Burton et al. 2001

Field Investigation of Dave Creek, tributary of EF Jarbidge River (September 11-13, 2001)

Tim Burton, James Klott, and Bruce Zoelick

I. Dave Creek

We investigated potential sediment effects to bull trout habitat resulting from the cattle crossing on Dave Creek and cattle trailing disturbances on the Little Island tributary to Dave Creek. Surveys were conducted on Dave Creek both upstream and downstream of the cattle crossing/disturbances to assess effects of these activities on bull trout. Section 7(a)(l) of the ESA requires federal agencies to utilize their authorities to conserve listed species. Clearly, BLM has authority to regulate any livestock grazing contributing to bull trout declines on lands we administer. If the upstream/downstream measurements suggest a grazing-derived problem for bull trout, then actions should be taken to correct the problem.

According to Frederick and Klott (1999) Dave Creek contains one of the three subpopulations of bull trout in the Jarbidge Watershed, suggesting that it represents an important proportion of the whole population. Figures 1 and 2 display maps of Jarbidge basin and Dave Creek. The lowest 3 miles of Dave Creek are on lands administered by BLM. No bull trout have been observed in section, has only been surveyed in summer months. Upstream of the BLM lands, Dave Creek flows on private lands (with one small ¼ section of public lands) over a distance of almost 4 miles. Because the stream in reach is above 6500 feet elevation, and because of the favorable gradients and gravel availability, it is estimated that reach has a significant potential to produce bull trout. In upper Dave Creek, upstream of the Forest boundary, there is approximately 1 mile of habitat.

Methods

Indicators for the habitat survey were selected from US Fish and Wildlife Service's "Framework" for assessing bull trout habitats (USF&WS 1998).

I). Percent fines and substrate embeddedness in rearing areas (target of <20%): The USF&WS references Shepard, Pratt, and Graham (1984) on work conducted in the Upper Flathead Basin. In that work, the authors estimated embeddedness using a technique whereby the observer rates embeddedness relative to one of 5 categories describing the extent to dominant sized particles are buried in sand and silt. method was tested for precision (repeatability) by Platts and others in 1983 and found to be a reasonably reliable estimator of substrate quality (observers differed by +/- 5.4% at the 95% level of confidence).

2). Substrate score was used by Shepard and others (1984) to describe rearing habitat potential for bull trout. Substrate scores were significantly related to juvenile bull trout densities. The score is determined from dominant and sub-dominant substrate particle size classes, and the degree to the dominant particles are embedded in fme sediment.

3). Spawning Habitat Survey: The spawning habitat survey is based upon: Graham, P.J., F. Shepard, and J.J. Fraley. 1981. Use of stream habitat classifications to bull trout spawning areas in streams. Montana Fish Wildlife and Parks, Kalispell, MT. Using

approach, the stream is walked in mid September and the locations of actively spawning fish are noted, along with stream segments with low gradient «2%), relatively large amounts of gravel material, and high quality pools.

Observations

At the confluence of Dave Creek and Little Island Tributary, we observed higWy complex stream habitats with dense overstory cover, frequent pools, much in-channel cover, and high levels of fine sediment embedded in the substrate. The stream channel is about 2-3 meters in width, and water temperature exceeded 15 degrees C on July 24, 2001. At the nearby cattle crossing, streambanks are bare for a distance of about 20 meters either side of the stream (Figure 3). A limited amount of fine sediment is entering the stream at this location. In the Little Island Tributary, heavy cattle trailing along the stream bottom was evident, and sediment transport was apparent, based on the observation of scour and deposition within the active channel of this intermittent stream. Sediment from this tributary is delivered directly to Dave Creek. A survey of substrate embeddedness and pool filling was conducted both upstream and downstream of the subject disturbances to assess the relative of these impacts, and to determine whether or not rearing habitats are impaired by excess sedimentation.

Figure 3. Cattle crossing on Dave Creek just upstream of the mouth of Little Island Tributary.

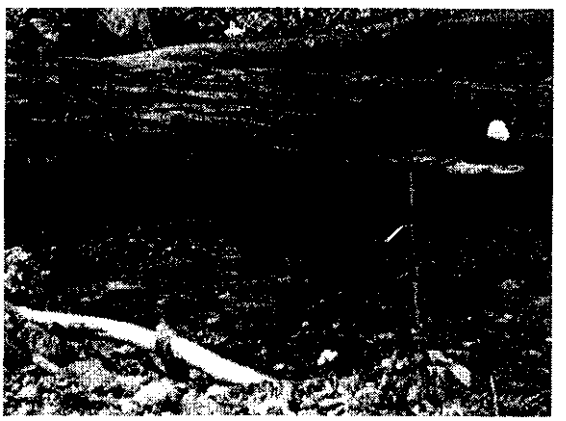
RESULTS

Percent Fine Sediment & embeddedness: The percentage of substrate particles as "fines" was examined to determine if contributions from the Little Island Tributary created a significant increase in substrate fmes within Dave Creek. As shown in Table 7 (Appendix 1), average % fine sediment increased slightly from 40.03 to 40.56%, upstream to downstream (not significantly different at p=.95). Embeddedness also increased slightly from upstream to downstream (56% to 63%) and the difference was not significant (at p>.95), as shown in Table 10 (Appendix 1). With high levels offme sediment observed both upstream and downstream of the Little Island Tributary, we investigated other sources upstream on Dave Creek. That investigation revealed that elevated sediment levels in Dave Creek likely originate from erosion of the degraded channel in sections 13,24,25, and 36. Substrate samples taken in Section 1, upstream of the Forest Boundary show a significant decrease of both % fines and embeddedness (Tables 7 and 10 in Appendix I). These differences are also displayed in the Figures of Appendix 2.

