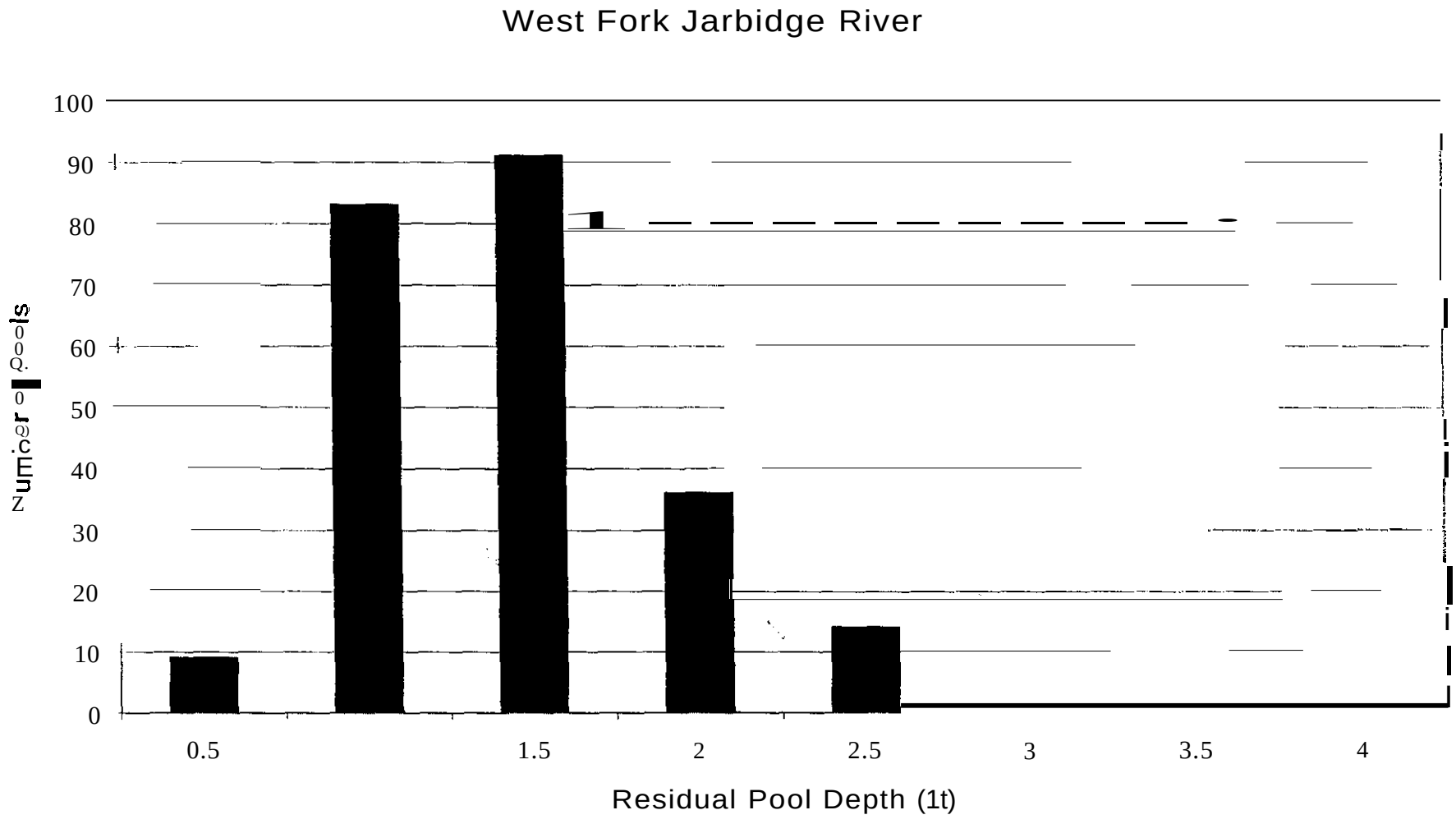


Figure 7. Depth Distribution of West Fork Jarbidge River Pools, October, 2001.

With the exception of Reach W6, all areas surveyed were substantially below the INFISH standard of 1.24 pieces /100 m of LWD, with each piece at least 9.1 m (30 ft) long, and 0.3 m (1 ft) in diameter (Table 10). In the West Fork, the lowest frequency of LWD occurred in Reaches W2, W3, and W5, all areas accessible by automobile. The average LWD dimensions (all size classes combined) were 6.0 m by 0.27 m (19.8 ft by 0,87 ft) in length and diameter, respectively, for the West Fork. Equivalent values for Pine Creek were 6. I m by 0.24 m (20. I ft by 0.80 ft), nearly identical to the wood size in the West Fork, Also notable, is the low percentage of LWD submerged in the stream (see Table II) rendering the available LWD largely non-functional in terms of creating or providing fish habitat under the observed low flow conditions. Rootwads were far more numerous than individual wood pieces, particularly in the West Fork. However, rootwads were nearly absent from Pine Creek (see Table II).

Table 10. Pebble Count Summaries for the West Fork Jarbidge River and Pine Creek by Survey Reach, 2001.

Survey Reach	Fines <2mm ("!o)	Small Gravel 2·8mm ("!o)	Gravel 8·64 mm ("!o)	Small Cobble 64-128 mm ("!o)	Cobble 128·256 mm ("!o)	Small Boulder 256·512 mm ("!o)	Boutder >512 mm ("!o)	Bedrock ("!o)	Replicate Counts
West Fork									
W1	6	4	37	38	14	2	0	0	4
W2	3	3	44	36	11	2	0	0	5
W3	5	3	42	37	12	2	0	0	2
W4	10	0	29	38	20	3	0	0	1
W5	7	1	33	41	15	4	0	0	2
W6	6	4	36	38	16	2	0	0	2
W7	6	10	31	35	14	7	0	0	2
W8	7	8	27	34	20	5	0	0	2
W9	4	5	40	37	14	2	0	0	2
W10	5	1	35	44	14	1	0	0	1
Average:	6	4	35	38	15	3	0	0	23
Pine Creek									
P1	6	18	26	34	7	7	2	0	1
P2	6	6	41	34	10	2	0	0	1
P3	15	8	44	26	6	1	0	0	1
P4	6	12	31	36	11	5	0	0	1
P5	2	33	10.5	24.5	15	15	0	0	1
P6	1	4	20	20	20	35	0	0	1
P7	2	70	24	0	4	0	0	0	1
Average:	5	22	28	25	10	9	0	0	7

Table 11. Size and Percent SUbmergence of LWD in the West Fork Jarbidge and Pine Creek, 2001.

Stream	Reach	Rootwads	Rootwads *1100* m	Mean Percent Submerged	Range in Percent Submerged	Number of Class 7,8 **Pieces'**	Pieces / 100 m[b]	Mean Piece Length (tt)	Mean Piece Diameter (tt)
West Fork									
	W1	15	2.14	0.48	0-4	4	.57	15.8	1.03
	W2	46	1.48	1.85	0-65	1	.03	13.9	0.86
	W3	18	1.13	1.18	0-5	0	.00	17.1	0.91
	W4	4	0.66	3.74	0-90	5	.83	20.1	1.01
	W5	9	0.59	2.69	0·50	4	.26	19.8	0.80
	W6	24	2.05	0.47	0-5	13	1.11	22.6	0.88
	W7	27	2.02	1.96	0-20	10	.75	27.8	0.88
	W8	13	0.91	0.32	0-3	7	.49	22.5	0.93
	W9	20	1.40	1.08	0-25	6	.42	22.1	0.77
	Wl0	6	1.02	1.05	0-5	2	.34	16.7	0.67
Pine Creek									
	P1	1	0.08	0.14	0·5	3	.25	19.8	0.91
	P2	2	0.17	0.87	0-5	2	.17	20.2	0.78
	P3	2	0.09	0.40	0·10	4	.18	18.9	0.81
	P4	2	0.18	4.92	0-50	2	.18	23.1	0.93
	P5	0	0.00	1.04	0-5	5	.66	23.7	0.73
	P6	0	0.00	0.30	o· 1	2	.30	20.6	0.66
	P7	0	0.00	4.33	0-10	0	.00	14.7	0.75

Class 7 = 10-20" diameler, >35 tt tong; Class B = >20" in diameter, >35 ft long.

b INFISH standard = >20 pieces/mile >12" in diameter, >30 ft in length. *20/mile* =1.24/100 m.