Shepard and others (1984) related percent fmes to bull trout spawning potential (Figure 4, Appendix 1). Predicted embryo survival rates are shown in Table 9 of Appendix 1. High embryo survival rates on most of Dave Creek averages about 50% (of pools). In the upper section, above the Forest Boundary, survival rates increase to about 100%, or all pools.

Figure 4. Pool substrate comparisons between Lower and Upper Dave Creek.

Poor substrate near Little Island Tributary.



Excellent substrate upstream of National Forest boundary on Dave Creek.

Substrate Score: Similar results were obtained for substrate score, as shown in Tables 1, 2, and 12 of Appendix 1. Using relationships developed for bull trout (Shepard et.a11984 - see Figure 5 in Appendix 2), we predicted existing and potential bull trout rearing densities in Dave Creek (Table 12). We estimated, that with degraded substrates, Dave Creek currently rears about 1100 bull trout. If Dave Creek substrates were to be restored, the estimated rearing capacity would increase to accommodate about 4000 bull trout. This would require modifications of livestock grazing intensity in the degraded stream reaches of upper Dave Creek.

Bull trout recruitment potential: Currently, high survival rates are predominant in upper Dave Creek, upstream of the Forest Boundary (100 % of pools). Low survival rates, poor pool habitat structure, and reduced rearing space downstream of the Forest Boundary constrains bull trout recruitment. If habitat structure and spawning condition were to be restored downstream of section 1 for approximately 4 miles, recruitment would increase significantly (5 miles at 100%/50% of pools = 4 X2 fold increase = 8 times).

Population recovery: Based on current rearing space (substrate score) and it's relation to bull trout density, we estimate the current bull trout population size at about 1000. A 4 fold increase in rearing density in 7 miles of stream, and a doubling of early life-stage survivals in the upper 4 miles of stream, would increase the population by at least 5000 fish, and possibly as much as 10,000 fish.

Figure 5. Degraded and good stream channel/habitats on Dave Creek.

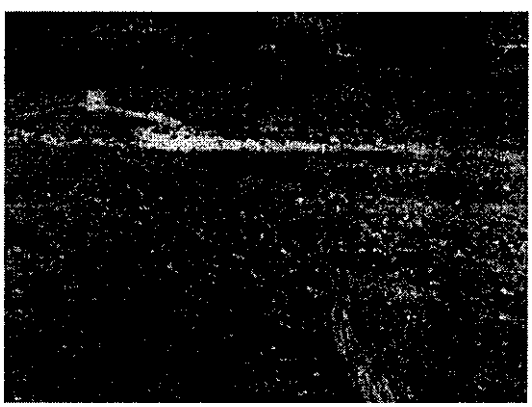


Figure 1. Location of Dave Creek in the Jarbidge Basin.