Areas of significant bank erosion along the lower reaches of the West Fork (WI-W4) were commonly associated with road fill and old mine tailings (Table 12; supplemental photo file). Elsewhere on the West Fork, most of the sites of significant erosion were those associated with high, steep, naturally erosive soils exposed to the river. Other instability areas upstream of Jarbidge were most commonly associated with natural events such as landslides and washouts from steep valley sidewalls.

Table 12. Location of Significant Bank Erosion, West Fork Jarbidge River and Pine Creek, 2001.

Stream	Reach	Habitat Unitls	Description	Photographs
West Fork	Wl	22	High Eroding LS	1
	Wl	28·34	Eroding RS Road Fill	5
	Wl	37	High Eroding LS	1
	W2	27	High (incised), eroding RS	2
	W2	68	RS Erosion at Sawmill Campground	2
	W2	71	RS Erosion at Sawmill Campground	2
	W2	74	RS Road Fill Erosion	2
	W3	7	RS Mine Tailings	1
	W3	9	RS Mine Tailings	1
	W3	15	RS Erosion	1

Table 12. Location of Significant Bank Erosion,
West Fork Jarbidge River and Pine Creek, 2001. (Continued)

Stream	Reach	Habitat Unit/s	Description	Photographs
West Fork (can't)				
	W3	33	High RS Erosion	
	W4	12	Erosion of Road Fill	None
	W6	27	LS Erosion	
	W7	22	RS Erosion	None
	WB	9	RS Erosion	
Pine Creek				
	P5	1	Eroding RS	
	P5	5	High RS Erosion	None
	P6	6	High RS Erosion	2
	P7	4	LS Erosion	1

4.1.2 Pine Creek

A total of 7.6 Ian (4.7 mi) of Pine Creek were surveyed. The'survey began at the confluence with the West Fork and ended near the headwaters (RM 4.7). Pine Creek is a wooded, moderately-confined to confined channel with a riparian zone consisting of alder, cottonwood, fir and willows. As in the West Fork, habitat type was dominated by riffle habitat which comprised 90.8% of the habitat surveyed. Stream water temperatures ranged from *4.4°* to *7.2°* C *(40°* to *45°* F), but these water temperatures were strongly influenced by time of day (see Table 7).

Habitat data for Pine Creek are summarized in Table 14. Habitat characteristics were fairly consistent along all stream reaches, with the exception of variables related to stream size, which decreased with increasing elevation. In addition, the upper reaches were almost exclusively riffle habitat with fewer pocket pools relative to the lower reaches. Overall pool frequency was higher than in the West Fork, averaging 5.8 per 100 m (93.3 per mi). Pool frequency in Pine Creek clearly meets the INFISH standard of 4.7/ 100 m, but the majority of the pools were 0.46 m (1.5 ft) deep or less (Figure 8). There were almost no pools at least 0.46 m deep in the upper reaches of Pine Creek, as seen in the table below. The mean width-to-depth ratio was 24.6, very close to that of the West Fork. The width-to-depth ratio is still much higher than may be desired for ideal salmonid habitat. extreme low flow conditions affected this ratio in both the West Fork and Pine Creek.

Table 13. Distribution of Pine Creek Pools by Depth Category and Stream Reach, October, 2001

Pine Creek	Number of Poofs by Maximum Pool Depth			
Reach	1.5 - 2.0 It	2.0 - 2.5 It	2.5 - 3.0 It	3.0 - 3.5 It
1	3	0	0	0
2	3	1	0	0
3	3	2	1	0
4	4	2	1	0
5	0	0	0	0
6	0	1	0	0
7	0	0	0	0

Table 14. Summary of Pine Creek Habitat Statistics by Reach, Jarbidge River Fisheries Study, 2001

	Pine Creek Habitat Survey Reaches								
Variable	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**Mean**	S.D.
Habital Unit Length (m)	33.9	40.6	48.8	29.3	75.7	73.6	75.2	53.9	20.49
Habitat Wetted Width (m)	3.7	4.0	2.8	2.4	2.8	2.8	1.7	2.9	0.74
Habitat Area (m2)	133.2	159.5	143.3	72.2	230.5	189.4	153.7	154.5	48.96
Habitat Mean Depth (m)	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.04
Habitat Maximum Depth (m)	0.6	0.6	0.7	0.5	0.0	0.6	0.4	0.5	0.22
Habitat Voiume (m3)	19.1	21.9	19.9	8.4	23.8	15.8	12.3	17.3	5.46
Percent of Reach as Fast Habitat	88.9	89.7	93.3	85.9	98.0	98.8	95.3	92.8	
Percent of Reach as Slow Habitat	11.1	10.3	6.7	14.1	2.0	1.2	4.7	7.2	
Percent of Reach as Riffie Habitat	85.4	89.2	88.8	84.1	95.7	97.1	95.3	90.8	
Pocket Pools *(n/I00m)*	4.4	7.0	4.8	4.5	3.6	1.4	3.0	4.1	1.72
Pocket Pool Depth (m)	0.3	0.4	0.4	0.3	0.3	0.3	0.9	0.4	0.22
Residuai Maximum Depth (m)	0.4	0.2	0.5	0.4	0.0	0.4	0.4	0.3	0.18
Width/depth Ratio	25.5	26.6	19.6	19.6	28.4	30.1	22.3	24.6	4.18
Number of Large Ciass LWD *11* 00 m	0.25	0.2	0.2	0.2	0.7	0.3	0.0	0.25	0.20
Totai Number of Pieces LWD *11* 00 m	3.1	1.2	2.4	1.2	3.7	3.0	1.1	2.26	0.99
Number of Pieces LWD/aggregate	3.0	3.9	3.8	5.5	4.2	4.0	2.4	3.8	0.96
Number of LWD Aggregates *1100* m	0.8	1.3	1.2	1.2	1.3	1.4	1.0	1.2	0.23
Rootwad *LWD/I00* m	0.1	0.2	0.0	0.2	0.0	0.0	0.0	0.1	0.08
Percent Stable - Left Bank	78.8	87.8	82.2	88.1	72.5	!I6.7	72.5	81.2	6.85
Percent Stable - Right Bank	81.9	77.1	81.1	74.3	72.2	51.4	72.2	72.9	10.26