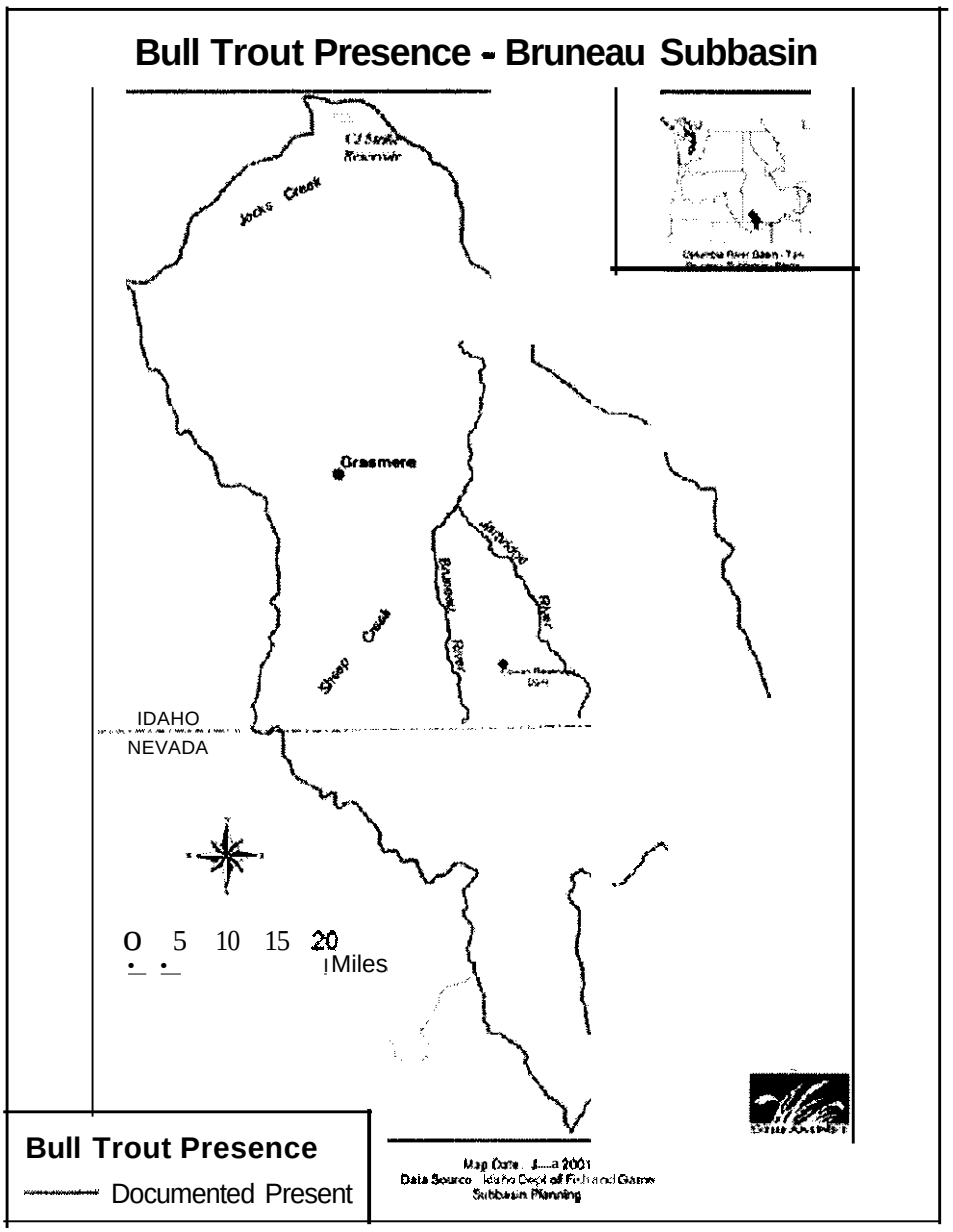
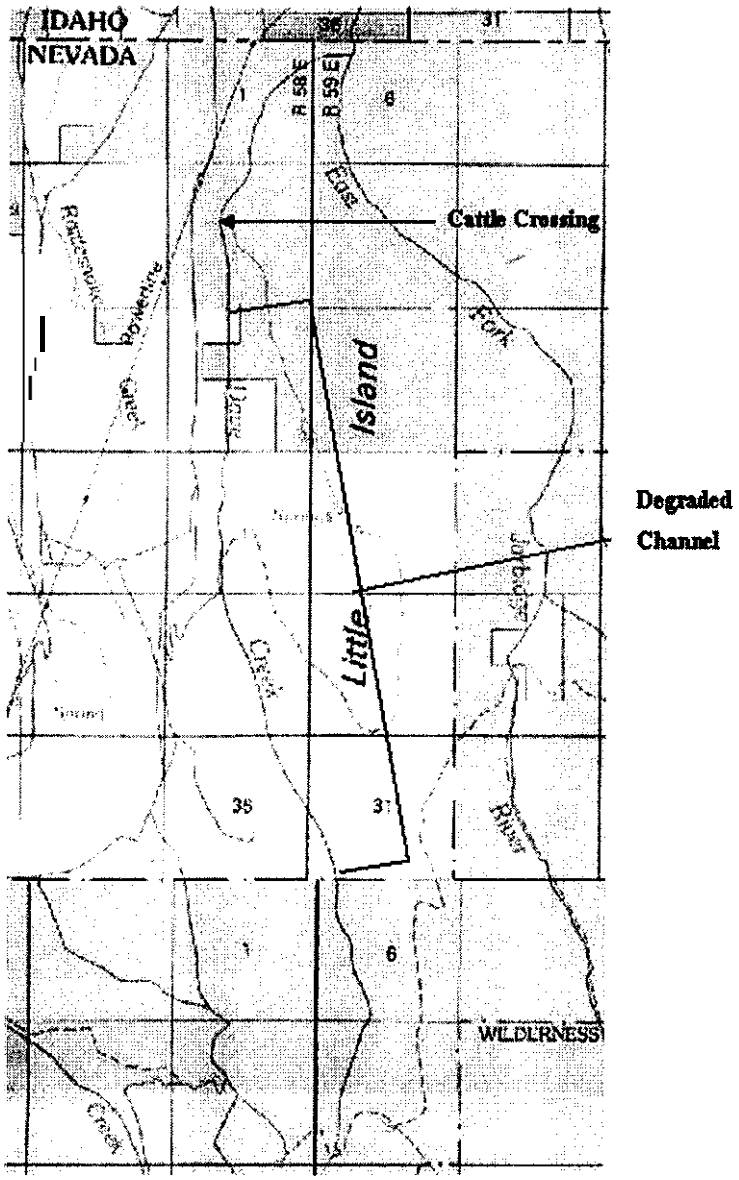


Figure 2. Dave Creek watershed, showing landownership and the location of the cattle crossing and degraded stream channel.



Appendix 1. Raw data and statistical analyses.

Table 1. Habitat data for Dave Creek UPSTREAM of the cattle crossing in Section 12.

Station	sand	peagravel	gravel	rubble	cobble	boulder	% Fines	Emb <5	Emb 5-25	Emb 25-50	Emb 50-75	Emb >75	EMBED	pool w	pool I	max	rear w	rear I	rear volume	Rime L
1	44	0	26	93	0	37	22	0	0	0	0	200	87	1.4	2.6	0.15	0	0	0	2
2	10	0	56	134	0	0	5	200	0	0	0	0	3	1.5	1.4	0.2	0.2	0.2	0.04	1.5
3	42	0	73	85	0	0	21	127	48	25	0	0	10	0.9	1	0.1	0	0	0	6.5
4	44	0	69	187	0	0	15	0	45	65	0	90	55	1.6	2	0.13	0	0	0	3.6
5	0	11	96	93	0	a	6	a	142	30	28	a	25	0.9	1.5	0.2	0.2	0.2	0.04	10
6	0	31	51	118	0	0	16	0	95	75	30	0	30	2.1	1.4	0.15	a	0	a	0
7	18	9	19	144	0	10	14	a	200	a	a	0	15	2.3	1.4	0.28	1.2	0.6	0.72	2
8	125	69	6	a	a	a	97	0	a	0	0	200	87	2	1.9	0.14	a	a	a	5.7
9	a	7	168	25	0	0	4	25	110	35	30	0	24	1.8	2.3	0.29	0.5	1	0.5	1.3
10	125	a	10	65	a	a	63	a	65	10	a	125	61	1.4	3.2	0.28	1	1.4	1.4	2.6
11	26	0	86	52	0	36	13	0	a	140	60	0	45	0.7	1.8	0.29	0.7	0.9	0.63	2.1
12	165	a	35	0	a	a	83	a	a	35	a	165	78	1.3	3.8	0.23	0.3	0.5	0.15	1.6
13	136	a	a	64	a	a	68	0	a	a	a	200	87	1.4	1.6	0.21	0.2	0.3	0.06	2.7
14	0	21	179	a	a	a	11	a	a	100	100	a	50	1.6	3.5	0.2	0.1	0.1	0.01	2
15	110	a	2	a	a	88	55	a	a	a	20	180	85	2.4	2.3	0.25	1	1.1	1.1	4.4
16	28	162	a	0	a	10	95	0	a	a	a	200	87	1.9	2.3	0.28	0.5	0.7	0.35	2.5
17	124	a	12	22	42	a	62	a	0	42	a	158	77	1	1.9	0.16	0	a	a	4.4
18	21	10	151	a	18	0	16	a	26	36	0	138	69	1.2	2.5	0.15	a	a	0	2
19	25	a	157	18	a	a	13	90	85	25	0	a	12	1.3	1.1	0.17	a	a	a	1
20	145	55	0	a	0	0	100	a	a	a	a	200	87	2.2	2.7	0.2	0.1	0.1	0.01	3.4
21	10	0	190	a	0	a	5	a	119	30	41	10	32	2	1.5	0.27	0.5	0.2	0.1	3.1
22	149	0	28	23	a	0	75	a	a	30	18	152	77	1	1.2	0.13	a	a	a	6.7
23	162	a	18	20	a	0	81	a	0	21	18	161	80	1.5	1.5	0.19	0	a	a	5.4
24	42	15	143	a	0	a	29	a	0	a	55	145	80	1.5	4	0.2	0.1	0.3	0.03	4
25	109	21	32	38	a	a	65	a	a	a	12	188	86	1.2	3.2	0.29	0.6	0.8	0.48	4.6
26	95	a	105	a	a	a	48	a	a	a	25	175	84	2	3.2	0.33	1.1	2.3	2.53	0
27	4	14	116	66	a	a	9	30	49	31	90	a	38	1.1	1.3	0.16	a	a	0	4.5
28	0	22	164	14	a	a	11	22	41	137	a	a	29	1.6	1.2	0.16	a	a	a	4.9
29	127	40	26	7	a	a	84	a	10	8	a	182	81	2.5	2.4	0.16	a	a	0	0.9
30	24	20	65	91	0	0	22	65	25	60	26	24	32	1	1	0.17	a	a	0	0

Table 2. Habitat data for Dave Creek DOWNSTREAM of the cattle crossing in Section 12.

Station	sand	peagravel	gravel	rubble	cobble	boulder	% Fines	Emb <5	Emb 5-25	Emb 25-50	Emb 50-75	Emb >75	EMBED	pool w	pool l	max	rear w	rear l	rear volume	Rime L	Particle size score	Embeddedness score	Sub Score
1	105	0	45	50	0	0	53	0	0	50	10	140	73	1.1	2	0.18	0	0	0	2.8	2.2	1.55	3.75
2	8	0	158	34	0	0	4	18	32	150	0	0	30	0.8	1.3	0.29	0.7	0.6	0.42	0.5	3.09	3.34	6.43
3	165	0	35	0	0	0	83	0	0	0	0	200	87	1.1	1.6	0.2	0.1	0.1	0.01	2.2	1.35	1	2.35
4	9	0	178	0	13	0	5	85	89	26	0	0	13	0.9	1.8	0.2	0.4	0.4	0.16	15.3	3.04	4.295	7.335
5	200	0	0	0	0	0	100	0	0	0	O	200	87	1.4	4.2	0.2	0.4	0.4	0.16	3	1	1	2
6	200	0	0	0	0	0	100	0	0	0	0	200	87	2	2	0.11	0	0	0	0	1	1	2
7	125	0	75	0	0	0	63	0	0	0	75	125	78	1.2	2.6	0.18	0	0	0	4.2	1.75	1.375	3.125
8	105	0	95	0	0	0	53	0	0	95	0	105	63	1.4	2.5	0.13	0	0	0	0	1.95	1.95	3.9
9	44	46	110	0	0	0	45	0	0	110	10	80	58	2	1.8	0.18	0	0	0	5.3	2.33	2.15	**4.46**
10	39	14	119	28	0	0	27	0	0	60	60	80	65	1.1	2	0.12	0	0	0	9.4	2.68	1.9	4.58
11	5	0	86	26	83	0	3	0	0	160	40	0	42	1.5	1.8	0.17	0	0	0	5.6	3.91	2.8	6.71
12	0	15	127	58	0	0	8	0	0	120	80	0	47	1.4	1	0.15	0	0	0	4.2	3.215	2.6	5.815
13	32	0	168	0	0	0	16	0	0	168	0	32	45	0.9	1.8	0.2	0.1	0.1	0.01	3	2.68	2.68	5.36
14	26	105	69	0	0	0	66	0	0	69	0	131	70	0.8	2.8	0.15	0	0	0	0.5	2.215	1.69	3.905
15	80	0	120	0	0	0	40	0	0	120	0	80	57	1	0.8	0.13	0	0	0	0.8	2.2	2.2	4.4
16	70	0	117	13	0	0	35	0	0	0	20	180	85	1	1.8	0.15	0	0	0	2.6	2.365	1.1	3.465
17	12	0	160	28	0	0	6	49	151	0	0	0	12	1.3	1.7	0.13	0	0	0	1.2	3.02	4.245	7.265
18	41	15	119	25	0	0	28	0	0	119	35	46	53	1	1.3	0.12	0	0	0	2.5	2.64	2.365	5.005
19	21	42	109	28	0	0	32	0	0	0	10	190	86	1.4	2.7	0.12	0	0	0	2.5	2.72	1.05	3.77
20	41	0	133	26	0	0	21	10	5	0	90	95	70	0.9	1.4	0.2	0.1	0.1	0.01	2.8	2.72	1.725	4.445
21	200	0	0	0	0	0	100	0	0	0	0	200	87	1.2	1.1	0.18	0	0	0	3.4	1	1	2
22	86	0	72	42	0	0	43	0	110	0	0	90	47	1.6	1.5	0.32	0.9	0.9	0.81	2	2.35	2.65	5
23	60	40	100	0	0	0	50	8	10	31	0	151	72	1.4	1.8	0.15	0	0	0	2	2.2	1.62	3.82
24	25	0	174	0	0	0	13	0	0	0	40	160	82	1.6	1.3	0.17	0	0	0	11.3	2.74874372	1.2	3.9487
25	52	0	148	0	0	0	26	0	0	0	O	200	87	1.5	2.4	0.23	0.4	0.8	0.32	0	2.48	1	3.48