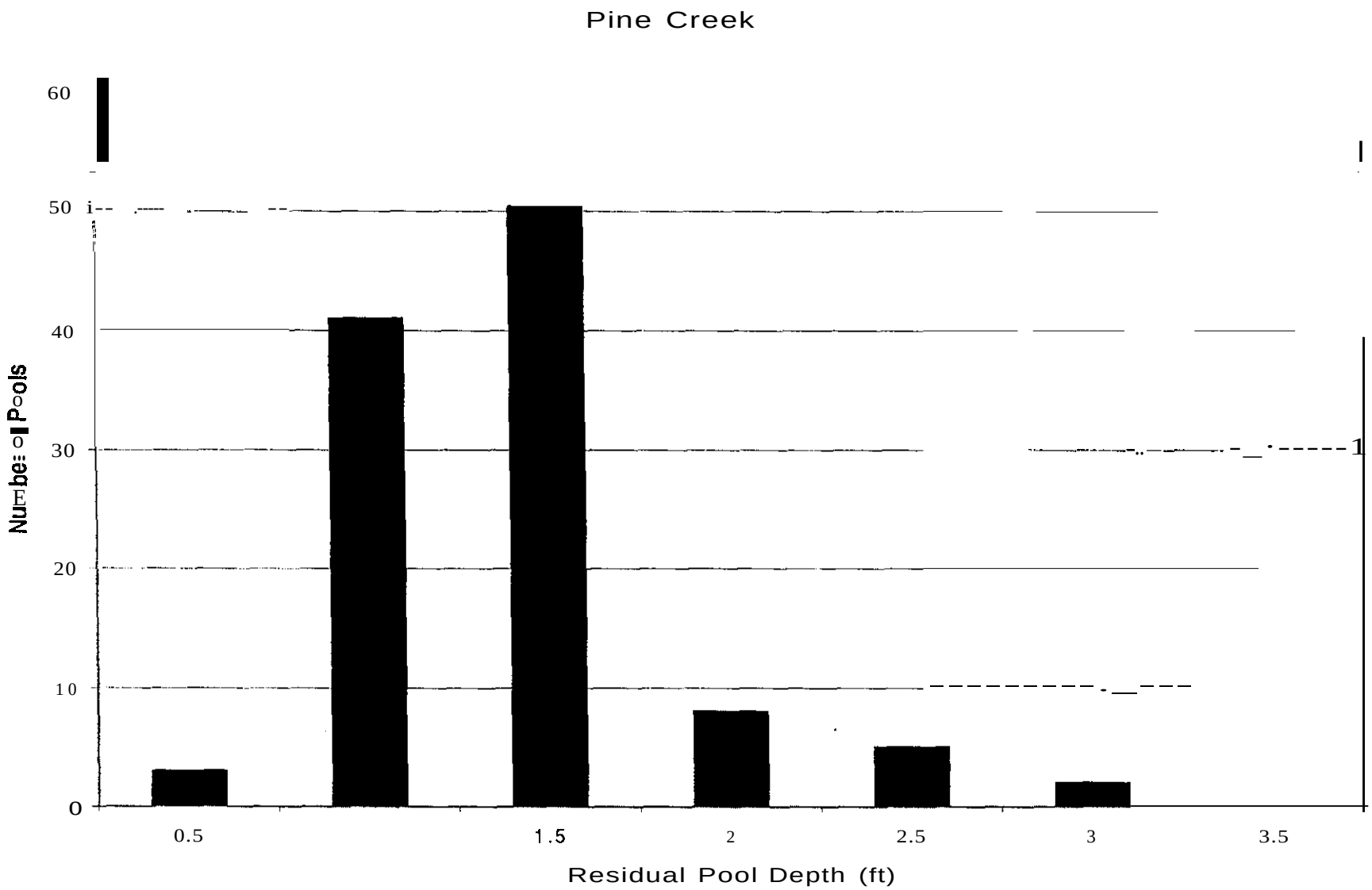


Figure 8. Depth Distribution of Pine Creek Pools, October, 2001.

A total of seven Wolman pebble counts were conducted along Pine Creek. The surface sediments were dominated by pea gravel, gravel and rubble. In general, there was a greater range of substrate size in Pine Creek compared to the West Fork, especially among the upper reaches of Pine Creek. Lengthy channel segments in Reaches P6 and P7 had relatively high proportions of coarse sand or fine pea gravel as seen in Photograph 34, Roll 14, October 15, 2001 (supplemental photo file). These substrate conditions are not adequately captured by the pebble count data (see Table 10). Small boulders comprised as much as 35% of the surface material in Reach P6, while P7 contained 70% pea gravel. (The low number of pebble counts taken in Pine Creek should be borne in mind [Bunte and Abt 2001] when considering extrapolation of these percentages.)

Larger LWD pieces meeting INFISH standards were generally absent in Pine Creek (see Table II). The average LWD dimensions were 6.1 m (20.1 ft) long by 0.24 m (0.8 ft) in diameter. As observed on the West Fork, a low proportion (1.71%) of the LWD was submerged under the low water conditions. Rootwads were much less as abundant or dense than on the West Fork.

Areas of bank instability along Pine Creek were associated with natural events and geologic features. There was little variability (72.2 to 88.1%) in bank stability between the seven reaches, with one exception. Right bank stability was low (51.4 %) overall in Reach P6 due to high, naturally-eroding banks in that area (see Table 12).

4.2 FISH SURVEYS

4.2.1 West Fork Jarbidge River

Special attention was paid in the headwater areas to determine the upstream limit of fish presence. An obvious barrier to upstream fish passage was noted in Reach WlI at about elevation 2353 m (7720 ft) (Photograph 28, Roll 6, October 13, 2002). A UTM location was obtained about 15 ıı (50 ft) north of these falls on the talus hillside: 633615,4627942. Each step pool was surveyed from this point downstream to the confluence with an unnamed left bank tributary (upper end of Reach WIO), and no fish were observed. There were numerous bedrock cascades and wood jams in this reach that were deemed barriers to upstream fish passage (see supplemental photographs). Most step and pocket pools in the next 590 meters (645 yds) of Reach WlO were surveyed, and again no fish were observed. The first trout, a redband trout <5 em «2 inches), was seen in Unit 37 of Reach W9 at UTM 632775, 4628923. Since fish were not seen above putative barriers located near the top of Reach WI0, habitat surveys were not extended into Reach WII.

A total of 173 redband trout were observed within the II stream reaches of the West Fork (Table 15). However, *nd* bull trout were observed. Four mountain whitefish were observed in Reach 2, ranging in size from 5 to 25 em (2-10 inches). Three sculpins were also observed, although no length estimates were made.

Table 15. Stream Reach Lengths and Fish Densities, Jarbidge River Fisheries Survey, October, 2001.

				Fish Observations			Fish Density	
Reach	Reach Length (m)	Cumulative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #1100m	Bull Trout #1100m
West Fork								
WI	702	42	39	7	a	a	18,1	0.0
W2	3114	197	181	64	a	4	35.5	0,0
W3	1588	74	68	5	a	a	7.4	0.0
W4	603	19	17	1	a	a	5,8	0,0

Table 15. Stream Reach Lengths and Fish Densities, Jarbidge River Fisheries Survey, October, 2001 (Continued).

				Fish Observations			Fish Density	
Reach	Reach Length (m)	Cumulative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #/100m	Bull Trout #1100m
West Fork (cont'd)								
W5	1514	111	102	15	0	0	14.7	0.0
W6	1173	66	60	18	0	0	29.8	0.0
W7	1335	25	23	44	0	0	195.1	0.0
W8	1433	NO	NO	15	0	0		0.0
W9	1433	NO	NO	4	0	0		0.0
W10	590	NO	NO	0	0	0	0.0	OO
W11	640	NO	NO	0	0	0	0.0	0.0
Totals:	14,124	534	489	173	0	4	35.4	0.0
Pine Creek								
P1	1184	62	57	2	0	0	3.5	0.0
P2	1207	32	29	6	0	0	20.5	0.0
P3	2175	43	39	17	0	0	43.2	0.0
P4	1102	NO	NO	4	1	0		
P5	757	28	25	8	0	0	31.6	0.0
P6	662	9	8	0,	0	0	0.0	0.0
P7	527	NO	NO	6	0	0		
Totals:	7,613	174	158	43	1	0	20	0
East Fork								
E1		92	84	21	0	1	25.1	0.0
E2		76	69	46	0	2	66.2	0.0
E3		49	45	22	0	0	49.1	0.0
E4		42	38	15	0	0	39.1	0.0
E5		26	24	31	0	0	130.4	0.0
E6		28	26	43	0	2	167.9	0.0
E7		38	35	31	0	0	89.2	0.0
E8		73	67	30	0	9	44.7	0.0
E9		52	48	49	0	10	103.1	0.0
E10		49	45	44	0	1	96.9	0.0
E11		52	48	15	0	1	31.3	0.0
E12		61	55	39	0	3	70.3	0.0
E13		124	113	50	0	0	44.2	0.0
E14		44	40	41	0	5	101.9	0.0
E15		56	51	49	1	0	95.7	2.0
E16		31	28	10	0	0	35.3	0.0
E17		38	35	25	0	0	71.9	0.0
E18		69	63	38	1	0	60.2	1.6

Table 15. Stream Reach Lengths and Fish Densities, Jarbidge River Fisheries Survey, October, 2001 (Continued).