Table 3. Habitat data for Dave Creek upstream of the National Forest Boundary in Section 6.

gravel	rubble	cobble	boulder	F % Illes	Emb <5	Emb 5-25	Emb 25-50	Emb 50-75	Emb >75	EMBED	pool w	pool I	max	rear w	rear I	rear volume	Riffle L
175	25	0	0	0	200	0	0	0	0	3	2.5	2.5	0.3	1	1.9	1.9	2.9
200	0	0	0	0	200	0	0	0	0	3	1.9	2	0.25	0.8	1	0.8	1.5
113	87	0	0	0	200	0	0	0	0	3	0.8	0.9	0.21	0.1	0.05	0.005	1.2
152	43	0	0	3	195	5	0	0	0	3	1.7	3.7	0.28	0.7	0.9	0.63	1
200	0	0	0	0	200	0	0	0	0	3	2.2	1.6	0.37	0.9	0.5	0.45	4.6
130	42	0	0	14	172	0	0	0	28	14	1.7	2	0.25	1.3	1.3	1.69	13
195	0	0	10	2	184	16	0	0	0	4	1.7	1.6	0.19	0	0	0	7.8
175	0	0	0	13	75	0	0	60	0	29	1	2.5	0.22	0.1	0.2	0.02	9.4
181	0	0	0	10	181	0	0	19	0	8	1.2	3.2	0.31	0.4	2.8	1.12	1
156	44	0	0	0	200	0	0	0	0	3	1.7	2.5	0.26	0.8	1	0.8	1

Table4. Substrate data for EF Jarbidge downstream of a tributary located .25 mile upstream of Murphy Hot Springs.

Station	Dominant	% Fines	Emb<5	Emb 5-25	Emb 25-50	Emb 50-75	Emb >75	EMBED	Embeddedness score	Sub Score
1	4.0	13	383	80	0	0	320	38	3.26	7.26
2	3.0	7	416	35	30	110	9	17	4.23	7.23
3	4.0	8	57	55	140	149	0	38	3.05	7.05
4	4.0	3	175	25	0	0	0	4	4.88	8.88
5	4.0	3	125	10	15	50	0	21	4.05	8.05
6	4.0	0	400	0	0	0	0	3	5.00	9.00
7	4.0	11	251	15	14	40	80	27	3.79	7.79
8	4.0	18	54	66	65	100	115	49	2.61	6.61
9	3.0	6	185	135	100	108	72	32	3.42	6.42
10	2.0	76	0	0	10	15	775	86	1.04	3.04
11	3.0	22	530	125	20	20	105	18	4.19	7.19
12	4.0	12	0	25	25	0	150	72	1.63	5.63
13	4.0	19	0	30	30	35	105	64	1.93	5.93
14	3.3	21	375	25	0	0	200	31	3.63	6.96
15	4.5	19	0	85	70	80	155	57	2.22	6.72

Table 5. Substrate data for EF Jarbidge upstream of a tributary located .25 mile upstream of Murphy Hot Springs.

Station	Dominant	% Fines	Emb<5	Emb 5-25	Emb 25-50	Emb 50-75	Emb >75	EMBED	Embeddedness score	Sub Score
1	3.0	7	240	75	20	65	0	16	4.23	7.23
2	4.0	21	10	50	40	100	0	42	2.85	6.85
3	2.7	17	215	100	85	25	175	37	3.26	5.93
4	3.7	5	525	65	10	0	0	4	4.86	8.53
5	6.0	16	175	25	0	0	0	4	4.88	10.88
6	3.3	19	205	30	115	130	320	51	2.59	5.84

Table 6. Substrate scores and statistics, EF Jarbidge River downstream and upstream of tributary.

Substrate Score

EF Jarbidge Upstream	EF Jarbidge Downstream
7.225	7.263090677
6.85	7.231666667
5.925	7.049875312
8.525	8.875
10.875	8.05
5.8375	9
7.225	7.7925
6.85	6.61
5.925	6.421666667
8.525	3.04375
10.875	7.19375
5.8375	5.625
7.225	5.925
6.85	6.958333333
5.925	6.717948718
8.525	6.917172092

Substrate Scores on EF Jarbidge River

t-Test: Paired Two Sample for Means

	EF Jarbidge Upstream	*EF Jarbidge Downstream*
Mean	7.4375	6.917172092
Variance	2.688979167	1.904813974
Observations	16	16
Pearson Correlation	0.06685198	
Hypothesized Mean Difference	0	
df	15	
t Stat	1.004726638	
P(T<=t) one-tail	0.16548106	
t Critical one-tail	1.753051038	
P(T<=I) two-tail	0.330962119	
t Critical two-tail	2.131450856	

Accept null hypothesis: the samples are not statistically diffferent

Table 7. Statistics for % fine sediment in Dave Creek.