				Fish Observations			Fish Density	
Reach	Reach Length (m)	Cumulative Snorkel Length (yd)	Cumulative Snorkel Length (m)	Redband Trout	Bull Trout	Mountain Whitefish	Redband #/100m	Bull Trout #/lOOm
E19		47	43	26		0	60.5	2.3
East Fork (cont'd)								
E20		46	42	8	0	0	19.0	0.0
E21		36	33	22	0	0	66.8	0.0
E22		45	41	27	1	0	65.3	2.4
E23		34	31	35	2	0	112.6	6.4
E24		31	28	3	0	0	10.6	0.0
E25		42	39	2	4	0	5.2	10.4
E26		36	32	0	2	0	0.0	8.2
		1316	1204	722	12	34	59.9	1.0

The redband trout in the West Fork ranged in estimated length from <5 cm (2 inches) to >25 cm (10 inches), with 62% <10 cm (4 inches). The length frequency histogram was skewed towards smaller fish when compared to that seen in Pine Creek and the East Fork (Figure 9). The cause of this difference is largely a matter of speculation, but could indicate relatively greater reproductive success in the West Fork, greater of older redband trout, or a lack of pool area to support larger fish. Estimated abundance ranged from 5.8 to 195.1 redbandtrout/100 m (mean 35.4 trout/100 m).

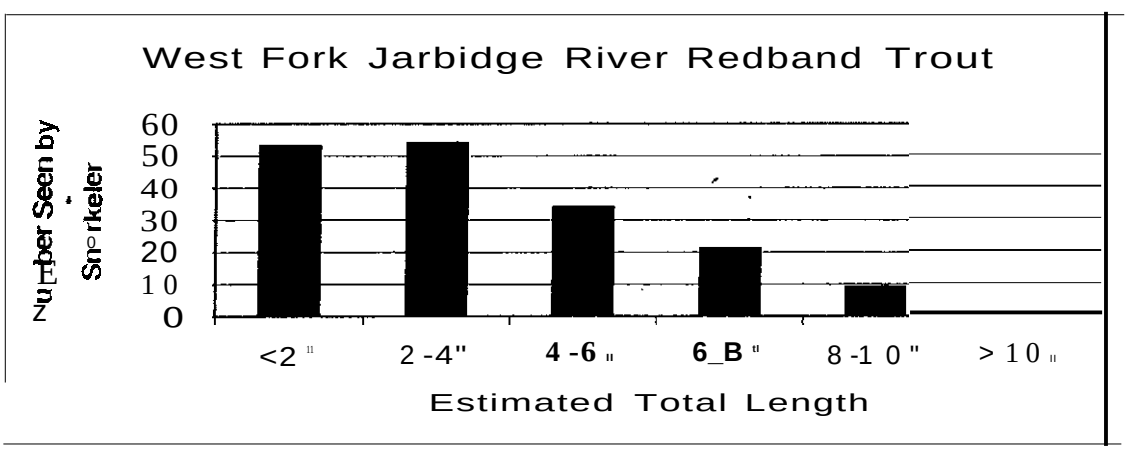


Figure 9. Categorical Length Frequency of West Fork Jarbidge River Redband Trout, October, 2001.

4.2.2 Pine Creek

A total of 43 redband trout and one bull trout were observed along the seven stream reaches of Pine Creek (see Table 15). There were four observations of sculpins, but no mountain whitefish were observed. The redband trout ranged in estimated length from <5 em (2 inches) to 25 em (10 inches), with 32% of the fish <10 em (4 inches). Redband trout abundance ranged from 3.5 to 43.2 redband trout/IOO m (mean 20.8 trout/100m). The length-frequency histogram indicates a more normal population size structure than the West Fork, but is limited in sample size (Figure 10).

The single bull trout (10-15 em [4-6 inches] in size) was observed in a run habitat unit in Reach P4 (elevation m [7300 fi]), approximately 5.2 km (3.2 mil upstream from the confluence with the West Fork. However, no accurate estimate of bull trout abundance or density can be generated because the snorkel distance was not recorded for this reach.

4.2.3 East Fork Jarbidge River

Over 21 km (13.15 mil of the East Fork were surveyed for fish. A total of 722 redband trout, 12 bull trout and 34 mountain whitefish were observed in the 26 reaches (see Table 15). There were also two observations each of sculpins and bridgelip suckers.

The redband trout ranged in estimated length from <5 cm (2 inches) to >25 em (10 inches), with 14.7% <.10 cm (4 inches). Redband trout abundance ranged from 0.0 to 167.9 fish/loa m (mean 59.9 fish/IOO m). The length-frequency histogram suggests there may be some limitations on redband reproduction in the East Fork (Figure 11).

The bull trout ranged in size from <5 cm (2 inches) to 20-25 cm (8-10 inches), with only one fish <10 cm (4 inches) and fish in the 15-25 cm (6-10 inches) size class were most abundant (66%) (Figure 12). Abundance estimates ranged from 0.0 to 10.4 fish/lOO m (mean 1.0 fish/loa m). Bull trout were most abundant in the upper reaches of the East Fork; 75% of the bull trout observed were seen above 2100 m (6900 fi) elevation. There were no observations of bull trout below elevation 1951 m (6400 fi).

Mountain whitefish were observed in most reaches below 1950 m (6400 fi). The estimated size range of the mountain whitefish was 5 to >30 cm (2 to>12 inches).

4.3 BULK SEDIMENT SAMPLES

A total of 45 bulk sediment samples were collected along the West and East (Table 16). One sample collected at station WF-4 (sample #3 I) was discarded because the sample core was strongly biased by a root mass from the adjacent riparian vegetation. Bulk sediment samples from the four West Fork sites contained a mean of 7.1 % fine sediments «0.85 rnm) and 85.3% >2 rnm (see Section 5.3). With the exception of Sample #1 at Site WF-l, the WF-4 outlier, and three samples potentially affected by the channel change (see below), most samples had low to very low percent fines <0.85 rnm (2.1 - 8.7 %). Since most of the replicate samples were taken from potential spawning sites, we conclude that spawning gravel in the areas sampled should support relatively high egg-to-fry survival rates, based strictly on substrate composition (Chapman 1988; Waters 1995; Kondolf 2000). Visual observations of gravel quality in most potential spawning areas surveyed in all three streams appeared similar to the bulk sample sites in terms of surface fines and embeddedness.

Analysis of variance of the <0.85 rnm sediment size percentages revealed that the higher fines fraction (14-18.2%) at the junction of the old channel with the relocated channel (Site WF-2) relative to sites both upstream and downstream was statistically significant (Appendix D). The statistical analysis was repeated with the three "old channel face" samples removed to determine if the increase in percent fines was a highly localized phenomenon. This analysis resulted in statistically indistinguishable levels of percent fines among any of the five sampling sites.