Downsueam		*Upstream*		*Above pvt land*	
Mean	40.5625126	Mean	40.03889	Mean	4.08809524
Standard Error	6.15150912	Standard Error	6.059094	Standard Error	1.78665954
Median	35	Median	22	Median	1.19047619
Mode	100	Mode	22	Mode	0
Standard Deviation	30.7575456	Standard Deviation	33.18703	Standard Deviation	5.64991354
Sample Variance	946.026611	Sample Variance	1101.379	Sample Variance	31.9215231
Kurtosis	-0.3852834	Kurtosis	-1.34792	Kurtosis	-0.7134121
Skewness	0.70376633	Skewness	0.521789	Skewness	1.06037423
Range	97.5	Range	96.5	Range	14
Minimum	2.5	Minimum	3.5	Minimum	0
Maximum	100	Maximum	100	Maximum	14
Sum	1014.06281	Sum	1201.167	Sum	40.8809524
Count	25	Count	30	Count	10

t-Test: Paired Two Sample for Means

	Downstream	*Upstream*
Mean	40.5625126	41.12666667
Variance	946.026611	1159.741389
Observations	25	25
Pearson Correlation	-0.3133901	
Hypothesized Mean Difference	0	
df	24	
t Stat	-0.0536702	
P(T<=t) one-tail	0.47882109	
t Critical one-tail	1.71088232	
P(T<=t) two-tail	0.95764217	
t Critical two-tail	2.06389814	

ACCEPT NULL HYPOTHESIS

t-Test: Paired Two Sample for Means

	Upstream	*Above pvt land*
Mean	26.0166667	4.088095238
Variance	908.521296	31.92152305
Observations	10	10
Pearson Correlation	0.30532988	
Hypothesized Mean Difference	0	
df	9	
t Stat	2.397677	
P(T<=t) one-tail	0.02002507	
t Critical one-tail	1.83311386	
P(T<=t) two-tail	0.04005013	
t Critical two-tail	2.26215889	

REJECT NULL HYPOTHESIS

Table 8. Cumulative frequency distributions for % fine sediment on Dave Creek.

% Fines	Downstream	Upstream	Above Pvt land
O	.00%	.00%	50.00%
5	12.00%	10.00%	70.00%
10	20.00%	16.67%	80.00%
15	24.00%	36.67%	100.00%
20	28.00%	43.33%	100.00%
25	32.00%	53.33%	100.00%
30	44.00%	56.67%	100.00%
35	52.00%	56.67%	100.00%
40	56.00%	56.67%	100.00%
45	64.00%	56.67%	100.00%
50	68.00%	60.00%	100.00%
55	76.00%	63.33%	100.00%
60	76.00%	63.33%	100.00%
65	80.00%	73.33%	100.00%
70	84.00%	76.67%	100.00%
75	84.00%	80.00%	100.00%
80	84.00%	80.00%	100.00%
85	88.00%	90.00%	100.00%
90	88.00%	90.00%	100.00%
95	88.00%	93.33%	100.00%
100	100.00%	100.00%	100.00%

Table 9. Predicted survival rates from frequency distribution of % **fin**es.

	Percent of samples less than			**% survival**		
% Fines	Downstream	Upstream	Above Pvt land	Downstream	Upstream	Above Pvt land
0	0	0	0.5	0	0	50
5	0.12	0.1	0.7	12	10	20
10	0.2	0.166667	0.8	8	7	10
15	0.24	0.366667	1	4	20	20
20	0.28	0.433333	1	4	7	0
25	0.32	0.533333	1	4	10	0
30	0.44	0.566667	1	9	2	0
35	0.52	0.566667	1	4	0	0
40	0.56	0.566667	1	1	0	0
45	0.64	0.566667	1	0	0	0
50	0.68	0.6	1	0	0	0
55	0.76	0.633333	1	0	0	0
60	0.76	0.633333	1	0	0	0
65	0.8	0.733333	1	0	0	0
70	0.84	0.766667	1	0	0	0
75	0.84	0.8	1	0	0	0
80	0.84	0.8	1	0	0	0
85	0.88	0.9	1	0	0	0
90	0.88	0.9	1	0	0	0
95	0.88	0.933333	1	0	0	0
			Total:	44.886	55.405	100
			ratio:	2.23	1.80	
			Overall = (rearing + spawning)	7.8	6.3	

Table 10. Statistics for % Embeddedness in Dave Creek.

Dave Creek Embeddedness

Downstream		*Upstream*		*Above pvt land*	
Mean	63.2802	Mean	56.31158	Mean	7.023944
Standard Error	4.53863026	Standard Error	5.27901	Standard Error	2.723652
Median	69.725	Median	64.87	Median	2.65625
Mode	87	Mode	87	Mode	2.5
Standard Deviation	22.6931513	Standard Deviation	28.91433	Standard Deviation	8.612944
Sample Variance	514.979115	Sample Variance	836.0385	Sample Variance	74.1828
Kurtosis	0.10391374	Kurtosis	-1.41425	Kurtosis	5.032524
Skewness	-0.8824961	Skewness	-0.41054	Skewness	2.248328
Range	75.0625	Range	84.5	Range	26.44444
Minimum	11.9375	Minimum	2.5	Minimum	2.5
Maximum	87	Maximum	87	Maximum	28.94444
Sum	1582.005	Sum	1689.348	Sum	70.23944
Count	25	Count	30	Count	10

t-Test: Paired Two Sample for Means - Embeddedness

	Downstream	*Upstream*
Mean	63.2802	57.0162
Variance	514.979115	881.5313115
Observations	25	25
Pearson Correlation	-0.1543881	
Hypothesized Mean Difference	0	
df	24	
t Stat	0.78188771	
P(T<=t) one-tail	0.22096328	
t Critical one-tail	1.71088232	
P(T<=t) two-tail	0.44192657	
t Critical two-tail	2.06389814	

Accept **nnil** hypothesis - not significantly different

t-Test: Paired Two Sample for Means

	Upstream	*Above pvt land*
Mean	39.648	7.023944444
Variance	953.803	74.18280235
Observations	10	10
Pearson Correlation	0.432364	
Hypothesized Mean Difference	0	
df	9	
t Stat	3.65212	
P(T<=t) one-tail	0.00265	
t Critical one-tail	1.833114	
P(T<=t) two-tail	0.0053	
t Critical two-tail	2.262159	

Reject **null** hypothesis.

Table 11. Cumulative frequency distribution - embeddedness on Dave Creek.