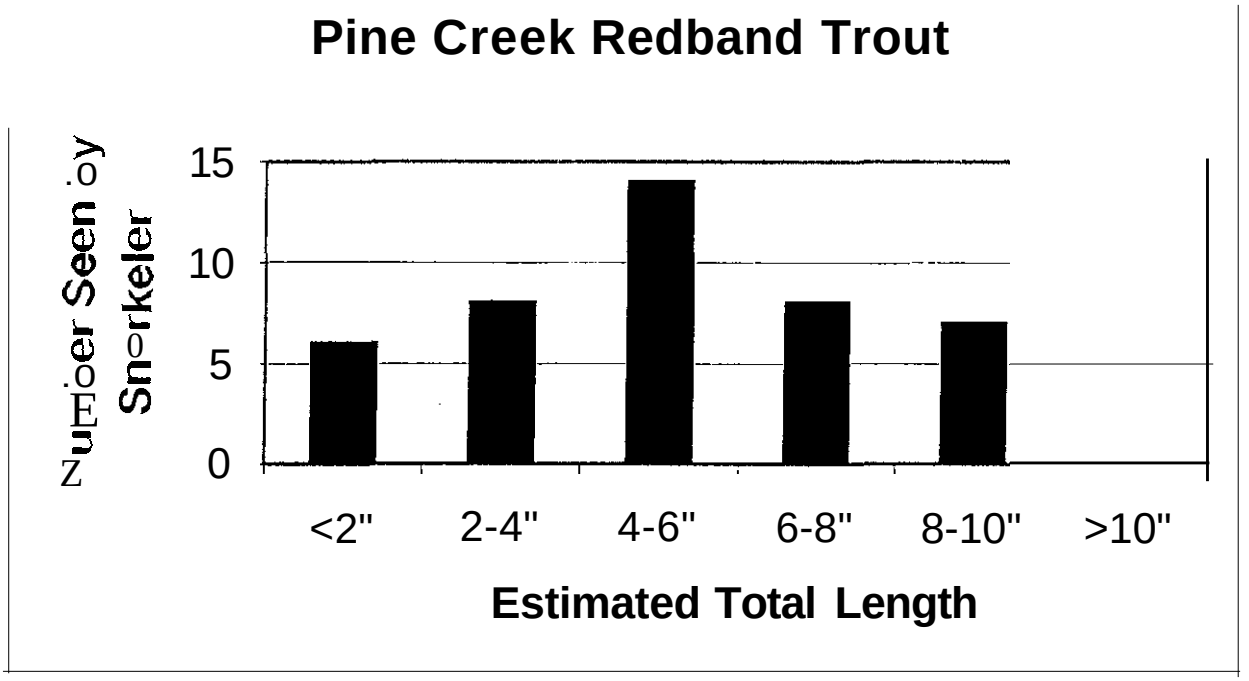


Figure 10 Categorical Length Frequency of Pine Creek Redband Trout, October, 2001.

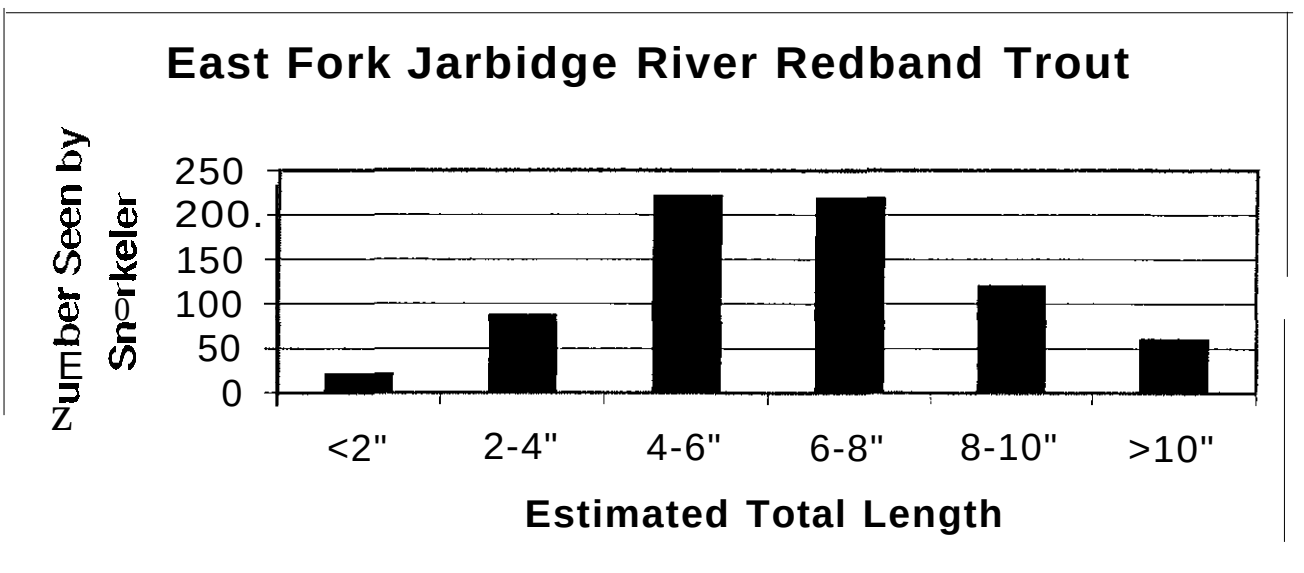


Figure 11. Categorical Length Frequency of East Fork Jarbidge River Redband Trout, October, 2001

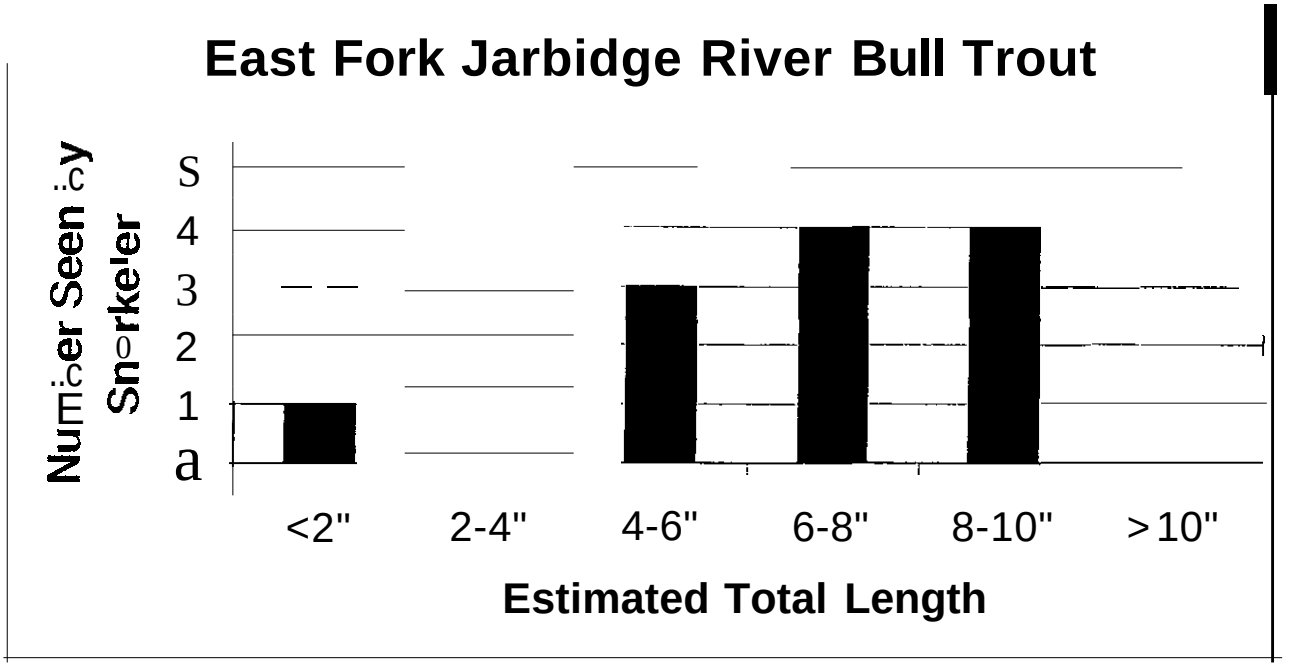


Figure 12 . Categorical Length Frequency of East Fork Jarbidge River Bull Trout, October, 2001.

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001.

Site Number	Site Description	Sample Number	Percent .85·2 mm	Percent <.85mm
WF·I	Upper WF·"Conlrol"	1	15.45	27.23
		2	5.96	7.76
		3	8.71	7.60
		4	5.10	2.14
		5	5.64	4.43
		6	5.41	4.02
		7	6.60	8.05
		8	6.31	7.79
		9	9.01	4.51
		Averages:	7.58	8.17
		SO	3.26	7.46
WF-2	Channel Relocation Site	10	12.32	8.16
		11	5.66	5.75
		12	13.65	18.15
		13	8.85	17.18
		14	7.66	14.01
		15	7.04	393

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001 (Continued)

Site Number	Site Description	Sample Number	Percent .85 -2 mm	Percent <.85 mm
WF-2 (con't)		16	13.21	8.68
		17	8.95	6.53
		Averages:	9.67	10.30
		SO	3.01	5.42
WF-3	Lower Campground Site	18	9.00	10.21
		19	7.92	7.83
		20	9.53	4.87
		21	11.17	6.16
		22	9.80	6.58
		23	4.02	3.26
		24	2.77	3.67
		25	5.18	6.20
		Averages:	7.42	6.10
		SO	3.05	2.26
WF-4	Bridge Below Pine Creek	26	4.01	4.99
		27	3.40	4.21
		28	4.12	3.18
		29	5.43	5.86
		30	5.22	4.71
		31	14.76	13.94
		32	4.04	6.67
		33	3.95	3.95
		Averages:	5.62	5.94
		SO	3.76	3.41
Deleting Sample #31:		Averages:	4.31	4.80
		SO	0.74	1.18
EF-l	East Fork Jarbidge· "Controls"	34	5.60	2.60
		35	10.12	7.34
		36	6.99	4.24
		37	4.66	4.25
		38	10.10	7.01
		39	7.87	388
		40	8.98	4.66
		41	9.91	4.14
		42	5.19	2.98

Table 16. Percent Fines « 0.85 mm) by Volume of West and East Fork Jarbidge River Substrate Samples, October, 2001 (Continued)

Site Number	Site Description	Sample Number	Percent .85·2 mm	Percent < .85mm
EF·l (con't)		43	8.99	6.31
		44	5.60	4.98
		45	8.71	5.75
		Averages:	7.73	4.84
		SO	2.04	1.49

5.1 HABITAT SURVEYS

The habitat survey indicates that West Fork and Pine Creek contain adequate, although not ideal habitat for bull trout. A primary determinant of suitable bull trout habitat is often considered to be the thermal regime (Dunham and Chandler 2001; NDoW 2000). The substantial number of fish and habitat studies conducted in the Jarbidge watershed unequivocally demonstrate, directly or indirectly, that the thennal regimes of the West Fork and Pine Creek are generally suitable for bull trout (Lawson and Pfeifer 2002). However, there are locations and times of the year when water temperatures probably limit bull trout movements or utilization of rearing habitat (McNeill et a1. 1997). This survey did not sample at a time of year when temperature may be problematic. The purpose of this report is to identify and describe the physical habitat, beyond temperature, available to fish utilizing these two streams.

Several studies have described habitat features thought to be beneficial to bull trout utilization (Table 17). Dambacher and Jones (1997), cited in Dunham and Chandler (2001), indicate important habitat variables include percent gravel, percent fines, LWD frequency and volume, and percent undercut banks. Other authors have indicated that bull trout distributions are influenced by the presence of other salmonids (e.g. Watson and Hillman 1997). lNFISH riparian management objectives (USFS 1995; Ramsey 1997) provide habitat criteria for pool frequency, LWD, and width-to-depth ratio.

Table 17. Authorities and Habitat Variables Important to Bull Trout

Study	Variables listed as beneficial to bull trout habitat
Dambacher and Jones (1997)	Percent Gravel, Percent Fines, Percent Bank Erosion, Percent Undercut Bank, LWD Frequency, LWD Volume
Watson and Hillman (1997)	Undercut Bank, Other Salmonids, Large Substrate (low fines), Pools
INFISH, USFS (1995)	Pool Frequency, LWD Frequency, LWD Size, Width-to-Depth Ratio

Because of the lack of bull trout observed on the West Fork and Pine Creek, and the lack of habitat data on the East Fork, it is not possible to make direct comparisons between habitat characteristics and bull trout abundance or distribution in this study. However, it should be noted that the majority of bull trout observed on the East Fork were concurrent with the fewest observations of redband trout. This observation is in agreement with the predictions of Watson and Hillman (1997) who found that bull trout abundance was often inversely con-elated with brook and/or redband trout abundance.

5.1.1 Substrate Quality

The pebble counts taken during the habitat study and the bulk sediment samples generally characterize the substrate quality in the West Fork and Pine Creek. The bulk sediment samples and the pebble counts indicated a low fraction of fine materials in the substrate. The percent of fine «0.85 mm) materials in the bulk sediment samples (7.1 %) and the fraction of sediment <2 mm from pebble counts (5.7%) exceed the criteria for high quality bull trout habitat «8%) given by Dambacher and Jones (1997). The pebble counts along the West Fork and Pine Creek were dominated by gravel and rubble and should provide suitable substrate for bull trout spawning. Careful observation of potential spawning sites in the headwater areas during the survey suggested there is a significant amount of suitable gravel for bull trout spawning, but we did not quantify the area of this habitat, nor did we sample these sites below the substrate surface. Without seeing spawners on redd sites, it is very difficult, if not impossible to locally quantify what is or is not useable spawning area by bull trout that have exacting spawning requirements.

The relative abundance of potential spawning area is based on the senior author's years of experience conducting bull trout spawning surveys in Washington.

Sites selected for spawning by resident or fluvial bull trout are expected to be protected from scour, in clean, well-irrigated coarse sand or small gravel ranging in size from roughly 5-8 mm up to about 35 nun, depending on spawner size. Some stocks also utilize sites that include some cobble 50 mm or larger (Goetz 1989). Areas with groundwater influence are often used preferentially. Confined channels with moderate gradients often present conditions where char or trout must utilize appropriately sized substrate that is only found in pockets or small patches, often in areas of reduced velocity or hydraulic energy. We tended to see these general bull trout spawning site conditions stochastically distributed throughout most of the reaches surveyed from Jack Creek to the headwaters. Therefore, it was impossible to define the boundaries of bull trout spawning habitat without gaining feedback by seeing spawners from the locally adapted population choose their preferred sites. In general, bull trout spawn in extreme headwater areas within river basins, and the information on bull trout fry production collected by Johnson (2001. Personal Communication) tends to indicate this pattern in the Jarbidge River forks as well. However, other populations spawn in 2nd or 3rd order river mainstems well below the headwaters, even though access to the headwaters is not blocked (e.g. Cedar River above Lake Chester Morse, Lake Washington drainage, King County, Washington). Bull trout use of lower Jarbidge River tributaries such as Dave Creek, Slide Creek, and Jack Creek suggest the potential for lower spawning in the West and East Forks proper, although this has not been documented to date. If bull trout naturally choose to spawn only in higher headwater areas in the Jarbidge River forks, this may be a response to somewhat more limiting thermal or hydraulic regimes in the mainstems at lower elevations.

5.1.2 Large Woody Debris Abundance

Other variables identified as critical to quality bull trout habitat include the frequency and size of LWD although there is substantial variation in the guidelines. INFISH riparian management objectives indicate that good quality habitat should have more than 20 LWD pieces per mile (1/100 m) of the larger size classes, while Dambacher and Jones (1997) suggests a frequency of at least 25 pieces/100m for "high" quality habitat. However, Dambacher and Jones (1997) describe habitat needs in Oregon, where both the sources of LWD and the need for LWD (for controlling erosion rate in higher flows) are greater. Only I of the 17 stream reaches surveyed on the West Fork and Pine Creek had large LWD present at 1.0 piece / 100 m or more (Reach W6). There was a distinct lack of this size LWD elsewhere, and the mean occurrences for all reaches of the. West Fork and Pine Creek were 0.48 and 0.25/100 m, respectively. Therefore, it appears that the frequency of larger LWD observed in this study a potential habitat deficiency for bull trout. This presumes that the larger (Class 7 and 8) LWD abundance guidelines cited above are appropriate for high elevation streams in northeast Nevada. When all sizes of LWD are considered, the number of pieces/iOO m is greater than the INFISH goal of 1.0 /lOOm for both streams (see Tables 9 and 14).

A 1996 habitat study along the West Fork (Ramsey 1997) documented a frequency of larger LWD of 2.41 pieces / 100m (n=31 pieces) for portions of Reach W8. This study documented only seven large pieces (0.54/ 100 m). We cannot explain this very large difference between statistics reported for 1996 and 2001. A possible cause might be differences in the physical start and end points of the surveys between the years. The large wood deficit in the Jarbidge River forks is noted in several recent reviews (e.g. Ramsey 1997). Past logging and citizen access to the wood for firewood collection have been noted as probable causes of the lack of large wood (McNeill et al. 1997).