% Fines	Downstream	Upstream	Above Pvt land
O	.00%	.00%	.00%
5	.00%	3.33%	70.00%
10	.00%	6.67%	80.00%
15	8.00%	13.33%	90.00%
20	8.00%	13.33%	90.00%
25	8.00%	20.00%	90.00%
30	8.00%	23.33%	100.00%
35	12.00%	33.33%	100.00%
40	12.00%	36.67%	100.00%
45	20.00%	40.00%	100.00%
50	28.00%	43.33%	100.00%
55	32.00%	46.67%	100.00%
60	40.00%	46.67%	100.00%
65	48.00%	50.00%	100.00%
70	56.00%	53.33%	100.00%
75	64.00%	53.33%	100.00%
80	68.00%	66.67%	100.00%
85	76.00%	80.00%	100.00%
90	100.00%	100.00%	100.00%
95	100.00%	100.00%	100.00%
100	100.00%	100.00%	100.00%

Table 12. Substrate score aud predicted population potential in Dave Creek.

Substrate Score & Bull trout

Parameter	Dave Creek Downstream	Dave Creek Upstream	Dave Creek Upper	Total
Stream length (mt)	3218	8688.6	1600	13506.6
Substrate Score	6.33	6.93	11.81	
Predicted Bull Trout Density	0.32	0.39	1.91	
Predicted population	131	524	520	1115
Potential Population	199	2636	520	3955

Potential production increase: 331%

Table 13. Results of stream-in-road survey on Dave Creek in Section 24.

Dave Creek road *9/12101*

(meters)

Inter-pool Jength	Max pool depth	Pool width	Pool length
49.5	0.12	0.5	1
19	0.15	0.2	0.7
4.3	0.13	0.1	0.5
205	0.18	0.5	1.2
46	0.11	0.5	1.2
1	0.18	0.6	1.3
4	0.34	0.7	1.7
10	0.15	0.4	0.8
13	0.2	0.8	0.9
44	0.3	I	I
10			
221.3	0.186	0.53	10.3

Dave Creek in
ROAD:

Total stream length=	221 meters (.14 mile)	
Pool Frequency =	23.16	meters of stream per pool
	69.5	Pools per mile
Dave Creek above Private Land		
Pool Frequency =	6.59	meters stream length per pool
	244	Pools per mile
Estimated reduction in productivity=	28%	
Potential recovery=	350%	

APPENDIX 2. GRAPHS

Figure 1

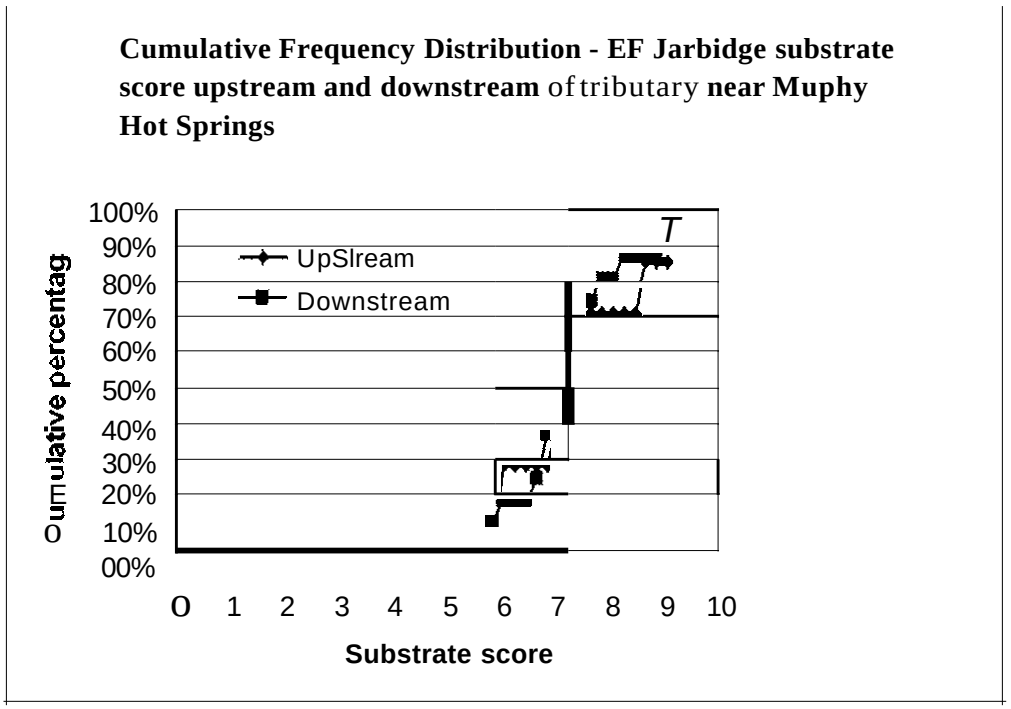


Figure 2.