LWD jams were common, particularly in the wilderness portions of the West Fork and Pine Creek. This is reflected in part by the very similar values for the number of aggregates/lOO m in the upper reaches of both of these streams (see Tables 9 and 14) - generally around 1.1-1.4 /100 m. Few, if any of these were

judged to be likely barriers 10 upstream fish passage. However, a notable exception was two relatively large jams fully spanning the East Fork at about elevation 2150 m (7060 ft) in Reach E23 (Roll 18, Photographs 14-17, October 19, 2001). Both bull trout and redband trout were observed above these jams, but all were less than 25 cm (10 inches). and all of the bull trout were less than 10 cm (8 inches). One 25-30 cm (10-12 inch) bull trout was holding in a pool immediately downstream of the lower jam. The stream had a 2.4 m (8 ft) vertical drop to this pool at the low flow condition. Upstream passage at this site is problematic, and should be surveyed during higher flows, particularly when fluvial bull trout may be moving upstream.

5.1.3 Large Woody Debris Size

Only a fraction of the LWD surveyed is in accordance with the INFISH size objectives for LWD piece density. INFISH recommends that the diameter of the LWD be >30 cm (12 inches) and >9.1 m (30 feet) in length. Although some wood certainly was seen in 2001 that met these criteria, the reach means were below, or well below 30 cm for all reaches except WI and W4 (see Table 14). Average LWD piece diameters ranged from 20 to 30 cm (8 to 12 inches) on the West Fork, and 20 to 28 cm (8 to 11 inches) on Pine Creek. The lack of larger wood is again probably largely due to historic logging, slow growth of new riparian timber, and firewood collection (McNeill et al. 1997).

5.1.4 Pools and Bank Conditions

INFISH management objectives recommend a pool frequency of approximately 4.7 pools per 100 meters based on a wetted width of 4.3 m (14.25 ft) (Ramsey 1997). In the present survey we documented an average of 4.6 pools /100 m in the West Fork and 5.8 pools /100m in Pine Creek. Most of these pools were relatively shallow due to the low flow period..

The extent of undercut banks along the West Fork (12-14%) exceeded the benchmark (>11%) for high quality bull trout habitat suggested by Dambacher and Jones (1997). However, there was very little undercut bank habitat along Pine Creek «1%). The primary reason for the limited undercut banks on Pine Creek is likely a result of the geomorphology of the stream. The bedrock formations and large boulders common along Pine Creek are not conducive to the development and maintenance of large expanses of undercut banks.

.The sources of bank erosion were not similar between the West Fork and Pine Creek. Major sources of bank erosion on the lower reaches of the West Fork were primarily associated with road fill and mine tailings. There was also a significant area of bank instability or erosion associated with the rechannelization work in Reach W6. Along the upper reaches of West Fork and along Pine Creek, bank instability or erosion was associated with natural events such as landslides and washouts, or simply steep erosive soils exposed to river toe cutting. The tally of bank erosion sites provides a rough index of the relative amount of conspicuous bank erosion, but this study was not designed to quantify sources of sediment or the area of banks being eroded. Twenty-one West Fork surveyed habitat units (5 percent) and four Pine Creek units (2.3 percent) had notable bank erosion points (see Table 12). These translate to 1.49 sites/km (2.4/mi) and 0.53/km (0.85/mi) in these streams, respectively, for a preliminary guideline on the frequency of significant erosion sites.

Bank erosion sites are also often sources of smaller sediment that is needed for spawning material by the fish community. Significant fine sediment accumulations were generally not seen in this survey except in some pools or other slow-water habitat. Given the apparent capability of the West Fork and Pine Creek to mobilize and transport fines from faster water habitat (pool tailout riffles, bar edges; see Section 4.3). bank erosion does not appear to be a significant factor potentially limiting bull trout reproduction. This sediment source may even be essential to retain a supply of the smaller grain sizes for pocket spawning

habitat (but see further discussion in Section 5.3). Direct or indirect evidence of bull trout spawning has only been documented in headwater areas of the West Fork, primarily above Sawmill Creek (Johnson 1999,2001), but we did not note any substantial bank erosion points in these locations (Table 12).

5.2 FISH SURVEYS

5.2.1 Bull Trout Abundance

There have been several fISh surveys conducted on the Jarbidge River watershed over the past 45 years (Appendix Table C-l) using a variety of collection methodologies and occurring at different times of the year, making direct comparisons among the findings difficult. The present study is unique in timing. coverage, and methodology. For example, of the 31 fish surveys conducted in the West and East Forks, only eight utilized snorkeling methods, and each of these were conducted during the summer months. This survey was conducted from October 9-21, 2001. No studies along Pine Creek have utilized snorkeling. With this caveat in mind, our findings concur with several of the general observations previously reported. Those surveys showed that bull trout are present in relatively low numbers along the East and West Forks and their tributaries, that bull trout occurrence is generally greater at higher elevations, and is also greater in the East Fork than in the West Fork (e.g. Parrish 1998; Johnson 1999).

The apparent absence of bull trout in the West Fork and their extremely low abundance in our survey of Pine Creek are most likely a result of the timing of the survey, and not necessarily an indication of true abundance or habitat use. Bull trout commence spawning when water temperatures drop to approximately 7_9° C (44.5-48° F) (Goetz 1989). Since spawning can be completed in a few days, it would be easy for us to have missed members of a small fluvial spawning population. Goetz (1989) reports studies of populations where spawning was completed in 4-6 days, and where females moved downstream after spawning. We saw no paired up bull trout, or any obvious redds. However, the substrate conditions in the likely spawning areas would make detection of redds quite difficult unless they were either very fresh, or spawners were nearby.

The morning water temperatures in the West Fork and Pine Creek decreased to 4.4-7.2° C (40-45° F) prior to beginning this survey, and a majority of the migratory bull trout might have already spawned and moved downstream, beyond the lower reaches of the survey. In particular, water temperatures ranged from 3.3-6.1° C (38-43° F) in the known bull trout spawning areas in the headwat.er areas. The resident fish and young of the year had probably moved into the substrate and deep cover, rendering them unobservable to the snorkelers. In fact, a brief electrofishing survey (covering about 90 m of stream) conducted by NDoW and USFS personnel on the West Fork (near Dry Gulch) shortly after our survey produced three bull trout. The surveyors reported that the fish were deep in substrate cover and difficult to capture (Amy 2001. Personal communication). Therefore, the low abundance of bull trout observed in the West Fork and Pine Creek in this study should not be interpreted as accurately representing true population size, and likely underestimates abundance due to sampling difficulties inherent in daytime snorkeling and the cold water temperature (Peterson et al. 2001).

The greater number of bull trout observed in the East Fork may be due to one or more factors. Stream temperatures may have warmed somewhat in the East Fork by the time we conducted our snorkel surveys. The observed temperature at midday in the headwaters (5.6° C or 42° F) was several degrees warmer than what we encountered in the West Fork at a similar time and elevation (3.3-4.4° C [38 - 40°FJ) (see Table 7). We noted that the far more abundant redband tront were more active in the afternoon, with more individuals venturing out from deep cover and feeding as stream temperatures approached 7.5° C (45° F) or higher. Movement out of refugia with stream warming may partly explain seeing more bull trout in the East Fork than in the West Fork or Pine Creek.

Despite the potential effect of water temperature on our study results, the East Fork may simply support a larger bull trout population size than the West Fork. Johnson (1999) and Johnson and Weller (1994) both suggest a greater population density in the East Fork relative to the West Fork. In addition, the East Fork is less impacted by anthropogenic influences due to its remoteness, both in terms of fishing pressure and habitat manipulations. Our total count of bull trout and their observed density in the three streams very likely under-represent their abundance at other times of the year regardless of the actual proportions of resident and fluvial life histories. The source of this probable bias is the late date of the survey, low stream temperatures, and the use of daytime versus nighttime snorkeling methodology (Peterson et al. 200I). We believe a more accurate estimate of bull trout population size, including the fraction of spawning adults, can be obtained by a sampling design using at least some night snorkeling in combination with foot and daytime snorkeling surveys. This should be initiated as stream temperatures begin to drop to 9°C (48.2 ° F) in the fall as compared to the <6° C (42.8° F) temperature of our surveys.

5.2.2 **Bull** Trout Distribution

The bull trout distribution observed in the East Fork during the present survey is consistent with previous studies despite differences among survey methodology and timing. With the exception of Partridge and Warren (2000), all reported observations of bull trout occurred at elevations greater than 2134 m (7000 ft) in elevation. In addition, Warren and Partridge (2000) sampled fluvial fish using a weir upstream of the confluence of the East and West Forks in Idaho, and their findings are not comparable to the other surveys. USFSlNDoW (1993) located four bull trout from elevations 2219-2301 m (7280-7550 ft) and Johnson (1999) observed eight bull trout at elevations greater than 2316 m (7600 ft). Both of these studies sampled from at or below Robinson Creek (elev. 1783 m or 5850 feet) to the headwaters. A single site was electrofished by NDoW (2000) at 2243 m (7360 ft), and spot shocking slightly upstream revealed the presence of seven bull trout. In the present study, 75% of the bull trout were observed at or above this elevation. To our knowledge, we report the scientific observations of bull trout at the lowest elevation (1951 m [6400 ft], Station E-15) in the Jarbidge River system.

There is a slight indication of an increase in fish length below 2134 m (7000 ft). Bull trout collected below 2134 m (7,000 ft) ranged in estimated length from 15-25 cm (6 to IO inches), while fish collected above 2134 m (7,000 ft) ranged in estimated size from <5 to IO cm (2 to 8 inches). This shift in size range suggests that perhaps the lower elevation fish were or included fluvial migrants, and the fish above 2134 m (7,000 ft) represent resident young of the year fish. However, the limited number of fish observed, especially below 2134 m (7000 ft), limits the strength of this inference.

In addition to the uncertainties associated with the sampling methodologies, we collected little or no habitat information in the East Fork. Therefore, we are unable to determine if habitat availability is influencing bull trout distribution and abundance among the three fish sampling areas.

5.2.3 Redband Trout and Other Fish Species

Redband trout were observed throughout all stream reaches surveyed, however the number of redband trout observed was lower in the upper-most reaches of all three streams. Mountain whitefish were observed in both the East and West Fork but there were no observations of whitefish in Pine Creek. The mountain whitefish observations were confined to the lower reaches of the streams (below 1950 m). Other fish species observed during the survey were bridgelip suckers (low numbers in East Fork only) and sculpins (all streams).

5.3 SPECIAL SEDIMENT SAMPLING

In the Jarbidge River system, the accumulation of fine-grained sediments in potential spawning areas does not appear to be a problem due to the system's ability to flush fines downstream (Ramsey 1997; Warren and Partridge 1993). The bulk sediment samples obtained in this study confirm this finding. Analysis of the bulk sediment samples indicated that substrate quality in the West Fork near Pine Creek is generally high, and should pose no limitation on egg-to-fry survival for salmonids. The percentage of fines averaged 7.1% among the four sites sampled. There was a localized site with an increased fraction of fine sediments in the area of the old channel adjacent to Pine Creek Campground. These may have been deposited during the earlier heavy equipment work in the original channel, and have not been scoured out despite being exposed to flow in the new channel. Although most of our samples were low in fines, there are likely other areas in eddies and behind boulders or other structures where the percent fines is higher, similar to what we observed at this site. The salient point of our samples, we believe, is that most of the sites sampled were low in fines <0.85 mm, and these sites were in part chosen for sampling based on their potential as spawning sites by trout or char species.

Kondolf (2000) noted in his recent review of salmonid spawning gravel assessment that field and laboratory studies of the effect of interstitial sediment on salmonid egg to fry survival varies both in terms of the sediment size threshold examined, and the resultant effect. Selection of the 0.85 mm threshold is largely arbitrary, and was originally based on the early work of McNeil and Ahnell (1964). It is largely an artifact of the Tyler sieves used in that study, and it does not correspond to a break in size classes found on the standard Wentworth (1922) scale, which has since been modified by others (Cummins 1962) for the convenience of fisheries workers (Bain 1999). Other researchers have proposed other measures such as the geometric mean diameter (Shirazi and Seim 1981) or fredle index (Lotspeich and Everest 1981) to obtain a more accurate reflection of the overall substrate size composition. However, as pointed out by Kondolf (2000), "gravel quality" is by nature highly variable and complex, making selection of a single variable descriptor problematic as a suitable index of salmonid egg to fry survival following spawning. Field and laboratory studies to date generally conclude that egg and alevin survival falls below 50 percent when fines 0.85 mm or smaller constitute 12-14% or more of the redd matrix (McNeil and Ahnell 1964; Koski 1966; Cederholm and Salo 1979; NCAS1 1984; Tagart 1976). Results for coarser particles (e.g. < 2rnm) are less consistent (about 30% for 50% emergence; Koski 1966, 1975; Phillips et al. 1975), hence our choice of the smaller particle size cutoff. Empirical and quantitative field observations of the senior author of this report are consistent with the observation by Kondoif (2000) and others that redd site selection and the spawning action of hull trout, chinook, and steelhead are often major factors influencing the composition of the redd gravel after spawning. However, the fractions of particles <2 mm and <0.85 mm that we observed in potential spawning sites were both below levels that current literature suggests would yield egg to fry survival levels exceeding 75% or more (Hall and Lantz 1969).

Our visual appraisal and pebble count samples indicate spawnable gravel pockets and riffles in the upper West and East Forks and Pine Creek are generally low in fines, and are considered good to excellent substrate for salmonid spawning. However, these conditions are not necessarily what will exist throughout the lengthy bull trout egg incubation period. Percent fines alone is an inadequate measure of gravel suitability throughout egg and alevin incubation (Reiser and White 1988; Kondolf 2000). Higher flows and higher suspended sediment levels during freshets or floods can infiltrate fines into constructed redds, and create conditions leading to low egg or alevin survival (Cooper 1965; Tagart 1976). Conversely, salmon and trout typically reduce, or liberate fines as part of their redd-construction process (Kondolf et al. 1993). Thus, some potential spawning sites with percent fines in the 10-15% range may still be rendered suitable for relatively high egg to fry survival after redd construction.

Several general conclusions can be drawn from the results of this survey:

- Based on the timing and level of detail of habitat elements surveyed, the West Fork Jarbidge River and Pine Creek appear to have suitable habitat for bull trout spawning and rearing in the fall. Fluvial bull trout can likely utilize most of the surveyed areas with the possible exception of the East Fork above approximately elevation 2150 m (7060 ft). This survey revealed no obvious habitat limitations for bull trout apart from the possible limitation on upstream movement just noted. However, other studies suggest water temperature may limit bull trout movements or habitat utilization at times, particularly in the lower forks or mainstem Jarbidge River, or some tributaries. There was a possible deficiency in larger sizes of woody debris, but this did not appear to translate into a laek of pools per se. There was a general lack of deep pools. Whether this is a limitation on holding habitat for fluvial char, or rearing resident char was not determined.

- Measured substrate parameters along with careful observation indicate that the sediment composition throughout most of the West Fork and Pine Creek is consistent with generally high quality salmonid habitat. The introduction or retention of fine sediments as a result of the rechannelization of the West Fork appears to be limited to the immediate channel change area.

- The limited number of bull trout observed during this survey was likely the result of the late date of the survey and associated cold water temperatures and does not represent an accurate measure of habitat use or population size.

Further information regarding the quality and utilization of habitat in the Jarbidge River watershed would be gained by:

- Conducting a fish survey prior to the onset of cold water temperatures (>9^0 C or 48.2^0 Fl.

- Fish surveys utilizing nighttime snorkeling.

- Habitat survey on the East Fork concurrent with fish survey.

- Monitoring scour and fines content of known bull trout redds or surrogate redds constructed in immediately adjacent, similar spawning habitat through the egg and alevin incubation period.

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