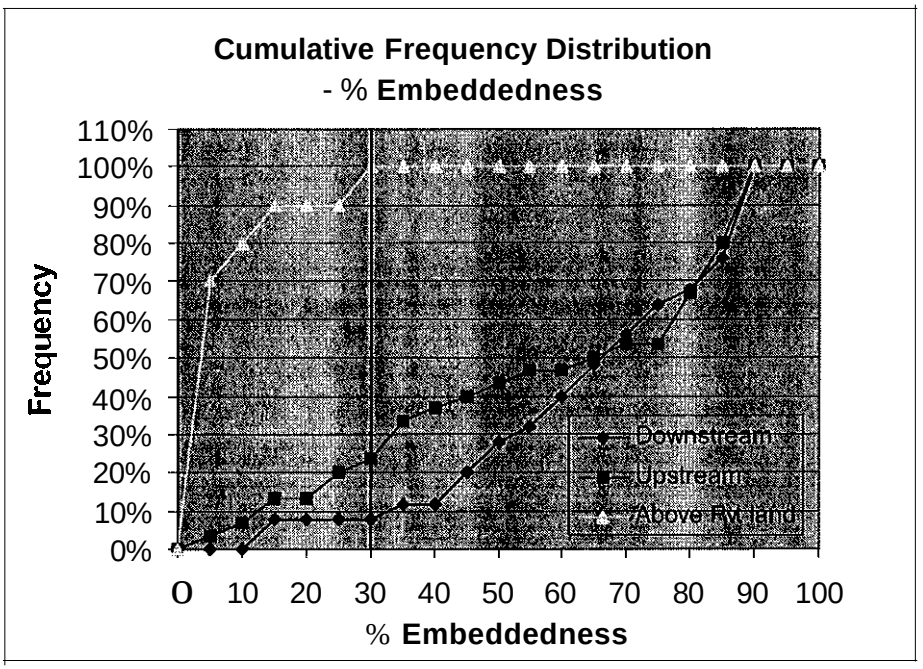


Figure 3.

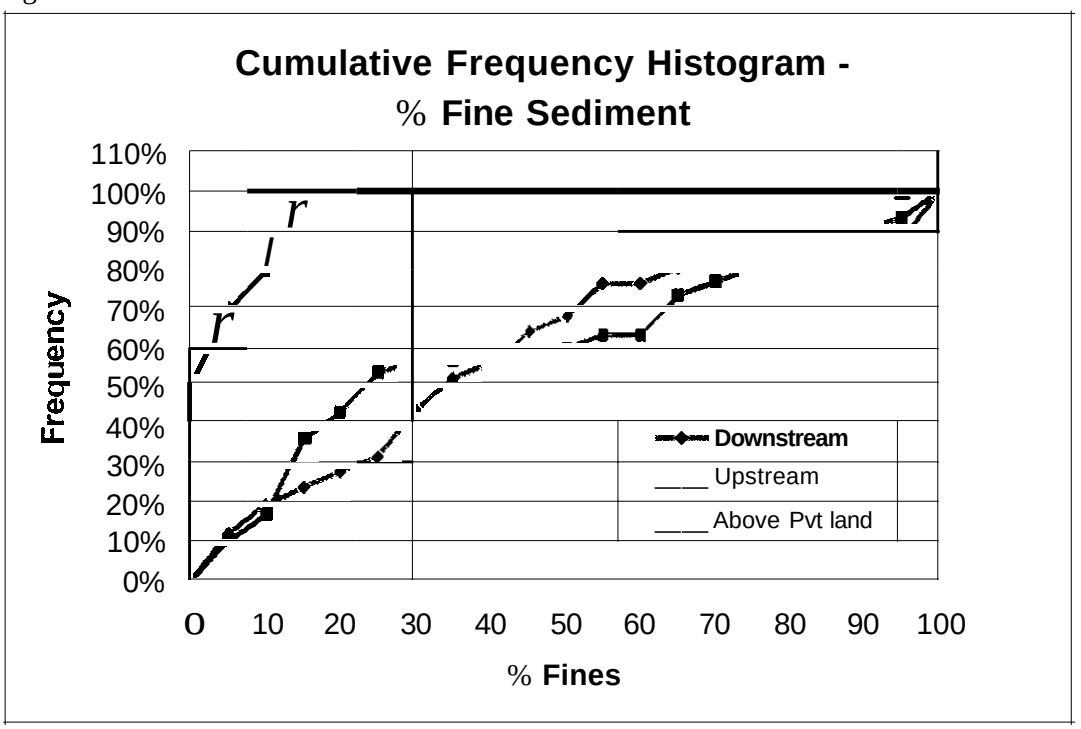
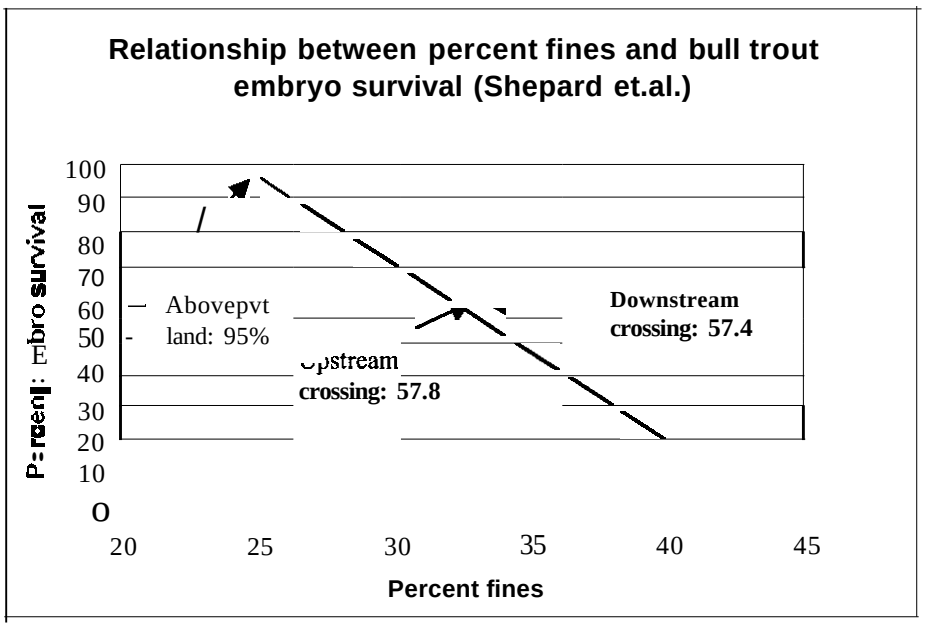


Figure 4.


Relationship between percent fines and bull trout embryo survival (Shepard et.al.)
100
90
80
70
60
50
40
30
20
10
O
20
25
30
35
40
45
Percent fines
Abovepvt
land: 95%
Downstream
crossing: 57.4
crossing: 57.8